Kenya National Highways Authority

Quality Highways, Better Connections

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY REPORT FOR THE PROPOSED CONSTRUCTION OF MAU MAU LOT 4: IHITHE - NDUNYU NJERU ROAD PROJECT.

Prepared and submitted by:

Norken International Ltd

ENGINEERING AND MANAGEMENT CONSULTANTS

CERTIFICATION

Report Title: Environmental and Social Impact Assessment study report of the proposed Ihithe-Ndunyu Njeru Road project.

FIRM OF EXPERTS:

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Disclaimer:

This Environmental Impact Assessment Project Report is strictly confidential to KeNHA (the Proponent) and any use of the materials thereof should be strictly in accordance with the agreement between the Proponent and with Norken (I) Limited (the consultant). It is, however, subject to conditions in section 34 of the Environmental (Impact Assessment and Audit) Regulation, 2003.

EXECUTIVE SUMMARY

Background

The Government of the Republic of Kenya (GOK) has earmarked funds through the Development Vote for the purpose of engaging the services of an Engineering Consulting firm to undertake a design review, tender documentation and construction supervision services for Ihithe-Ndunyu Njeru Road (Mau Mau Lot 4 Roads). The Government of Kenya, through its implementing agency, the Kenya National Highways Authority (KeNHA), awarded Norken International Limited the consultancy services contract for the Design Review and Construction Supervision of the subject Road.

The order to commence the work was issued by the Director, Development, Kenya National Highways Authority, through letter Ref. No. KeNHA/2445/2021 dated 16th September 2021 and an order to commence works was issued through letter Ref: KeNHA/0.5A/GOK/3541Vol. III dated 1st December 2021, effectively setting the commencement date as 14th December 2021.

The Kenya Government policy on all new projects requires that an Environmental and Social Impact Assessment (ESIA) be carried out at the project planning stages to ensure that significant impacts on the environment are taken into consideration. The ESIA must ensure that environmental consequences are considered at all stages of the project. In addition, the ESIA will assist KeNHA and its consulting engineers to implement the Proposed Project in adherence to sound environmental principles.

The ESIA is one of the studies undertaken which has resulted in this report. The ESIA has been conducted in line with the requirements of the laws of the government of Kenya particularly the Environmental Management and Coordination Act, 1999 and its subsidiary legislations as well as international best practices.

The specific objectives of this ESIA are as follows:

- Provision of an overall assessment of the social and biophysical environment affected by the project;
- Identification and detailed assessment of potentially significant impacts associated with the project;
- Identification and recommendation of appropriate mitigation measures for potentially significant environmental and social impacts;
- Public/stakeholder consultations to ensure that that the affected communities are engaged throughout the ESIA process and their issues and concerns addressed;
- Developing an Environmental and Social Management Plan necessary to minimize, mitigate any potential environmental impacts identified by the ESIA; and
- Preparation of an ESIA report (comprehensive project report) in accordance with the requirements of the Environment (Impact Assessment and Audit) Regulations, 2003.

Project Location

The project road is approximately 97.8 km long and is situated in Nyeri and Nyandarua Counties of Central Region. The main section starts at Ihithe, takes a south-westerly course through the Nyayo Tea Zone and enters the Aberdare National Park. The road then emerges from the park at about km 33 (Mutubio Gate). From this gate, the road descends through a series of hair-pin bends to Kahuruko. The stretch between Mutubio Gate and Kahuruko (approx. 10 kms) is tarmacked. From Kahuruko, the project road continues to descend and ends at its junction with the C69 Road at Ndunyu Njeru.

Other road sections included in the project are the Njengu- Treetops Gate - Amboni, the Ihithe - Kiamutiga - Mukarara, the Ark Gate Access, the Munyaka - Koinange - Heni - Mwendandu and the Njoma - Weru road sections, all totalling approximately 46 km in length.

Summary of Road Sections for the Project.

S. No.	Description of Road Section	Classification	Length (Km)	Location (County)
1.	Ihithe - Ndunyu Njeru	C509/C481/C482	52	Nyeri/Nyandarua
2.	Njengu - Treetops Gate - Amboni	G24520/G24452/R25-Nyeri	12	Kieni, Nyeri
3.	Ihithe - Kiamutiga - Mukarara	G24612/614/615/616	3.6	Nyeri
4.	Ark Gate Access Road	D1345	2	Kieni, Nyeri
5.	Munyaka - Koinange - Heni - Mwendandu	E1766/L3785	21	Nyandarua
6.	Njoma - Weru Road	L3782	7.2	Nyandarua
Total			**97.8**	

Project Alternatives

Designing road projects involves a complex decision-making process whose objectives should be the implementation of the road design and its utilization in the narrowest sense, but also the facilitation of mobility, economic development of the area and improvement of the quality of life in a wider sense.

All of this requires the consideration and understanding of many problems multi-criterial in nature, and decision making with regard to technical components, environmental constraints and the impact on society.

There are two main alternative routes to the proposed project.

a) Ndunyu Njeru through Olkalau-Nyahururu-Ndaragwa-ihururu - Nyeri town.
b) Ndunyu njeru-Njambini-Githuma-Othaya-Nyeri town.

The first route will take a road user 3hours 17 minutes to drive through and the second option 3 hours 46 minutes. The proposed road is the most fiable option since the road user will drive through the section for 1 hour 30 minutes saving them money and time.

The major consideration in the design of this road has been that the horizontal and vertical alignment will follow the existing track as much as possible to avoid heavy earthworks and unnecessary bridges and other drainage structures. The design standards were adopted to minimize both construction cost and interference with the environment. Details of the proposed road pavement design options and Pavement cost options are captured in chapter six of the report.

Legal and Administrative Framework

All the relevant national and county policies, laws, regulations and institutions were reviewed and discussed to ensure total compliance with the governing laws and regulations as well as contributing towards achievement of the objectives of the operational policies. Liaison with the identified relevant institutions will further contribute towards the success of the proposed project. The identified national policies, laws and guidelines include:

No	Legislation/Guidelines	Relevance to the project
1	The Kenyan Constitution,2010	The Constitution of Kenya provides for sound management and sustainable development of all of Kenya's natural resource related projects, both publicly and privately owned. The proposed project complies with the Constitution by proposing a structure in its ESIA on how to deal with Social, Health, safety and environmental issues for sustainable development.
2	Kenya Vision 2030	The project will lead to employment creation; local livelihood is expected to improve thus contributing positively to both economic growth rate and the engendering of just, cohesive, and equitable social development within a clean and secure environment.
	Policy framework	**Relevance to the project**
1	National Environmental Policy, 2013	The policy aims at better quality of life for present and future generations through sustainable management and use of the environment and natural resources. One of the principles of the policy which this project must adhere to is that the right to development should be exercised taking into consideration sustainability, resource efficiency and economic, social and environmental needs.
2	National Land Policy, 2009	The overall purpose of this policy and implementation is to secure and conserve all affected household's sources of livelihoods while protecting necessary cultural sanctity. Land acquisition is anticipated in the project therefore, the proponent in collaboration with NCL will address all issues related to land acquisition and compensation before the project commences.
3	National Biodiversity strategy,2007	This policy is triggered by any project with the potential to cause significant conversion (loss) or degradation of natural habitats, whether directly (through construction) or indirectly (through human activities induced by the project). The Environmental Monitoring Management Plan (ESMP) in the ESIA report has addressed all impacts related to degradation of natural habitats within the project area.
4	National Water Policy, 2012	The policy aims at ensuring a comprehensive framework for promoting optimal, sustainable, and equitable development and use of water resources for livelihoods

		of Kenyans.The contractor will be required to have necessary permits for water abstraction and also adhere to water pollution control as provided in the policy.
5	Gender Policy,2011	This policy should be adhered to by the contractor during initial project implementation, especially during hiring of staff, compensation /livelihood restoration processes, procurement of suppliers, and contracting of sub consultants / contractors.
6	Guidelines for prevention and control of soil Erosion in Road works,2010	The guidelines acknowledges that road works potentially result in environmental hazard through the spillage of carbon products, contaminating the surrounding land, dust and noise pollution, interference with the drainage pattern hence extensive soil erosion, the contractor will will be required to minimize environmental damage by adhering to these guidelines.
7	Environmental Guidelines for roads and bridges,2010	The guidelines require assessing environment before and after road construction period in order to achieve sound environmental management. It requires preparation of ESIA study report with is subject to this report.
8	Codes, specifications and Standards	Standard Specification Clauses 116, 117, 125, 135, 137 address protection of the environment, with regard to water, health, safety and accidents, water supply, maintenance of the engineers' staff houses, offices, laboratories, and attendance upon the engineer and his staff. The contractor will be required to adhere to it during all project phases.
	Legal Framework	**Relevance to the project**
1	County Government Act	Implementation of this project will also seek goodwill and approval of the County Governments of Nyeri and Nyandarua because the project will affect lives of populations within these counties.
2	Environmental Management and Coordination Act (EMCA), 1999 and the subsequent Amendment Act No 5,2015	EMCA outlines the requirements for EIA, environmental audits, monitoring procedures and environmental-quality standards. The proposed project will be undertaken in accordance with relevant sections of the EMCA, specifically Clauses 58 – 63. These sections of the Act are operationalized by subsidiary legislation promulgated under the Act and specifically Legal Notice (L.N.) 101: Environment (Impact Assessment and Audit) Regulations, 2003.
3	L.N. 101: EIA/EA Regulations, 2003 And 2016 Amendments	The proposed project is subject to relevant provisions of these regulations and subsequently, the ESIA has been undertaken in accordance with the requirements.
4	L.N. 120: Water Quality Regulations, 2006	The regulation provides for the sustainable management of water used for various purposes in Kenya. The contractor will be required to properly manage the effluent from construction activities in accordance with the above regulations prior to discharge into the environment.
5	L.N. 121: Waste Management Regulations, 2006	During the construction phase, the proposed project will generate various types of wastes. For the most part, it is expected that the wastes will be non-hazardous in nature and can be disposed of in accordance with the above regulations.
6	L.N. 61: Noise and Excessive Vibration Control Regulations, 2009	Based on the nature of activities during construction of the road construction sites, it is not envisaged that noise levels will exceed the limits given in this regulation. However, if any appointed contractor expects to generate noise levels in excess of the limits given in the table above, that contractor shall apply for a noise permit from NEMA for the duration of exceedance.

7	Environmental Management and Coordination Act (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006.	Documentation on the regulation states that project activities can only be carried out upon presentation of a comprehensive EIA report and licensing by NEMA. The regulations also empower lead agencies in the conservation and natural resource management to keep and update an inventory on the endangered species in the country. Safeguarding the ecosystem resources in accordance with the EIA License during the project implementation phase ensures compliance with these regulations.
8	Environmental Management and coordination (Air Quality), Regulation, 2014	During construction period, the Contractor will be required to ensure compliance to emission of the air pollutants levels in adherence to the Ambient Air Quality levels specified in the regulations. During the construction phase, there will be the need for establishment of baseline levels of priority air pollutants set out in the second schedule of the regulation under Part I; General source pollutants and include; particulate matter, nitrogen oxides and Sulphur oxides.
9	Environmental Management and Coordination Act (Fossil Fuel Emissions Control) Regulation,2006	This regulation is triggered in that the proponent will use vehicles and equipment that depend on fossil fuel as their source of energy. The contractor is expected to implemented the regulations in order to eliminate or reduce negative impacts air quality.
10	The forest Conservation and Management Act,2016	This Act provides for the development and sustainable management, including conservation and rational utilization of all forest resources for the socio-economic development of the country. The Proponent and contractors are expected to adhere to mitigation measures outlined in the ESMP in regard to vegetation clearance and the provisions of this act will be observed.
11	The Wildlife Conservation and Management Act,2013	The Wildlife Conservation and Management Act consolidate the previous laws relating to the protection, conservation, and management of wildlife in Kenya. This Act is administered by the Government of Kenya through the Ministry responsible for the matters relating to wildlife in conjunction with other relevant government agencies – most importantly, the Kenya Wildlife Service (KWS). Since the project area is within a wildlife zone, The contractor is expected to adhere to the provisions of this act.
12	Water Act, 2016	The Road construction activities will need bulk supply of water for mixing and curing concrete, suppressing dust, cleaning and maintenance of equipment, among others. The Act promotes water resources management through soil and water conservation, protection, development and utilization of water resources. The construction of the project road will have to apply water resource management measures since the project area has several lakes and small streams. Various permits from the Water Services Regulatory Board (WASREB) will be required for proposed water abstraction methods, whether surface or ground water.
13	Public Health Act (Cap.242)	The activities and operations of the proposed project can be detrimental to human and environmental health and safety in the absence of appropriate measures. For example, waste, dust, noise and air emission generated from these activities of the proposed project can directly or indirectly have adverse impacts on human and environment. It is therefore recommended that measures be taken in accordance to these Acts in order to safeguard the health of the workers and the public at large during project implementation and after commissioning.

14	National Transport and Safety Authority Act,2012	The project will adhere to NTSA's road safety rules, standards, and motor vehicle licensing requirements. In addition, all vehicles using the road will be required to adhere to these set rules and regulations.
15	Public Procurement and Disposal Act,2005	This Act establishes procedures for procurement and the disposal of unserviceable, obsolete or surplus stores and equipment by public entities. The contractor will be required to adhere to provisions of this act.
16	Physical and Land use Planning Act, 2019	The Developer will need to seek approval for the construction of the temporary camp (s), while KeNHA will be required to discuss its development plans (road designs) with the respective County Physical Planning Officers and liaise with the local governments in development control along the corridor.
17	The Work Injury Benefit Act,2007	The construction activities and operations may pose safety and health risks to construction workers. The contractor will need to abide by all the provisions of WIBA when handling injuries reported in the course of implementation of the proposed project.
18	The land acquisition Act, Chapter 295 laws of Kenya,2012	The implementation of the project will involve land acquisition and this should be done in accordance to this Act.
19	Land Control Act (Cap.302) Revised edition 2012	The Act controls transactions in land including sale, transfer and lease, the proponent will abide by this act during the land acquisition and compensation period.
20	The Lands Act, 2012 and Land Laws (Amendment) 2016	Part II Section 8 of Land Act, 2012 provides guidelines on management of public land by National Land Commission on Behalf of both National and County Governments. The proponent will be required to follow this legislation in regards to land acquisition in the project area.
21	National Land Commission Act No.5 of 2012	The National Land Commission will therefore play a very important role in the land acquisition process. The proponent should liaise with the National Land Commissions County Offices of Nyeri and Nyandarua counties on issues regarding land to ensure compliance with these provisions of the act.
22	Occupational Safety and Health Act (OSHA), 2007	This act was enacted to provide for the health, safety and welfare of persons employed in workplaces. The project construction site should be registered with this authority as workplaces before the commencement of the construction works and the safety management plans, training and emergency preparedness, done in accordance with the relevant guidelines issued by DOSHS.
23	Employment Act,2007	This is an Act of parliament that applies to all employees employed by any employer under a contract of service. The contractor will need to follow the requirements of the Act during employment, especially by being just and fair on recruitment, contract management, remuneration, and termination of service, as they are straight forward.
24	Mining Act,2016	The Contractor will need to comply with the Act by obtaining construction materials/minerals from licenced dealers. The possible material sources identified during material investigation undertaken for the proposed project are presented in chapter 2 of this report. The contractor may consider obtaining the materials from these existing sources or from new sources. In the event the contract decides to

		source the materials from their own new sites, then it should obtain mining licence as well as other licenses specified in this Act such as EIA Licence and comply with permitting requirements therein.
25	Valuer's Act, Cap 532	This act governs valuation practices in the country. The project proponent will comply with the Act by ensuring that registered / certified land valuers are involved in the proposed acquisition of private land for the proposed road realignment which will be carried out in line with the provisions of this law.
26	The Kenya Roads Act – (Cap 399) No. 2 of 2007	Section 23 of the Act outlines procedures for acquisition of land for the purpose of the Authority's development while Section 24 (1) allows any authorized employee of an Authority to enter upon any land and survey such land or any portion thereof for the purposes of the Authority's development activities. Section 24 (2) provides that where any damage to land is caused by reason of the exercise of the powers conferred by this section, the owner or occupier of the land shall be entitled to compensation therefore in accordance with this Act. By undertaking this project, the project proponent is exercising his mandate and, therefore, has the powers and duties to construct, upgrade, rehabilitate and maintain roads under its control.
	Climate Change Act, 2016	This is an Act of Parliament enacted to provide for a regulatory framework for enhanced response to climate change, to provide for mechanism and measures to achieve low carbon development. Part IV Section 15 provides on how Climate change considerations should be integrated in every public-sector entity. A public entity is expected to observe the Act together with provisions of the National Climate Change Action Plan. The National Climate Change Action Plan Section 4.3.1 (d) has specified how the road infrastructure sector can contribute towards the achievement of low carbon climate resilient sustainable development.
	HIV/AIDS Prevention and Control Act (Act No. 14 of 2006)	The Environmental Monitoring Management Plan (ESMP) in the ESIA report has addressed all impacts and mitigation measures to contain the spread of HIV/AIDs and STDs, The Contractor will be expected to liaise with available health facilities as well as the HIV/AID, STD prevention, awareness and training services providers during the project construction period.
	Sexual Offences Act, 2006	Implementation of a project creates changes in a community in which it is implemented and is has potential to can cause shifts in power dynamics between community members and within households. For instance, male jealousy is a key driver of Gender Based Violence (GBV) which can be triggered by labor influx on a project when workers are believed to be interacting with community women. Hence, abusive behavior can occur not only between project-related staff and those living in and around the project site, but also within the homes of those affected by the project.
	Children Act,2001	The Act also notes that a child shall be protected from sexual exploitation and use in prostitution, inducement or coercion to engage in any sexual activity, and exposure to obscene materials. Sensitization to the community on the need to ensure the protection of children has been done and will continue throughout the project cycle. In addition, the contractor will sensitize workers against abuse and exploitation of children.

Baseline environment

Bio-Physical features

The Ihithe - Ndunyu Njeru and Ihithe - Kiamutiga - Mukarara roads traverse generally flat to rolling terrain. The project commences at an altitude of about 2100m amsl. at Mukarara and rises quite sharply up to Kiandongoro then rises gently through undulating terrain up to Mutubio Gate. From there, the road falls sharply to Kahuruko and then gently up to Ndunyu Njeru at an altitude of 2420m a.s.l.

Vegetation along the project road is generally forest and farmlands. The Njengu - Treetops Gate- Amboni and Ark Gate Access roads also traverse generally rolling terrain and the vegetation along the road is generally forest and farmlands. The Munyaka - Koinange - Heni - Mwendandu and Njoma - Weru roads traverse generally flat terrain and the vegetation along the road is generally farmlands.

The project area is drained by 2 main rivers; namely Magura and Karimu.The climate in the project area is classified as cool and wet. The rains in the project area are fully influenced by the topographic effect and hence relief rainfall is experienced all along the alignment. The principal rocks in the project area are basalts, basaltic agglomerates (autobreccias), trachytes, phonolites, pyroclastic rocks and lacustrine deposits.

The habitat in the Nyeri Spur Roads consist of cropland, few wetlands (artificial), farm hedges and bushlands. Natural wetlands occur along the streams that crosses the road. Some of these were artificial wetlands that naturalizes due to colonization by aquatic macrophytes and inhabitation of wetland birds and other organism. This type of wetland occurs in the project areas especially where existing roads crosses drainage channels which are in the form of small streams and seasonal streams. The roads create a barrier for channel which creates a potential reservoir in the upstream of the road. Wetlands creating by this process is colonized by vegetation and becomes naturalized habitat that support immense number of birds and invertebrate species.

The habitat in the Nyandarua Spur Roads consist of grassland, cropland, wetlands (natural and artificial), farm hedges, and woodlots. Natural wetlands occur along the streams that crosses the road. Some of these were artificial wetlands that naturalizes due to colonization by aquatic macrophytes and inhabitation of wetland birds and other organism. This type of wetland occurs in the project areas especially where existing roads crosses drainage channels which are in the form of small streams and seasonal streams. The roads create a barrier for channel which creates a potential reservoir in the upstream of the road. Wetlands creating by this process is colonized by vegetation and becomes naturalized habitat that support immense number of birds and invertebrate species. Other artificial wetlands are in form waterpans constructed to hold water for community use including watering livestock. The vegetation features are constituted by Forest plantations near Geta, several woodlots and hedges forming fences to farm adjacent to the road. The northern spur road in Nyandarua terminates into an urban environment surrounded by dense human settlements.

Socio-economic

According to the County poverty index, 28.8 per cent of the population is living in extreme poverty conditions. The majority of these peoples are located in the slums of Nyeri Town, these include areas such as Majengo, Kiawara, colonial villages in Mathira, Kieni and Tetu.

Residents of Nyeri County that are landless and reside in villages nearby forested areas fall under this bracket as well. In Nyandarua County, poverty level in the County is at 46%. In urban areas, high unemployment especially among the youthful population expose majority of them into anti-social behaviors especially excessive consumption of illicit brew.

Nyeri and Nyandarua Counties are predominantly agricultural areas with farm holdings that are generally small. The main food crops grown in Nyeri County, for example are maize and irish potatoes while the cash crop include tea, coffee, fruits and horticultural crops.

In Nyandarua Counties, the main food crops include maize, beans, peas, potatoes, cabbages, carrots, kales, onions and tomatoes, while the cash crops comprise of wheat, pyrethrum and cat flowers. Nyandarua County has great potential for food crops and upgrading of the roads will increase market access. Gazetted forests and Aberdare National Park are other land uses.

Consultations and Public Participation

The stakeholder engagement exercise commenced in February 2022.During the exercise, the consultant identified the various stakeholders of the project such as the National and County government stakeholders, various organisation representatives and project affected persons along the project area. This was done to develop an understanding of their stakes, interests and influences on the project. It also aided in understanding stakeholder views on the project and in identifying issues that should be taken into account in the prediction and evaluation of impacts. The consultant engaged the stakeholders through Courtesy visits, public meetings, key informant interviews and Surveys through questionnaire administration. The key outcomes of the stakeholder consultation process are summarised in chapter 6.

Impact Assessment and Mitigation

The potential environmental and social impacts associated with the Project were assessed based on field inspections and literature sources. The assessment found that most impacts associated with the Project are of a temporary nature resulting during construction and can be minimised by good engineering practice and implementation of appropriate safeguards as outlined in the ESMP.

The biophysical impacts of the Project are expected to be minimal and short term. The proposed roads will follow the existing alignment and therefore they are not expected to significantly affect the bird areas. Much of the vegetation along the route has been disturbed by mixed subsistence farming such that there is unlikely to be a loss in biodiversity of plants or vegetation communities.

Because of the construction of the proposed roads will occur within the existing corridor, it is anticipated that the Project will have minimal impact on communities or persons, and on private or common property assets. However, compensation will be due where Project right-of-way (ROW) result in land-take, partial or total removal of residential and commercial buildings and trees cultural properties such as churches, mosques, or archaeological sites. Although the Project will have minimal impact upon PAPs, site-specific relocation may have to occur where the road is to be re-aligned.

Project impacts are anticipated to occur predominantly during the construction phase with the construction of work camps, temporary access roads and construction of the roads. While major attention will be focused on loss of income due to temporary disturbance to crops, and on health

conditions related to the influx of construction workers from other areas (HIV/AIDS being the major concern), positive opportunities to PAPs may be presented in the form of temporary employment, as well as through income generated by the sale of food to immigrant workers. For the most part, however, compensation is expected to be characterized by small payments for the loss of assets.

To address the impacts related to loss of assets indicated above, a resettlement action plan will be prepared for the project. A summary of positive and negative environmental and social impacts as well as their significance pre-and post-mitigation are provided below;

Positive impacts

- Employment and income generation
- Skill development
- Stimulation of local Economy
- Reduction of vehicle operation cost and travel time

Negative impacts

Environmental Impacts

Impact	Significance (pre-mitigation)	Residual Impact (Post mitigation/ enhancement)
Impact on vegetation cover	High	Low-Medium
Potential human-Wildlife conflict	Low-Medium	low
Wildlife Poaching	Medium	Low
Barrier to Elephant movement	Medium-High	Low
Barrier to Rhino movement	Medium-High	Medium-Low
Impact on Aberdare Cisticola	Medium-High	Low-Medium
Impact on Aesthetic Value	High	Low
Solid Waste Pollution	Medium high	low
Accidental Oil Spill	Medium High	Low Medium
Impacts on conservation of the grey-crowned crane	Medium -high	Very Low
Impacts of road construction on aquatic biodiversity	Medium -high	Very Low
Potential collision with low flying birds	Medium -high	Low
Pit falling effect on some reptiles and amphibians, and rodents	Medium -high	Very Low
Impact on Introduction of Alien Invasive Plant Species	Medium -high	Low

Accidental killings of reptiles, amphibians, small mammals and low flying birds crossing the roads during operation phase	Low	Low
Potential flooding Incidences on farms	Medium -high	Low
Potential erosions of farmlands along the proposed road	Low-Medium	Low
Pollution of streams, rivers, reservoirs by loose soil	Very high	low
Draining of wetland habitats and poor resilience to climate change	Very High	Low

Socio-Economic Impact

Impact	Significance (pre-mitigation)	Residual Impact (Post mitigation/ enhancement)
Impact on Labor and Working Conditions	Medium	Low
Increased transmission of HIV/AIDS and Other STIs	High	Low - medium
Impacts on Employment, Procurement and the Economy	Low	Low
Loss of Property and Livelihood Sources	High	Low medium

Environmental and Social Management and Monitoring

All the recommended mitigation measures for the identified impacts have been summarized in the table below. Chapter 8 of the report outlines ESMP with clear monitoring indicator for each of the impacts and responsibilities to ensure effective implementation and management of the impacts.

It is expected that effective implementation of the ESMP will maximize the project benefits whilst minimizing all the associated negative impacts to acceptable levels.

	Anticipated Impacts	Mitigation Measures
	Construction phase	
1	Reduced vegetation cover and above-ground biomass	-Cleared trees should be kept within the forest and should be used in order to prolong period of carbon emission. -Sites should be identified for offsetting the loss of forest cover and biomass. This will require an adoption of compensation plan
2	Potential Human-Wildlife conflict	-Construction of the road should be conducted faster to minimize potential diversion of animal movements. -Excavation of deep long channels should be avoided.

3	Wildlife Poaching	-KWS should screen contractor personnel working in the project. -Contractor should work within the construction space of the road and designated construction camp. -KWS should screen contractor's construction plant, equipment, containers, etc. -Security in the region should enhance surveillance on vehicles
4	Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	-Construction of road should be conducted faster during dry season to allow for natural dispersal tendency of wildlife during wet seasons; -Crossing ramps should be put in place where temporary trenches are constructed; -Avoid deep trenches as much as possible; -Provide drinking water troughs and mud puddles away from the roads.
5	Impact on aesthetic Value	-Plant grasses, lianas and climbers on cut slopes; -Level of road fillings on valleys should be synchronized with the gradient of the topography in the valleys; -Trees should be planted near the road reserve to moderate on visual intrusions; -Structures should be painted green colour; -Control the spread of solid wastes in the protected areas; -Control introductions and spread of AIPS.
6	Solid waste pollution	-Dumping used foods, food covers and water bottles **Construction waste** -Contractor to provide solid waste storage bins and skips; -Contractor to ensure that the solid waste collected is disposed of in an approved dumpsite.
7	Accidental oil spill	-Contractor should have well maintained engines and equipment to avoid accidental oil leakages; -Construction camp should not be established within the Protected Areas (National Park and Forest Reserve); -Construction should be confined during dry seasons only to avoid rains washing oily equipment and machines; -All Earthmovers, vehicles and equipment should be removed from the water tower before the onsets of rainy seasons; -Clear spills immediately they occur.
8	Pollution of streams, rivers and reservoirs	-Avoid generating piles of soils along the road; -Cover piles of soils with waterproof materials to prevent erosion; -Excess generated loose soils should disposed safely
9	Draining of wetland and poor resilience to Climate Change	The contractor Construct barrier before the road crossing to prevent water from wetland drained when channel is excavated for bridge construction
10	Impact on conservation of the grey-crowned Crane	Active feeding of the Grey-crowned Crane is mostly in the early morning and in the evening. -Construction on site should begin from 8am and ends at 4pm to allow the birds including other wetland birds to forage

11	Potential road kill of the Aberdare Cisticola	-Introduction of speed bumps specifically towards the mooreland valleys; -Avoid clearing of tall vegetation on valleys to allow these birds to scale flight height higher than the height of cars. - Plant the indigenous shrubs and trees near the valleys to control the flight speed of the bird and allow this bird to scale its flight higher once the trees grow taller.
12	Introduction of Alien Invasive Plant Species	-Equipment to be used should be decontaminated; -Always avoid the top surface of the soil from borrow pit when excavating gravels for road reinforcements in order to avoid transporting AIPS propagules to new areas; -Since AIPS appears later after soil disturbance, aftermath proliferation of AIPS should be controlled by regularly reducing their population and recruitment.
13	Pitfalls resulting from excavation of trenches	-Provide a temporary crossing over the trench to enable the small mammals, reptiles and amphibians cross easily before backfilling of soil is done. -Construction personnel should provide a ramp to enable trapped animals to get out and monitor trenches for animal rescue.
14	Potential collection of live specimens of chameleon	-Contractor personnel should be educated on CITES in order to understand how to protect species from collection of live specimens -Environmentalist expert should be incorporated in the personnel team to monitor on incidences of collection of live specimens
15	Accidental killings of reptiles and rodents crossing the roads	-The contractor to employ proper methods of bush clearing and excavation to minimize this impact.
16	Climate Cange impact	-To mitigate this the workers should be trained on management of air pollution from vehicles and machinery. -All construction machinery shall be maintained and serviced in accordance with the legal requirements and the contractor's specifications.
	Social	
1	Exposure of Workforce to Poor Labour and Working Conditions (Pre- Mitigation)	-Regular checks by KWTA should be undertaken to ensure the relevant labour laws and occupational health and safety plans are adhered to at all times. -All project workers should, as part of their induction, receive training on health and safety -KeNHA will put in place mechanism to ensure no employee or job applicant is discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation. -All workers will have contracts which clearly state the terms and conditions of their employment and their legal rights. Contracts will be verbally explained to all workers where this is necessary to ensure that workers understand the provisions. Contracts must be in place prior to workers reporting to duty for the first time. The contract document will be enhanced by the Code of Conduct that will be provided by the Proponent.

		-The Proponent and the Contractor will put in place a worker grievance redress mechanism accessible to all workers, whether permanent or casual, directly or indirectly employed. The Proponent worker grievance mechanism shall be open to the Contractor workforce in the event that their grievance is not adequately resolved by their direct employer. The Proponent will then have the authority to act to resolve this grievance. -All project workers should have access to training on communicable diseases and STDs and community interactions in general. This training will be developed in collaboration with local health institutions. -Contractor should ensure that all the laborer's are over 18 years of age
2	Increased transmission of HIV/AIDS and Other STIs	-The Contractor should develop and implement pre-employment screening measures for workers, which should include applicable diseases. Individuals found to be suffering from these diseases will need to be sensitized on prevention of transmission to others and management of the disease prior to mobilisation to site. -The Contractor should develop and implement a HIV/AIDS and other STIs policy and an information document for all workers directly related to the Project. The information document should address factual health issues as well as behaviour change issues around the transmission and infection of HIV/AIDS and other STIs. -The Contractor will make condoms available to employees and communities neighbouring the site office during construction ➢ All project personnel should be inducted on a Code of Conduct that gives guidelines on worker-worker interactions, worker-community interactions and development of personal relationships with members of the local communities. ➢ As part of the Code of Conduct, the Proponent should explicitly forbid all Project personnel as well as the Contractor staff from engaging in illicit activities including procuring of commercial sex workers which could affect the reputation of the Agency and or its relationship with communities. Anyone caught engaging in illegal activities should be subject to disciplinary action. If workers are found to be in contravention of the Code of Conduct, which they will be required to sign at the commencement of their contract, they will face disciplinary action including dismissal from duty
3	Impacts on Employment, Procurement and the Economy	➢ The Project should prioritise the employment of labour from the local villages in the first instance especially for unskilled and semi-skilled positions. In the event the position cannot be filled from the project area, labour should be sourced in order of preference from neighbouring communities within the Counties. ➢ The Proponent should adopt a fair and transparent employment and procurement strategy to avert any potential favoritism. The strategy should be well understood by local communities.

		➢ Employment should be fairly distributed among the local ethnic representations to avoid any conflict over the project. ➢ KeNHA should notify identified representatives of the County Government and Public Administration (i.e. the County Commissioner's office) of the specific jobs and the skills required for the Project, prior to the commencement of construction. This will give the local population time, prior to the commencement of construction, to identify persons with the relevant skillset to be employable in the Project. ➢ The Project should prioritise the procurement of raw materials from Nyeri and Nyandarua Counties. In the event that goods and services cannot be procured from within the Counties, then preference should be given to regional companies. The Contractor should however aim at procuring locally available materials where feasible and use local suppliers where appropriate.
4	Loss of Property and Livelihood Sources	➢ Further the process should identify persons who have been affected in this regard, with an aim of generating their socio-economic profile to determine which alternative intervention can be suitable to help them cope with their loss. ➢ Consider implementing suitable alternative livelihood options as supported by local conditions and as proposed by the affected communities would entail: job opportunities in the project, setting up tree nurseries, tea farming, bamboo plantation, bee keeping for honey production, dairy farming, establishing medicinal herb garden etc. ➢ The local leaders including special interest groups such as village elders, women, youth and political leaders should be involved and consulted in identification of interventions and restoration of community livelihoods ➢ Positive interventions geared towards capacity building and restoration of livelihoods may attract those who were not affected and these may in turn lead to competition for limited slots in the various opportunities. For this reason, the Proponent should work closely with the local leaders to ensure a fair, transparent and inclusive process. ➢ Establish a community grievance redress mechanism to address concerns arising from the community and to avoid conflict.
	Operation Phase	
1	Wildlife Poaching	Security in the region should enhance surveillance on vehicles
2	Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	Provide drinking water troughs and mud puddles away from the roads
3	Potential road killing of the Aberdare Cisticola	-Introduction of speed bumps specifically towards the mooreland valleys -Avoid clearing of tall vegetation on valleys to allow these birds to scale flight height higher than the height of cars.

		-Plant the indigenous shrubs and trees near the valleys to control the flight speed of the bird and allow this bird to scale its flight higher once the trees grow taller
4	Impact on aesthetic Value	-Level of road fillings on valleys should be synchronized with the gradient of the topography in the valleys -Trees should be planted near the road reserve to moderate on visual intrusions -Structures should be painted green colour -Control the spread of solid wastes in the protected areas -Control introductions and spread of AIPS
5	Accidental oil spill by vehicles or during mentainance	-Vehicles using the road should qualify for vehicle inspection in order to ensure they are well maintained - Oil spills should immediately be cleared from road and containers of oil removed from the road side
6	Impact on conservation of the grey-crowned Crane	Conservation awareness and education should be provided to local and road users on conservation need for the species
7	Introduction of Alien Invasive Plant Species	Physical uprooting of AIPS recruitments before the develop seeds
8	Potential collection of live specimens of chameleon	Road users should be educated on CITES in order to understand how to protect species from collection of live specimens - The Public Service Vehicles should not allow carrying of wild animals or specimen or part of the species in the vehicle.

Conclusion

Based on the assessment undertaken for the proposed project it is unlikely that the Project will have significant adverse environmental and social impacts. Most adverse impacts will be of a temporary nature during the construction phase and can be managed to acceptable levels with implementation of the recommended mitigation measures in the ESMP for the Project such that the overall benefits from the Project will greatly outweigh the adverse impacts. The team therefore finds no reason why the Project should not be authorized, contingent on the mitigations and monitoring for potential environmental and socio-economic impacts as outlined in the ESMP.

LIST OF ACRONYMS

AIPS	Alien Invasive Plant Species
CITES	Convention on International Trade in Endangered Species
CIDP	County Integrated Development Plan
CDF	County Development Fund
DOSHS	Directorate of Safety and Health Services
EA	Environmental Audit
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EN	Endangered Species
ESIA	Environmental and Social Impact Assessment
ESF	Environmental and Social Framework
ESS	Environmental and Social Standards
ESMP	Environmental and Social monitoring Plan
GoK	Government of Kenya
GRM	Grievance Redress Mechanism
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
KeNHA	Kenya National Highway Authority
KeRRA	Kenya Rural Roads Authority
KCC	Kenya Cooperative Creameries
KII	Key Informant Interviews
KURA	Kenya Urban Roads Authority
KTWA	Kenya Water Towers Agency
KWS	Kenya Wildlife Service
KShs.	Kenya Shillings
LC	Least Concern
L.N	Legal Notice
LPG	Liquefied Petroleum Gas
NEMA	National Environment Management Authority
NMT	Non-Motorized Traffic

OSHA	Occupational Safety and Health Act
PAP	Project Affected Persons
RAP	Resettlement Action Plan
STDs	Sexually Transmitted Diseases
TVET	Technical and Vocational Education Training.
VU	Vulnerable Species
WHO	World Health Organization
WIBA	Work Injury Benefit Act

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1 INTRODUCTION

1.1 Background

Kenya National Highway Authority is a statutory body established under the Kenya Roads Act of 2007.KeNHA is responsible for the development, rehabilitation, management and maintenance of all National Trunk Roads.Recognizing the importance of infrastructure to sustainable economic development of the country, The Government through implementing agency, (KeNHA) is proposing to upgrade the existing road alignments of Ihithe-Ndunyu Njeru Road.

The order to commence the work was issued by the Director, Development, Kenya National Highways Authority, through letter Ref. No. KeNHA/2445/2021 dated 16th September 2021 and an order to commence works was issued through letter Ref: KeNHA/0.5A/GOK/3541Vol. III dated 1st December 2021, effectively setting the commencement date as 14th December 2021.

The overall objective of the project is to attain a sustainable, safe road network, which facilitates economic growth and improves living standards in Kenya and the specific objectives of this contract are to ensure that the Project Roads are upgraded to bitumen standard to enhance accessibility for socio-economic development.

The Kenya Government policy on all new projects requires that an Environmental and Social Impact Assessment (ESIA) be carried out at the project planning stages to ensure that significant impacts on the environment are taken into consideration. ESIA ensures that Environmental consequences are considered at all stages of the project. In addition, the ESIA will assist KeNHA and its consulting engineers to implement the Proposed Project in adherence to sound environmental principles.

The ESIA is one of the studies undertaken which has resulted in this report. The ESIA has been conducted in line with the requirements of the laws of the government of Kenya particularly the Environmental Management and Coordination Act, 1999 and its subsidiary legislations as well as international best practices.

1.2 Project Feasibility

The project Roads routes are of strategic importance to the economic well-being of the project area and the country at large. These routes need to be maintained and improved to enhance movement between the region and the rift valley and accommodate increased traffic volumes. The assessment has indicated that the improvement of the roads would be a feasible route to open up vast areas of vegetable and tea growing hinterland hence improve the economy of the area. Ultimate viability hinges on construction cost, traffic volumes, traffic growth, possible revenue streams, and other factors; looking at all these variables, the proposed upgrade is feasible.

1.3 ESIA Team

In line with EMCA, 1999 and EIA/EA regulations of 2003 and their subsequent amendments, KeNHA has appointed an Independent Consultant; Norken International Limited, a firm registered with NEMA to undertake ESIA for the proposed project.

Norken is experienced in environmental management and assessment, familiar with the EIA requirements for road development and rehabilitation projects, and has worked in the project area. Additionally, Norken is well known for its integrity, independence and skill in assisting stakeholders to participate in the ESIA process. The team involved in the assessment include:

Table 1-1 ESIA/RAP Team Composition

Team Member	Position
Isaiah Kegora	Lead EIA Expert
Dr. Dickens Odeny	Lead EIA Expert, Biodiversity Expert
Loise Kioko	Associate EIA Expert
Beatrice Githinji	RAP Expert/Senior Sociologist
Eng. Kipchirchir Daniel Chepsiror	Hydrologist
Eng. Alex Wawire	Highway Engineer
Joseph Muthike	Surveyer

1.4 Objectives of the ESIA

The purpose of the ESIA is to ensure that project activities under consideration are environmentally and socially acceptable and potential impacts from the Project are properly assessed and mitigated. The assessment was also conducted to ensure that the project complies with the Kenya's EMCA and the Environmental (Impact Assessment and Audit) Regulations.

The specific objectives of the ESIA are to:

- Provide an overall assessment of the social and biophysical environment affected by the project;
- Identify and detail assessment of potentially significant impacts associated with the project;
- Identify and recommend appropriate mitigation measures for potentially significant environmental and social impacts;
- Public/stakeholder consultations to ensure that that the affected communities are engaged throughout the ESIA process and their issues and concerns addressed;
- Develop an ESMP necessary to minimize, mitigate any potential environmental impacts identified by the ESIA; and
- Prepare an ESIA-Comprehensive Project Report in accordance with the requirements of the Environment (Impact Assessment and Audit) Regulations, 2003.

1.5 Rationale of ESIA Study

An Environmental and Social Impact Assessment (ESIA is an initial requirement for implementation of a proposed road project since permit is needed prior to construction. ESIA predicts consequences of the proposed project on the environment and social receptors. It is carried out before project implementation and proposes measures to mitigate potential negative impacts. An ESIA has two aims:

1) To minimize or avoid adverse environmental and social effects before they occur;

2) To integrate environmental and social concerns into decision-making.

An ESIA is a process that consider community engagement and acceptance, technical design, construction, and operation. It involves public participation and external consultation as well as the development and comparative assessment of alternative approaches.

1.6 Scope of the ESIA Study.

The ESIA scope encompasses assessment of the environmental, socio-economics aspects potentially affected within the project foot-print. These include the immediate area of the project location and areas of influence adjacent to the project location. These are Ihithe – Kiandogoro gate, Kiandogoro Gate – Mutubio gate, and Mutubio gate to Kahuruko. General background information is generated through a review of the environmental and socio-economic status of the project location in context of the region. The review also covers policy, legislation and regulatory framework related to the project and management of associated impacts.

Environmental issues covered in the assessment consist of the ecological baseline assessment, and water quality, noise and air pollution. The ecological issues covered included species richness (diversity), distribution on landscape, breeding sites, and movements of biodiversity taxa such as the mammals, herpetofauna (reptiles and amphibians), birds and invertebrates (terrestrial and aquatic benthics). Water quality parameters outlined for the assessment were the pH, Temperature, of streams and rivers, ponds and waterpans adjacent to the road. Assessment of noise level and air quality establishes the baseline and change of levels with distance from the road to receptors.

The approaches to the assessment are mainly through reconnaissance, rapid assessments and desktop reviews (literatures and database). Conservation status of species under biodiversity taxa are analyzed using the IUCN red list of threatened species and only the threatened species identified are further scrutinized for impacts from the proposed road project. Impacts of the proposed road project are identified through the findings from the reconnaissance and rapid assessment. Mitigation measures are only recommended for impacts identified with significant negative effects on the environment and socio-economic status of the local people. The environment and social monitoring and management plan (ESMMP) is drawn only from the impacts with significant negative effects stipulating indicators for monitoring, and actions for management.

1.7 Methodology and Approach.

1.7.1 Environmental and Social Data Collection Approach

A preliminary reconnaissance survey and literature review was used for identifying conservation issues within the proposed Project Roads. Through this, scope of environment and social study for the proposed project was developed. This was followed by field survey and desktop analysis.

1.7.2 Field Reconnaissance

Reconnaissance study was preliminarily conducted to determine environment and social issues along the proposed project roads. It was conducted with the objectives of;

- Familiarizing with the location and orientation of the proposed Roads;
- Identifying potential ecological issues that would be affected by the potential construction and operation of the Roads;
- Developing the scope for environmental and socio-economic baseline study and impact assessment for the proposed Roads;
- Assisting with proper planning for baseline study (desktop and field surveys).

During reconnaissance, the proposed project location was surveyed to identify potential environmental processes and social issues that would be affected negatively or positively along the road alignment. A number of issues were identified as matters of ecological concern from the proposed project. This included interaction of the project with;

- Ecological behaviours of wild animals –
  - ✓ movement/migration routes
  - ✓ breeding patterns
  - ✓ foraging/predation behaviours
  - ✓ watering points
- Triggered Human – Wildlife Conflict
- potential poaching for bushmeat and trophy
- Pit falling of reptiles and amphibians, and rodents
- Road kill of herpetofauna, rodents, birds
- Elevation restricted habitats and species of plants and animals
- Draining of wetland habitats
- Draining or discharge of groundwaters
- Piles of loose sediments: siltation of wetlands, earth dams, water pans, streams and fish ponds on downstream
- Triggered erosion on downstream of the road by accumulated runoffs
- Tree species and population
- The above-ground carbon stock
- Introduction and spread of invasive species
- Micro-climate patterns: precipitation (fog/mist), temperatures

1.7.3 Consultation and Public Participation

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

Data on environmental impacts and stakeholder perceptions, views and concerns were collected through public consultation meetings, Key informant interviews with various organisation representatives along the project area, Courtesy visits to the County commissioners and questionnaire administration to the respondence along the project area.

1.7.4 Ecological Field Study

Detail study on environment was conducted by desktop review and field observation. Additional information was derived from interviews with few local residents to improve the knowledge of fauna species distribution in the area that was not possible to record within the study period. The result of interview on fauna distribution were validated using relevant guide books for each taxa. The study covered biodiversity taxa in the following groups; mammals, birds, invertebrates, fish, amphibians and reptiles in aquatic and terrestrial systems. Field sampling for aquatic survey were conducted along the proposed roads.

1.7.4.1 Aquatic macroinvertebrate survey

Aquatic benthic macroinvertebrate considered for survey are species that can be retained by a 1 mm mesh screen. These species potentially include aquatic insects such as mayfly, dragonfly and caddis fly (larvae), aquatic worms, amphipods (scuds), leeches, clams and snails. Kick-sampling was used for three minutes, kicking/sweeping water media using a standard 1 mm mesh pond (hand) net. Loose pebbles were turned to observe invertebrates hiding under stones. Physical observation was made on dragonflies and damselflies along the river within the riverine system. Identification was conducted in the field and further in the laboratory.

Figure 1-1 Sampling of aquatic macro-benthic invertebrate using kick-sampling method with pond net

1.7.4.2 Water quality parameters:

Water quality parameters that were measured include pH, temperature, the total dissolved substance, and electrical conductivity. Measurements were conducted using Hansatech Instruments for the above parameters (Fig 1-2).

Figure 1-2Water quality parameter measurement on wetlands and streams within the Mau Mau Lot4 Road Clusters

1.7.4.3 Fish sampling

Fish sampling were carried out using pond net in different parts of the rivers crossing the road. Sampling of fish were carried out on lotic and lentic parts of the rivers. Pond net is convenient in riverine areas with shallow pebble/stony areas. With this approach, any caught fish is released back to the river.

1.7.4.4 Mammal survey

1.7.4.4.1 Small Mammals Survey

This group was sampled using Sherman live traps that was set on 10 trap stations along the Line Transect. At each station, two 8.3x9.3x23 cm Sherman live traps (H. B. Sherman Traps, Tallahassee, Florida, USA) were placed on flat ground at the likely capture spots. The traps were baited with the mixture of oat, peanut butter and cooking oils (Eymann, 2010). A 3 days trap session was conducted at each station. Captured animals were photographed, identified to species level, where possible, in the field using the keys provided in Kingdon (1997). They were released back into the habitat where they were caught.

1.7.4.4.2 Large mammal survey

Large mammals were surveyed on line-transects at a walking speed of 1km per hour. The survey was conducted between 8.00 to 11.00 am when the species are active. Where the animal was not observed, dug and pellet, and trail (tracks) were used for further identification of species occurrence.

a) Dung and Pellet Survey

Many animals leave behind a number of signs of their presence, such as dung, pellets, nests or tracks, which are often much easier to quantify than the animals themselves. Indirect counts provide qualitative data regarding relative use of habitat by herbivores. Line transect sampling was used to allow for observation and identification of the animals (Marques et al., 2001). Transect was 1000 meters in length. Identification of dung and pellets were carried out in the field with the help of field guide.

b) Trail sampling, scanning and sign surveys

Trail sampling were used for detection of mammals in different habitats of the study area. Trails were identified for observation the Line Transect. Scan sampling and sign surveys were carried out along trails, ridges and streams once in each of the other four sites.

1.7.4.4.3 Herpetofaunal sampling

Visual Encounter Survey protocol with time constrained searches (Heyer et al 1986) were used for Systematic searches along the Line Transect at a speed of 1 km/hr along the proposed road alignment. While on the river, searches were made for frogs and toads including their tadpoles and eggs. The trapped live specimens were released back into the river.

1.7.4.5 Bird sampling

Bird survey were conducted using Point Counts along the proposed spur-roads in Nyeri. The survey was conducted from very early in the morning; from 6am to 9am in each site. Bird species were identified based on direct observation and their unique calls they make. Photographs of birds were taken as evidence and to assist in the identification and verification of the species identities. Physical observation of wetland birds was conducted on wetlands along the transects. Opportunistic sampling of birds was conducted from 9am to 11am and in the evening from 4pm to 6pm.

1.7.4.6 Terrestrial Invertebrate Sampling; Sweep net sampling

Sweep netting was used as a technique for sampling terrestrial invertebrates on herbaceous vegetation. Ten sweeps, one taken at each step, to constitute a sample were conducted randomly on selected points at point locations and on Line Transect. The collector followed a standard route each day at each sample location, between 08:00 and 12:00 hours, and from; 14:00–18:00 hours. At each sampling location the collector made sweeps of the vegetation tops of understory vegetation with a 40 cm diameter sweep net. The net contents were observed and released back into their habitat. Additional physical observations were made on the side of the road for opportunistic sampling.

1.7.4.7 Plant sampling

The plot-less method was employed on point locations along the Proposed Roads, and along the line transects. The identification was done with reference to the field guide books. Photographs were taken for representative plant species or vegetation formations occurring in the riverine system.

1.8 Validation of Species of Conservation Importance

These are threatened species listed under IUCN red list, species endemic to the region, and species listed under CITES. Impacts of the proposed Project Roads were analyzed against the ecology of species and ecological processes.

Conservation status of species in checklist generated by desktop analysis, field observations and local accounts were validated using IUCN red list of threatened species. There are different categories of conservation status of species described in the IUCN red list data. Based on the categories, species were assigned status:

- CRITICALLY ENDANGERED (CR) when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria (A to E in the IUCN Red List Categories);
- ENDANGERED (EN) when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria (A to E in the IUCN Red List Categories);
- VULNERABLE (VU) when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria (A to E in the IUCN Red List Categories);
- LOWER RISK (LR) when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Species included in the Lower Risk category are separated into three subcategories;
- Conservation Dependent (CD). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years;
- Near Threatened (NT). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable;

- Least Concern (LC). Taxa which do not qualify for Conservation Dependent or Near Threatened;
- DATA DEFICIENT (DD) when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status, and;
- NOT EVALUATED (NE) when it has not been assessed against the IUCN criteria

The IUCN online database was used to validate species checklist generated from the field and literature search for status of endemicity. Other online database was also used for verification. Species checklist were run against list of CITES which is categorized into Appendices, according to the degree of protection species require. (For additional information see www.cites.org). Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. Appendix III contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

1.9 Layout of the report

Table 1-2 Report layout.

SECTION	TITLE	DESCRIPTION
Section 1	Introduction	Introduction to the Project and ESIA study scope and methodology adopted.
Section 2	Project Description, Design and activities	Technical description of the Project & related infrastructure and activities.
Section 3	Policy, legal and institutional framework.	Discusses the applicable Environmental and social regulatory framework and its relevance for the Project.
Section 4	Physical, Environmental and Social Conditions	Outlines Environmental and Social Baseline status in the study area of the Project
Section 5	Consultation and Stakeholder Engagement	Provides an overview of the stakeholder engagement activities undertaken during the ESIA, stakeholder categorization and profiling Additionally, it details the provision of Grievance Redress Mechanism for the project.
Section 6	Analysis of Project alternatives	Provides project alternative on Routing, Construction Materials, Project Design and Technology
Section 7	Environmental and Social Impact Assessment and Management	This section includes details of identified environmental impacts and associated risks due to Project activities, assessment of significance of impacts and presents mitigation measures for minimizing and /or offsetting adverse impacts

		identified.
Section 8	Environmental and social Monitoring Plan	Outline of the ESMP taking into account identified impacts and planned mitigation measures and monitoring requirements.
Section 9	Conclusion and Recommendations	Summary of impacts identified for the Project and conclusion of the study.
Section 10	Reference	List of references
Section 11	Appendices	This section includes all attachments including Species diversity, NEMA licenses, layout plan, Minute of the meeting, list of participants and Baseline measurements.

2 PROJECT DESCRIPTION, DESIGN AND ACTIVITIES

2.1 Project Location and Description

The project road is approximately 94km long and is situated in Nyeri and Nyandarua Counties of Central Region. The main section which is approximately 49km starts at Ihithe, takes a south-westerly course through the Nyayo Tea Zone and enters the Aberdare National Park. The road then emerges from the park at about km 29 (Mutubio Gate). From this gate, the road descends through a series of hair-pin bends to Kahuruko. The stretch between Mutubio Gate and Kahuruko (approx. 10 kms) is tarmacked. From Kahuruko, the project road continues to descend and ends at its junction with the C69 Road at Ndunyu Njeru.

Other road sections included in the project are the Njengu- Treetops Gate - Amboni, the Ihithe - Kiamutiga - Mukarara, the Ark Gate Access, the Munyaka - Koinange - Heni - Mwendandu and the Njoma - Weru road sections, all totaling approximately 44 km in length.

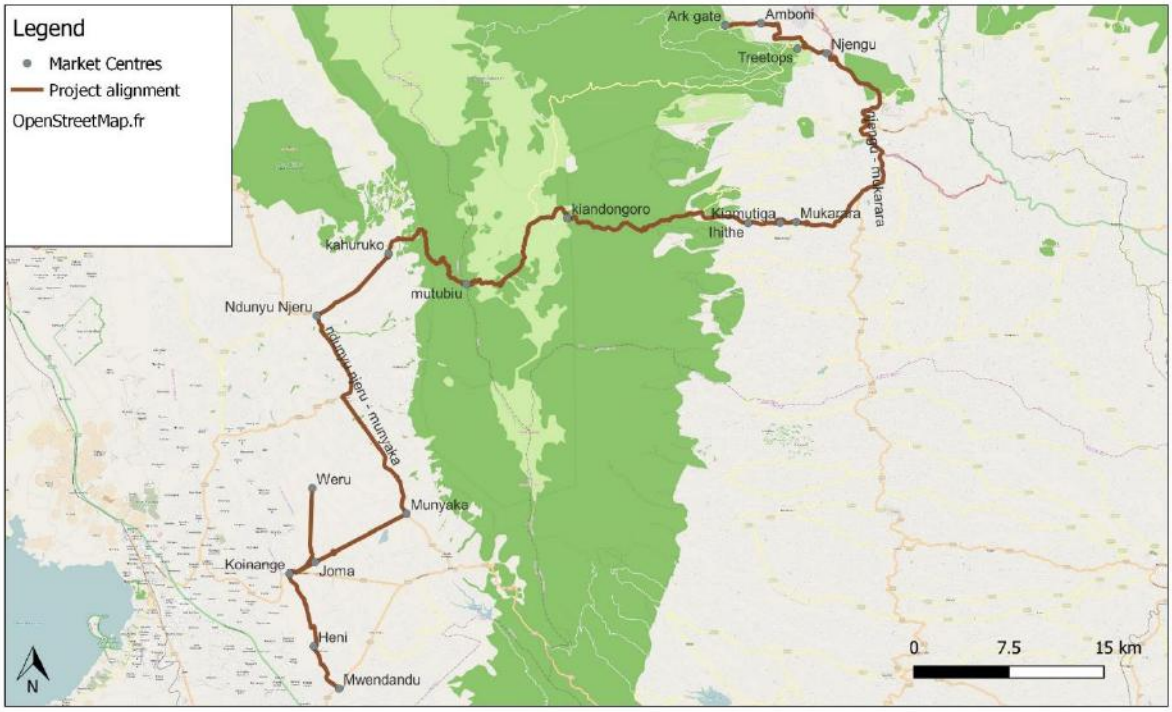


Figure 2-1 Project Area Location Map

2.2 Project Objectives

The overall objective of the proposed project is to attain a sustainable, safe road network, which facilitates economic growth and improves living standards in the project area and Kenya at large. The specific objectives of this contract are to ensure that the Proposed Roads are upgraded to bitumen standard to enhance accessibility for socio-economic development.

2.3 Project Design Components and Activities

2.3.1 Geometric Design and Standards

The geometric design deals with the engineering design of the alignment, cross-section, intersections and road furniture.

The design was carried out with a view to obtaining the optimum solution commensurate with the adjacent land use, topography, physical features, vehicles, vehicle type and volume, aesthetics and costs. The Metric system has been used throughout the design.

2.3.1.1 Design standards

2.3.1.1.1 Design Standards Codes and Guidelines

The basic geometric standards of the project road follow guidelines contained in the Road Design Manual Part 1: Geometric Design of Rural Roads, Roads Department, Ministry of Works, Republic of Kenya, January 1979 and circulars issued by the Chief Engineer (Roads). Where found necessary, to ensure the most suitable design criteria and standards for the project additional reference was made to the American Association of State Highway and Transportation Officials (AASHTO): Policies on Geometric Design of Highways and Streets, 2011.

The objective of the exercise is to ensure an optimal utilization of funds without sacrificing technical requirements, especially aspects of road safety. The key design elements and factors, which govern the functioning of any highway, can be broadly grouped under the following: -

- Road classification;
- Design considerations;
- Road reserve;
- Terrain;
- Design speed;
- Design cross-sections;
- Land use;
- Geometric design, alignment and profile;
- Side slopes;
- Traffic capacity;
- Pavement;
- Cross drainage works and structures;
- Junctions and intersections;
- Traffic control and safety measures;
- Roadside facilities;
- Climbing lanes;
- Road safety.

The basic design philosophy is based on the consideration of providing suitable alignment, cross-sectional layout, geometric, safety and access control to cater to the fast and uninterrupted movement of through traffic.

The geometric design was based on the Road Design Manual, Part 1: Geometric Design of Rural Roads, January 1979 of the MORPW&H. The Circular No. R.5960/ P27 of 12/07/1988 and recent communication from the Chief Engineer (Roads) regarding minimum widths of shoulders was adopted.

The main road section between Ihithe-Ndunyu Njeru is classified as Class C Primary Road as defined in Section 2.2 of RDM-1 with desirable road reserve width of 40m however this has been reduced to 25m in sections traversing Aberdares forest to lower environmental impact to the wildlife/forest ecosystem.

The classification in Nyeri and Nyandarua spur roads range between class G and L. In consultation with the Client, a road reserve width of 25m has been proposed to accommodate the improvement works. Efforts have been made to accommodate the proposed road corridors within the proposed road reserves with minimal acquisition anticipated.

2.3.1.1.2 Design Speed

The choice of design speed is dependent on the following factors according to the Road Design Manual Part I:

- The classification and function of the road;
- The nature of the terrain;
- The density and character of the adjoining land use;
- The traffic volumes expected to use the road.

In flat and gentle terrain, drivers will normally accept higher operating speeds in line with the absence of the physical constraints such as tight road curvature and steep vertical grades, with the horizontal geometry constraints having greater effect. The terrain traversed by the main road Ihithe-Ndunyu Njeru and Nyeri spur roads is predominantly mountainous with isolated rolling to flat sections. On the other hand, Nyandarua spur roads traverses rolling to flat sections.

The land use in the area traversed by the roads and intersections is the most important environmental factor to be considered during the selection of design speed. A significant portion of the main road and Nyeri spur roads passes through forested National Park and agricultural set up with a few urban and peri urban localities.

More importantly, the design speeds adopted have been influenced by the requirement that the road be retained within the **existing horizontal** and **vertical alignments to reduce acquisition, impact to environment and construction costs.**

The RDM part 1 gives guidance on the design speeds to adopt for the different road class in different terrains as shown in the table below.

Table 2-1 Guide Values for Design Speeds.

Terrain	Road Classification		
	A & B	C	D & E
Level	100-120	90-100	80
Rolling	70-100	60-90	50-80
Mountainous	50-70	40-60	30-50

Taking into account considerations such as road function, terrain, roadside demography and environment, the project road has two proposed design speeds.

Table 2-2 Road Design Speeds

	Section Chainage(km)	Terrain Classification	Length (m)	Max Design Speed	Road Function
Main road					
Ihithe-Kahuruko-Ndunyu Njeru	0+000 – 40+110	Mountainous	39700	50 Kph	Nyeri to Nyandarua link
	40+110 – 47+290	Rolling to Flat	6920	60 Kph	
	47+290 – 49+315	Flat (Urban)	1970	50 Kph	
Nyeri Spur roads					
Mukarara-Ihithe	0+000 – 3+447	Mountainous	3447	50 Kph	Local Access
Ark Gate Access	0+000 – 1+851	Mountainous	1851	50 Kph	
Amboni Loop 1	0+000 – 1+477	Mountainous	1477	50 Kph	
Amboni Loop 2	0+000 – 3+141	Mountainous	3141	50 Kph	
Njengu Tree tops	0+000 – 5+512	Mountainous/Rolling	5512	50 Kph	
Nyandarua Spur roads					
Mwendandu-Heni	0+000-4+690	Flat	4690	50 Kph	Local Access
Heni-Koinange	0+000-6+499	Flat	6499	50 Kph	

Koinange-Munyaka	0+000-9+810	Flat	9810	50 Kph	
Njoma-Weru	0+000-7+131	Flat	9131	50 Kph	

Short length changes in design speeds are undesired as they result to variance with the operating speeds.

2.3.1.2 Design Vehicle

The type of heavy goods trucks commonly found on the major transport corridors are slightly longer than the 15m long Semi-trailer truck depicted in the Kenya Road Design Manual Part 1: Geometric Design of Rural Roads Page 3.17. For turning movement design, the AASHTO standard adopts a 16.59m long semi-trailer truck. The Table below shows the adopted design vehicle parameters for a typical 17.9m long 6 axle semi-trailer truck.

Table 2-3 Typical Design Vehicle Dimensions - Semi Trailer Combination

Design Vehicle Type	Overall (m)			Overhang (m)		Wheelbase (m)	Minimum Design Turning Radius (m)
	Length	Width	Height	Front	Rear		
Kenya	15.0	2.5	3.8	1.2	0.6	4.8 + 8.4	12.5
AASHTO WB-15	16.9	2.6	4.1	0.9	0.6	4.4 +10.9	13.7
NZ Semi-Trailer	17.9	2.5	4.3	1.4	0.75	4.4+8.75	12.5

2.3.1.3 Design Criteria

The major consideration in the design of this road has been that the horizontal and vertical alignment is to follow the existing track as much as possible to avoid heavy earthworks and unnecessary bridges and other drainage structures. The design standards were adopted to minimize both construction cost and interference with the environment. However, a few re-alignments have been accommodated wherever they were found necessary from considerations of road user safety and the need to meet minimum design standards. Subsequent section details how the design addresses environmental and socio-economic requirements.

2.4 Existing Alignment

The project road is in three sections, viz. Mukarara - Ihithe - Kiandongoro Gate - Mutubio Gate - Kahuruko - Ndunyu Njeru section; the Njegu - Treetops - Amboni - Ark Gate section; and the Mwendandu - Heni - Koinange - Njoma - Weru and Njoma - Munyaka section.

2.4.1 Mukarara - Ihithe - Kiandongoro Gate - Mutubio Gate - Kahuruko - Ndunyu Njeru Section in Nyeri and Nyandarua Counties

This section of the project road commences at the junction of the Gitugi – Othaya (C502) road at Mukarara Centre in Nyeri County.

i) Mukarara - Ihithe Section

The Mukarara - Ihithe (3.6 km long) section is a gravel road of 4 – 5m width with no shoulders or side drains, and traversing alternating flat and rolling terrain with a few steep sections. The horizontal alignment is characterized by successive gentle curves.

ii) Ihithe - Kiandongoro Gate Section

The first 6 km of the Ihithe – Kiandongoro Gate (19 km long) section between Ihithe and Wandumbi Centres is on the newly upgraded Mau Mau Lot 3 road being constructed by Synhydro Contractors. The first 3.7 km is asphalt surfaced whilst the next 2.3 km is surface dressed, both sections being 7m wide with paved shoulders and gently traversing rolling terrain.

From Wandumbi Centre, the road turns off to the left. This section is a gravel road of 3 – 4m width with no shoulders or side drains, and traversing mainly rolling terrain with a few steep sections. The horizontal alignment is characterized by both gentle and sharp curves.

iii) Kiandongoro Gate - Mutubio Gate Section

The Kiandongoro Gate – Mutubio Gate (13.1 km long) section is a gravel road of about 3 – 4.5m width with no shoulders or side drains, and traversing rolling and mountainous terrains with steep sections. The horizontal alignment is characterized by short straights, reverse and compound sharp curves.

iv) Mutubio Gate - Kahuruko Section

The Mutubio Gate - Kahuruko (12.1 km long) section is a tarmac road paved with surface dressing and is about 4 - 5m wide with no shoulders or side drains. The road section traverses rolling terrain with a steep section between Km 40 – 42.4.

The horizontal alignment is characterized by long straights and long curves. The area adjacent to the road section is predominantly forest land.

v) Kahuruko - Ndunyu Njeru Section

The Kahuruko - Ndunyu Njeru (7.8 km long) section is a gravel surfaced road and is about 8m wide with no shoulders. The road section traverses gently rolling to flat terrain. The horizontal alignment is characterized by very gentle curves. The alignment traverses through both Kahuruko and ends at the junction with the Njabini - Ol Kalau (C69) road at Ndunyu Njeru Centre.

2.4.2 Njengu - Treetops - Amboni - Ark Gate Section in Nyeri County

i) Njengu - Treetops Gate Section

This section of the project road commences at Njengu Centre at the junction of the Mweiga - Nyahururu (B5) road in Nyeri County. The Njengu - Treetops Gate (1.8 km long) section is an earth/gravel road of 3.5m width with no shoulders or side drains. The road traverses generally

mountainous terrain with sections of steep grades up to 12%. The horizontal alignment is characterized by both gentle curves.

ii) Amboni – Treetops Gate Section

This section of the project road commences at Amboni Centre at the junction of the Mweiga – Nyahururu (B5) road in Nyeri County. The Amboni – Treetops Gate (6.1 km long) section is a gravel road of about 3.5m width with no shoulders or side drains. The road traverses mountainous terrain with steep sections at Km 1.8 – 2.3 and Km 5.5 – 6.1. The horizontal alignment is characterized by alternating gentle and sharp curves. It is noted that there is no existing road in the last 1.5 km section between the Game Rangers staff houses (RHS) and Treetops Gate.

iii) Ark Gate Access Section

This section of the project road commences at about 1 km after Amboni Centre at the junction of the Mweiga – Nyahururu (B5) road in Nyeri County. The Ark Gate Access (1.8 km long) section is a gravel road of about 4 – 5m width with no shoulders or side drains. The road traverses gently rolling terrain. The horizontal alignment is characterized by long straights and curves.

2.4.3 Mwendandu - Njoma - Weru and Njoma - Munyaka Section in Nyandarua County

i) Mwendandu – Heni - Koinange Section

This section of the project road commences at the junction of the Fly Over – Njabini (C490) road at Mwendandu Centre.

The Mwendandu – Njoma (11.7 km long) section is a gravel road of 4 – 6m width with no shoulders or side drains. The road section traverses mainly flat terrain with a few sections in gently rolling terrain. The horizontal alignment is characterized by gentle curves.

The town centres along the road section are Heni at Km 4.0, Karuru at Km 8.7 and Koinange at Km 10.7. It is noted that the last 1 km between Koinange and the road to Njoma is on the newly upgraded Naivasha – Njabini (C489) road. The section has a 9.5m wide asphalt surfaced carriageway with paved shoulders and large side drains on both sides.

ii) Njoma - Weru Section

This section of the project road commences at the junction of the Naivasha - Njabini (C489) road about 2 km after Koinange Centre.

The Njoma - Weru (7.2 km long) section is a gravel road of about 4.5m width with no shoulders or side drains. The road section traverses mainly flat terrain. The horizontal alignment is characterized by long straights and long curves. The town centres along the road section are Njoma at Km 1.5 and Weru at Km 4.5.

iii) Koinange - Munyaka Section

The Koinange - Munyaka (7.9 km long) section is a gravel road of 3 - 4m width with no shoulders or side drains between Njoma and Munyaka at Km 5.2, and 5 - 6m width with no shoulders or side drains between Munyaka and Munyaka. The road section traverses mainly

flat and gently rolling terrain. The horizontal alignment is characterized by long straights and long curves.

2.5 Horizontal Alignment Design

The Road Design Manual stipulates the requirements for minimum design parameters such as curve radii, sight distances etc at given speeds. The horizontal alignment standards adopted for the selected design speeds are presented in the following table: -

Table 2-4 Horizontal Alignment Standards

Table 2-4: Horizontal Alignment Standards		
Design Elements	Design Speed (km/h)	
	50	60
Normal passing sight distance	250 m	475 m
Reduced passing sight distance	325 m	225 m
Minimum horizontal radii	100 m	160 m
Minimum "A" for Minimum hor. radii	74	98
Horizontal radii without transition	> 2000 m	> 2000 m
Horizontal radii without Superelevation	> 4000 m	> 4000 m
Max. rate of change of Superelevation	1.25 %	
Min. rate of change of Superelevation	0.3 %	1.0 %
Maximum Superelevation - Rural	6.0 %	0.3 %
Maximum Superelevation-Urban	4.0%	6.0 %

The criteria for minimum curves could not be achieved along the whole alignment of the main road (Ihithe Ndunyu Njeru) with radii as low as 15m were used except the spur roads where the criteria were achieved. This was done to avoid construction of many major structures and heavy earthworks which would have increased the cost of construction tremendously. Other factors considered were damage to flora and fauna and disturbance to the wildlife habitat. This was appropriate, as the road is lightly trafficked and passes through a National Park hence user savings less significant. On this basis, the proposed horizontal alignment follows the existing road as close as possible so as to lower construction costs and minimize impact to the environment.

To improve road safety, appropriate signage and road marking have been proposed in locations where standards are compromised to warn drivers of hazards. Additionally, guardrails have been provided in sections with high fills.

2.6 Vertical Alignment Design

2.6.1 Vertical Curves

The design criterion for vertical curves is that of ensuring the fulfilment of the requirement for the minimum stopping sight distance as stipulated in the Road Design Manual for safety reasons. Other design considerations include drainage, aesthetics and comfort for vehicle occupants.

The vertical curves were checked for compliance to the design criteria. All the curves were found to meet the requirements for minimum sight distances and length of curve. A summary of the vertical alignment standards adopted for the project road is presented in the table below:

Table 2-5 Vertical Alignment Standards

Design Elements	Design Speed (km/h)	
	50	60
Max. gradients, flat terrain	-	-
Max. gradients, rolling terrain	7.0%	6.0%
Max. gradient, mountainous terrain	11.0%	10.0%
Min. gradients (in cuts)	0.5%	0.5%
Minimum stopping sight distance	65m	80m
Min. crest curve radii (stopping sight dist.)	550m	700m
Min. crest curve radii (passing sight dist.)	7900m	12500m
Min. sag curve radii (stopping sight dist.)	1250m	2000m

2.6.2 Gradients

The vertical curves and the vertical gradients of the proposed design closely follow the existing terrain as much as possible to minimize deep cuts and fills. This will reduce impact to the wildlife habitat and the forest ecosystem. There are no proposed animal crossing underpasses along the road owing to the fact that animals will not be restricted to cross at specific locations, therefore all animals are expected to cross at grade. Proper speed calming measures such as bumps and requisite warning signs have been proposed to improve road safety.

There are afew sections shown in the table below which exceeded the maximum gradient (11%) stipulated in design manual.

Table 2-6 Ihithe-Ndunyu Njeru: Sections Exceeding Vertical Gradient Limitations

Ihithe-Ndunyu Njeru: Sections Exceeding Vertical Gradient Limitations			
Location (km)	Gradient (%)	Design Speed (km/hr)	Length (m)

0+860	0+900	12.89	50	440
4+540	4+603	11.13	50	63
6+385	6+685	13.3	50	300
8+260	8+370	11.07	50	110
9+240	9+442	12.39	50	202
9+840	9+902	13.6	50	62
13+294	13+496	13.5	50	202
15+230	15+275	13.56	50	45
15+508	15+580	13.34	50	72
32+320	32+330	11.22	50	10
13+230	13+610	11.96	50	380

2.6.3 Typical Cross-Sections

2.6.3.1 Existing Cross-section

The existing project roads are two - way single carriageways.

2.6.3.2 Proposed Cross-section

The choice of cross-section elements depends on a number of factors, the most important of which are:-

- The traffic volumes which the road will have to accommodate
- The selected design speeds
- The road function, i.e. the predominant type of traffic that the road serves for example, “long distance” versus “access”, or “heavy goods” versus “passenger cars”.

From the traffic analysis, The table below shows the recommended roadway cross-section.

Table 2-7 Recommended Geometric Traffic Cross-section

Road Section	**AADT in year 10**	**Design Cross-Section Type**	**Width of Carriageway (m)**	**Shoulder Width (m)**
1) Ihithe-Ndunyu Njeru				
i) Ihithe – Kiandogoro Gate	5,151	II	7.0	2.0
ii) Kiandogoro – Mutubio Gate	1,584	IV	6.0	1.0
iii) Mutubio Gate - Kahuruko	2,742	III	6.5	1.5
iv) Kahuruko – Ndunyu Njeru	8,056	II	7.0	2.0

2) Ihithe – Kiamutiga - Mukarara	1,847	IV	6.0	1.0
3) Ark Gate Access	1,212	IV	6.0	1.0
4) Njeng'u – Treetops Gate - Amboni	2,270	III	6.5	1.5
5) Mwendandu – Heni – Koinange – Joma - Weru	4,677	II	7.0	2.0
6) Joma - Weru	2,835	III	6.5	1.5

In order to cater for Non-Motorised Transport (cyclists and pedestrians) within Ndunyu Njeru market (approx. 2km) an urban road cross-section is recommended: 7.0m single carriageway with 2 x 1.5m cycle track width and 2 x 2.4 m parallel parking bay (flash parking) lane. A covered rectangular drain separation and 2 x 3.0m wide pedestrian walkway fronting the line of shops.

However, due to anticipated environmental impact, the width of the carriage way and the road shoulders of Ihithe-Ndunyu Njeru have been reduced as shown in the following sections;

Table 2.8 Recommended Geometric Traffic Cross-section of ihithe-Ndunyu Njeru section

Road Section	**AADT in year 10**	**Design Cross-Section Type**	**Width of Carriageway (m)**	**Shoulder Width (m)**
2) Ihithe-Ndunyu Njeru				
i) Ihithe – Kiandogoro Gate	5,151	IV	6.0	1.0
ii) Kiandogoro – Mutubio Gate	1,584	IV	6.0	1.0
iii) Mutubio Gate - Kahuruko	2,742	IV	6.0	1.0

2.6.4 Pavement Widening

The RDM Part I recommends widening of the pavement at horizontal curves to ensure operating conditions are compatible with those on tangents/ straights. The widening is required for the following purposes:

- Vehicles on curves occupy a greater width as the rear axles normally tracks inside the front axle
- Drivers usually experience difficulties in maintaining a vehicle at the centre of a lane on a curve
- The widening is introduced as a factor of the design speed and the horizontal curvature. One half of the widening shall be applied to each lane.

2.6.5 Camber, Cross Fall and Shoulder Slopes

A roadway camber of -2.5% (from centerline), which complies with the Road Design Manual's standards for bituminous pavements, will be applied. The adopted shoulder slop will be 4% except in sections with super-elevation exceeding 4%, where the shoulder slope on inside of curves will be continuous with the super elevation.

2.6.6 Embankment and Cut Slopes

The table below indicates adopted embankment and cut slopes as per RDM part 1

Table 2-9 Embankment and Cut Slopes

Embankment and Cut Slopes				
Type of slope		Slope		
		v < or = to 1m	1 < v < 3m	v > 3m
Cut on normal soils		1:3	1:2	1:1.5
Cut on rock	Weathered rock	3:1	3:1	3:1
	Sound rock	10:1	10:1	10:1
Embankment		1:4	1:2	1:1.5

Elements complementary to the normal cross-section include cycle tracks for non-motorized traffic; bus stops; and pedestrian footpaths will be adopted where necessary.

Slope protection is proposed on sections where the natural slope extends beyond the road corridor.

2.6.7 Super-Elevation

Super-elevation was applied according to Section 5.3.4 of the Road Design Manual. Generally, super elevation is required for all horizontal curves except where R>4000m on roads with VD<100km/hr and R≥7000m on roads with VD>100km/hr. For horizontal curves, which satisfy these conditions, normal cross fall or camber was maintained. The Super-elevation was applied within the transition curves included in the horizontal alignment design.

The following formula was used to calculate super-elevation:

$V^2/127R=S+Sf$

Where V=Design Speed

R=Horizontal Curve Radius

Sf=Side friction (0.18 for speeds upto 50kph, 0.15 for speeds above)

S=Super elevation

For these roads, the maximum super elevation of 4% was adopted in the urban sections to avoid adverse crossfall which are undesired in the slow-moving traffic (operating speeds of less than 50 kph) while a maximum super elevation of 6% was adopted for the rural and peri-urban section where higher speeds are anticipated.

2.7 Road Furniture

2.7.1 Traffic Signs and Road Markings

The Traffic signs and road markings have been designed and sited generally in accordance with the Manual for Traffic Signs in Kenya Parts I and II.

Provision has been made for carrying out all road markings under the contract. This includes lane carriageway markings at junctions and accesses.

2.7.2 Guard-rails, edge-marker, culvert marker and road reserve boundary posts

As the road traverses a hilly to rolling terrain, guardrails have been provided in accordance with the requirements of the Road Design Manual Part I. Their design incorporated steel posts for box culverts and reinforced concrete posts at high embankment and steep slope locations. The culvert marker and road reserve boundary posts have also been reinforced concrete have also been proposed. The road reserve boundary posts will have chainage engraved.

2.8 Drainage structures Design

Structural analysis and design of the drainage structures focused on the design of new structures. The basic approach with regard to the design of new drainage structures entailed the following:

- Selection of the most suitable location with regard to foundation conditions, river channel location, safety requirements and construction costs.
- Structures designed Euro Codes.
- Analysis of the most ideal structure type considering various aspects of hydrological requirements, construction and future maintenance works.
- Detailed design prepared for all drainage structures having span of 10 metres or greater.
- Standard Designs for drainage structure adopted for spans less than 10m.
- Preparation of drawings and bar bending schedule

2.8.1 Design Standards

2.8.1.1 Bridge and culvert Traffic loading

Bridges and box culverts designed to “Eurocode 1: Action on structures – Part 2: Traffic loads on bridges” for load models LM1, LM2, LM3 and LM4 as defined in the UK NA. The project roads are expected on completion to attract traffic classified within other public roads as defined in UK NA, thus the design will check for LM3 SV80 vehicle will be performed.

The load Models 1 to 4 were combined to form 'Groups' of traffic loads. The Groups are referenced as gr1a, gr1b, gr2, gr3, gr4, gr5 and gr6 and the load models used in each group are defined UK NA to determine the most onerous group of traffic load

2.8.1.2 Structural Design

The structural design of the bridges and culverts was done to conform to Euro code 2 – Design of concrete structures – Concrete bridges – Design and detailing rules.

2.8.1.3 Box Culvert Sizes

a) General

From the hydrological report, eight box culverts have been incorporated along the proposed roads. The sizes of the box culvert have been arrived at after consideration of -

- Discharge calculations in the Hydrological report.
- Observations noted during the visit to the site.
- Improved geometrical approaches at culvert locations.
- Raising the height of the culvert walls to reduce the fill on the roof slab.

Design of box culverts has been done following procedures given in PD 6694-1 'Recommendations for the design of structures subject to traffic loading to BS EN 1:2004'.

b) Box Culvert Foundations

Any soft spots/ unsuitable materials will be removed from the foundation level for the box culverts and replaced with suitable material. This will ensure that any differential settlement will be negligible. Also, a suitable factor of safety will be applied to the allowable bearing pressure when checking the maximum bearing pressure under the box to ensure that settlement will be minimal.

2.8.1.4 Minor Drainage Structures (Pipe Culverts)

Standard design will be adopted for access and cross pipe culverts. Similarly, to the box culvert, at locations where unstable ground is encountered the material will be removed and replaced with suitable material.

In addition to the pipe culverts, catch water drains and mitre drains will be introduced along the road to enable the road to have adequate drainage.

2.8.1.5 Erosion Protection of Drainage Structures

Scour checks in the form of stone pitching, gabion works and other appropriate materials for arresting erosion of the sides and steep drains have been designed and detailed. The details are contained in the separately bound book of drawings.

2.8.2 Project Activities

The project will involve the following activities:

- Site clearance and top soil stripping
- Earthworks
- Excavation and filling for structures
- Culvert and drainage work
- Bituminous surface treatments and surface dressing
- Bituminous mixes, binder courses and wearing courses
- Concrete works
- Structural steelwork
- Signalling & street lighting relocation, recovery and installation

2.8.3 Construction Materials and Spoils

Material spoils (soil and rock) will be generated during the construction activities. It is anticipated that the majority of material spoils will be used as construction fill. Spoils that cannot be immediately used will be stockpiled. Spoils stockpiles will employ adequate erosion and storm water controls. Any excess spoils remaining in the stockpiles after construction will be graded to match the surrounding land contour and restored with natural vegetation.

Other construction materials required will include gravel, sand, aggregates, and concrete. These materials will be sourced from authorized vendors. Material storage yards will be established to store the construction materials at the project site and will include storm water and spill prevention controls. Material storage yards will be restored after the construction phase or when no longer needed for construction.

2.8.3.1 Material Sites

The table below details proposed material utilization for the various material sites including the haulage distances. The table also indicates approximate quantities of material required calculated from the typical cross sections and approximate available quantities from each of the material sites using the recommended pavement option.

Table 2-10 ***approximate material quantities***

Material Site Name	Location (km + m)	Usage	Length (Km)	Haulage distance (Km)	Approx. required quantity (m3)	Approx. available quantity (m3)
Engineer	10Km South East of Ndunyu Njeru along Ndunyu Njeru - Engineer Road	Sub-base / Base for Mutubio Gate – Kahuruko - Ndunyu Njeru	20.0	20.0	90,000	95,000
Heni	2.0 Km off, LHS at Heni (Km 4+000) along Mwendandu – Koinage Road	Sub-base / Base for Mwendandu - Heni - Joma Road section	13.0	8.5	66,000	80,000
Sasumua	11 Km South East of Munyaka along Njabini - Munyaka Road	Sub-base / Base for Joma - Munyaka and Joma - Weru Roads	15.2	18.6	75,000	86,000
Honi	5 Km North East of Amboni along	Sub-base / Base for Njengu –	10.3	10.15	49,000	66,000

	Nyeri - Muiga Road	Treetops Gate - Amboni Road				
		Sub-base / Base for Ark Gate Access Road	1.9	7.95	8,000	
Nyaribo	28 Km and 22 Km Nort East of Ihithe and Mukarara respectively along Chaka - Nyaribo - Nyeri - Ihithe Road	Sub-base / Base for Ihithe - Mutubio Gate Road	29.3	42.65	127,000	187,000
		Sub-base / Base for Mukara - Ihithe Road	3.7	23.85	18,000	
Roben Aberdare Quarry	35 Km and 29Km Nort East of Ihithe and Mukarara respectively along Chaka - Nyaribo - Nyeri - Ihithe Road	Surfacing and Concrete works for Ihithe - Mutubio Gate Road section	29.3	49.65	22,000	Adequate
		Mukara - Ihithe road	3.7	30.85	3,000	Adequate
	17.3 Km West of Njengu along Chaka - Golden Gates Hotel - Njengu Road	Njengu - Treetops Gate - Amboni Road	10.3	22.45	8,000	Adequate
	22.1 Km West of Ark Gate along Chaka - Muiga – Ark Gate Road	Ark Gate Access Road	1.9	23.05	1,500	Adequate
HYoung Quarry	44.0 Km South West of Ndunyu Njeru along Hyoung Quarry - Naivasha - Murungaru -	Surfacing and Concrete works for Mutubio Gate - Kahuruko - Ndunyu Njeru	20.0	54.0	15,000	Adequate

	Ndunyu Njeru Road	Mwedandu - Heni - Munyaka Road	21.2	41.6	16,000	Adequate
	31.0 Km North East of Koinange along Hyoung Quarry - Naivasha -Koinange - Githioro Road	Joma - Weru Road	7.0	36.1	6,000	Adequate

The contractor may consider obtaining the materials from the above sources or acquire them from other new sites.

2.8.4 Required Equipment and Machinery

The Project will use a fleet of heavy vehicles for transporting materials and equipment and heavy equipment for excavations and earthworks. There will be a wash bay to service these vehicles and adequate parking provided. Owned or hired vehicles will also be used to transport construction staff to the work area(s). During construction, it is anticipated that the following types of equipment will be used (but not limited to):

- Light vehicles for personnel transport;
- Excavators and wheeled loaders;
- Dump trucks;
- Concrete mixing and pumping trucks;
- Rollers and compactors;
- Motor graders;
- Bull dozers;
- Mobile cranes;
- Air compressors;
- Electricity generators;
- Electric or gas-powered drills and saws.

2.9 Decommissioning

Decommissioning of the construction phase will include dismantling all temporary structures and facilities and properly salvaging or disposing of the materials. Land that was leased for temporary facilities will be restored to its pre-construction condition and returned to the owners. Temporary roads will be closed and any drainage obstructions removed. An Environmental Management Plan covering the decommissioning phase should be developed prior to the start of construction.

2.10 Estimated Project Cost

Table 2-11 Project cost

SUMMARY BILL OF QUANTITIES		
ITEM	**DESCRIPTION**	**AMOUNT (Kshs.)**
1	Preliminary and General Items	805,752,368.53
4	Site Clearance and Topsoil Stripping	132,893,079.50
5	Earthworks	1,826,093,098.75
7	Excavation & Filling for Structures: Box Culverts & Bridges	285,731,010.00
8	Culvert and Drainage Works	247,048,430.00
9	Passage of Traffic	146,720,765.40
12	Natural Material for Sub-base and Base	390,590,412.00
14	Cement and Lime Treated Material	663,187,229.32
15	Bituminous Surface Treatments and Surface Dressing	373,434,856.30
16	Bituminous Mix Bases, Binder Courses and Wearing Courses	1,268,738,965.00
17	Concrete Works	73,035,980.00
20	Road Furniture	162,276,530.00
21	Miscellaneous Bridge Works	3,671,345.12
22	Day works	49,061,034.00
24	Landscaping and Environmental Mitigation Measures	16,650,000.00
25	HIV/AIDS Awareness and Education	16,750,000.00
26	Road Safety and Awareness Campaign	8,625,000.00
	Sub-total 1	**6,470,260,103.92**
	Add 10% of Sub-total 1 for Physical Contingencies to be expended in whole or in part or deleted as directed by the Engineer.	647,026,010.39
	Add 15% of Sub-total 1 for Variation of Prices in accordance with Clause 70 of the Conditions of Contract.	97,053,901.56
	Sub-total 2	**7,214,340,015.88**
	Add 16% of Sub-total 2 for Value Added Tax (VAT)	1,154,294,402.54
TOTAL CARRIED FORWARD TO FORM OF BID		**8,368,634,418.42**

3 POLICY, LEGAL, AND INSTITUTIONAL FRAMEWORK

3.1 Introduction

This section examines the relevant policy and legislative frameworks in Kenya to ensure that the planned road development project complies with policy and legislative requirements, as well as that the applicable regulations are incorporated into project design and implementation.

3.2 International Framework

3.2.1 International Policies, Guidelines, and Standards

Kenya is a signatory to various international agreements, conventions, treaties and protocols relating to the environment which aims at achieving sustainable development. These agreements are both regional and international and became legally binding on Kenya upon ratification thereof by the rightfully designated Kenyan Authority. The agreements of interest to Kenya can be categorized as those for protecting natural resources, atmosphere and the social wellbeing of mankind as discussed below.

3.2.2 Kyoto Protocol to the United Nations Framework Convention, 1997

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets. In this project, there will be use of vehicles, machinery and equipment that depend on fossil fuel as their source of energy hence contractor must comply with emission levels as highlighted by the conventions.

3.2.3 Vienna Convention for the Protection of the Ozone Layer, 1985

Intergovernmental negotiations for an international agreement to phase out ozone depleting substances concluded in March 1985 with the adoption of the Vienna Convention for the Protection of the Ozone Layer. This Convention encourages intergovernmental cooperation on research, systematic observation of the ozone layer, monitoring of CFC production, and the exchange of information. The proposed project is expected to use substances that does not release gases that will contribute to ozone layer depletion.

3.2.4 United Nations Convention on Biological Diversity (UNCBD)

The purpose of this convention is to ensure the conservation and sustainable use of biodiversity. Kenya signed the convention on 5th June 1992 and ratified the same on 26th July 1992. The National Environment Management Authority (NEMA) is the National Focal Point to this Convention. The provisions of this Convention have been integrated in many laws of Kenya.

This project will be implemented in a manner that it will not lead to degradation of environment but in sustainable use of biodiversity

3.2.5 The Basel Convention (1989)

Sets an ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system. The proposed project is expected to use substances that minimise the release of greenhouse gases in to the atmosphere.

3.2.6 The Ramsar Convention for the conservation and sustainable utilization of wetlands (1971)

The Ramsar Convention (formally known as the Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. The proposed Mau Mau Lot 4 Roads have potential of impacting a number of wetlands crossing the road. Appropriate mitigation measures will need to be implemented as detailed in the Environmental Management Plan.

3.2.7 United Nations Framework for Convention on Climate Change (UNFCCC) (1992)

The primary objective of the convention is to achieve the stabilization of greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with climate systems and within a specific timeframe which will allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. The UNFCCC was adopted on 9th May 1992 and came into force on 21st March 1994. The Convention has been ratified by 189 states. Kenya ratified the Convention on 30th August1994 with NEMA as the focal point for the Convention.

3.3 Legislation/Guidelines

3.3.1 The Kenyan Constitution, 2010

Article 42 under the Bill of Rights of the Kenyan Constitution provides that every Kenyan has a right to a clean and healthy environment. Specifically, every Kenyan has a right to the following:

- To have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and
- To have obligations relating to the environment fulfilled under Article 70.

Clause 1(f) within Article 69 of the Kenyan Constitution requires the State to develop systems for Environmental Impact Assessment (EIA). The State utilises the EMCA 2012 and its subsidiary legislation titled Legal Notice 101: Environment (Impact Assessment and Audit) Regulations, 2003 (L.N. 101) as its system for EIA standards of implementation on local projects. (See Section 3.3.1.1).

Clauses 2(a-c) within Article 70 of the Kenyan Constitution give the State full rights to stop, discontinue, prevent, or sequester compensation from any "act" that is deemed "harmful to the environment".

The Constitution of Kenya provides for sound management and sustainable development of all of Kenya's natural resource related projects, both publicly and privately owned. The proposed project complies with the Constitution by proposing a structure in its ESIA on how to deal with Social, Health, safety and environmental issues for sustainable development.

3.3.2 Kenya Vision 2030

Kenya Vision 2030 is the current national blueprint for development from its inception in 2008 until the milestone year of 2030. This plan is the national long-term development policy that aims to transform Kenya into a newly industrialized, middle-income country by 2030. The Vision is comprised of three key pillars (economic, social, and political), two of which are projected to be positively affected by project implementation.

Through the creation of employment, local livelihoods can be expected to improve thus contributing positively to both economic growth rate and the engendering of just, cohesive, and equitable social development within a clean and secure environment.

3.4 Policy Framework

3.4.1 National Environmental Policy, 2013

The National Environmental Policy seeks to provide the framework for an integrated approach to planning and sustainable management of natural resources in the country. It recognizes the various vulnerable ecosystems and proposes various policy measures not only to implement sound environmental management practices in all sectors of society within Kenya but also to institute strong institutional and governance measures to support the achievement of the desired objectives.

- The objectives of this Policy are to:
- Provide a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources.
- Strengthen the legal and institutional framework for good governance, effective coordination, and management of the environment and natural resources.
- Ensure sustainable management of the environment and natural resources, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods.
- Promote and support research and capacity development as well as use of innovative environmental management tools such as incentives, disincentives, total economic valuation, indicators of sustainable development, Strategic Environmental Assessments, ESIAs, Environmental Audits (EA), and Payment for Environmental Services.

- Promote and enhance cooperation, collaboration, synergy, partnerships, and participation in the protection, conservation, and sustainable management of the environment and natural resources.
- Ensure inclusion of cross-cutting and emerging issues such as poverty reduction, gender, disability, HIV&AIDS, and other diseases in the management of the environment and natural resources.
- Promote domestication, coordination, and maximization of benefit from Strategic Multilateral Environmental Agreements (MEAs).

The Implementation of this Policy is guided by the following principles:

- Environmental Right: Every person in Kenya has a right to a clean and healthy environment and a duty to safeguard and enhance the environment.
- Right to Development: The right to development will be exercised taking into consideration sustainability, resource efficiency, and economic, social, and environmental needs.
- Ecosystem Approach: An integrated ecosystem approach to conserving environmental resources will be adopted and enhanced to ensure that all ecosystems are managed in an integrated manner while also providing a range of benefits to the citizenry.
- Total Economic Value: The benefits that ecosystems generate will be integrated into the national accounting system, programs, and projects.
- Sustainable Resource Use: Environmental resources will be utilized in a manner that does not compromise the quality and value of the resource or decrease the carrying capacity of supporting ecosystems.
- Equity: The management of the environment and natural resources will ensure equitable access to resources for present and future generations.
- Public Participation: A coordinated and participatory approach to environmental protection and management will be enhanced to ensure that the relevant government agencies, county governments, private sector, civil society, and communities are involved in planning, implementation, and decision-making processes.
- Subsidiarity: The management of the environment and natural resources will be through decentralization and devolution of authority and responsibilities to the lowest possible level.
- Precautionary Principle: Where there are credible threats of serious or irreversible damage to key environmental resources, lack of full scientific certainty will not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
- Polluter Pays Principle: The polluter and users of environmental and natural resources shall bear the full environmental and social costs of their activities.

- International Cooperation: MEAs and regional instruments will be domesticated and implemented cooperatively for better environmental management of shared resources.
- Good Governance: Rule of law, effective institutions, transparency and accountability, respect for human rights, and the meaningful participation of citizens will be integrated in environmental management.
- Benefit sharing: Where benefits will accrue from utilization of biodiversity, these will be shared in order to promote conservation and sustainable use of biodiversity.
- Community Empowerment: Communities will be involved in decision making and empowered in the implementation of such decisions.

The proponent is therefore required to adhere to the laid down policy framework to ensure that the proposed facility operates within the policy guiding principles to safeguard the environment

3.4.2 National Land Policy, 2009

The Chapter three (3) of the National Land Policy is linked to constitutional reforms, regulation of land ownership, and property rights. It is vested in the government by the Constitution with powers to regulate how private land is used in order to protect the public interests. The government exercises these powers through compulsory acquisition and development control. Compulsory acquisition is the power of the State to take owned private land for public purposes defined within the 2009 Policy as:

"Compulsory acquisition is the power of the State to extinguish or acquire any title or other interest in land for a public purpose, subject to prompt payment of compensation, and is provided for in the current Constitution."

In accordance with this policy, the Government must make prompt and reasonable payment for land acquisition. The enactment of this policy is laid out in the Land Acquisition Act, Chapter 295, 2012. (See Section 3.8.1) The overall purpose of this policy and implementation thereof is to secure and conserve all affected household's sources of livelihoods while protecting necessary cultural sanctity.

3.4.3 National Biodiversity Strategy 2007

The National Biodiversity Strategy and Action Plan (NBSAP) is a national framework of action to ensure that the present rate of biodiversity loss is reversed and the present levels of biological resources are maintained at sustainable levels for posterity. The general objectives of the strategy are to conserve Kenya's biodiversity to sustainably use its components; to fairly and equitably share the benefits arising from the utilization of biological resources among the stakeholders; and to enhance technical and scientific cooperation nationally and internationally, including the exchange of information in support of biological conservation. It is recommended that landscaping programmes of the road project should involve use of certified plant species to prevent them from affecting project area negatively in terms of invading wetlands, vegetation and even farmlands. No alien species that might colonize the project area should be introduced for such programmes.

3.4.4 National Water Policy, 2012

The National Water Policy of 2012 (NWP 2012) has been developed in response to the mandate, vision and mission of the ministry responsible for water affairs in Kenya. It is informed by the gains made during the past decade of implementation of reforms in the water sector anchored on the National Water Policy of 1999 (NWP 1999) also referred to as Sessional Paper No. 1 on National Policy on Water Resources Management and Development, the Water Act 2002, existing related policy documents, and the globally recognised Integrated Water Resources Management (IWRM) approach. These reforms have culminated into the development of the Water Sector Strategic Plan (WSSP) 2010 – 2015, which is designed to institutionalise a stakeholder and participatory approach to the management of water affairs in the country.

The policy aims at ensuring a comprehensive framework for promoting optimal, sustainable, and equitable development and use of water resources for livelihoods of Kenyans.

The policy seeks to:

- Ensure increased per capita water availability above the international benchmark of 1000 cubic meters by 2030;
- Ensure progressive restoration and protection of ecological systems and biodiversity in strategic water catchments;
- Maximise use of trans-boundary water resources in coordination with other riparian countries;
- Enhance storm water management and rainwater harvesting;
- Enhance inter-basin water transfer in Kenya as a strategic intervention for optimised used of water resources;
- Enhance pollution control;
- Establish sound research and development in the water sector;
- Enhance enforcement of regulation and other IWRM actions;
- Improve effluent water treatment and recycle for use;
- Ensure sustainable groundwater resources for present and future generations;
- Ensure sufficient funds for sustainable development and management of water resources;
- Resolve conflicting mandates with better cross-sectoral coordination; and
- Develop a water management system which contributes to the protection of the environment.

The NWP 2012 outlines the need for promoting optimal, sustainable, and equitable development and use of water resources in Kenya.

3.4.5 Gender Policy, 2011

The overall aim of the Gender Policy 2011 is to provide precedence for the prevention of discrimination on the basis of sex in the national development process in order to improve social, legal/civic, economic, and cultural conditions of women, men, girls and boys in Kenya. Of the identified policy priorities, two were identified as relevant to project implementation. One of the priorities is incorporating gender equality objectives, indicators, as well as preventative action identification into the ministerial performance frameworks to which the

project must comply. Additionally, the policy lays out a priority that each project will develop integrated gender equality strategies at the initiative level in priority areas.

This policy will be adhered to during initial project implementation, especially during hiring of staff, compensation/livelihood restoration processes, procurement of suppliers, and contracting of sub consultants/contractors.

3.4.6 Guidelines for Prevention and Control of Soil Erosion in Road Works, 2010

The main objective of the guideline is to benefit all persons engaged in the road works (engineers, consultants, constructors and supervisors) but lack information on the extent of damages caused by uncontrolled run-off from the road corridor. It acknowledges that road works potentially result in environmental hazard through the spillage of carbon products, contaminating the surrounding land, dust and noise pollution, interference with the drainage pattern hence extensive soil erosion. The guidelines therefore focus to minimize the damages to the environment through the use of innovative construction methods and procedures which are less damaging to the environment in controlling soil erosion. The guidelines discuss several issues on the soil and water conservation principles which entail:

i.) The design and construction of water ways and soil erosion control measures in road drainage systems,
ii.) Soil erosion control measures needed in upper and lower catchment areas,
iii.) Soil erosion and their mitigation measures against anticipated damages from the road drainage discharge,
iv.) Use of vetiver grass to stabilize and heal erosion damages, and
iv.) Indicative cost of soil and water conservation measures for planning purposes.

The contractor to ensure 100% adherence to the above guidelines in order to minimize damage on the environment.

3.4.7 Environmental Guidelines for Roads and Bridges, 2010

The guideline for roads and bridges provides detailed analysis of environmental issues arising from road works along with mitigation measures that have been used in the national and the international contexts. The main focus is on simply, fulfilling the law that requires assessing the state of environment before and after the road construction period hence achieving sound environmental management for the road transportation system. It also addresses environmental practices to be followed during the development stages starting from tender, feasibility, design, construction, operation and maintenance phase.

The guidelines recommend:

i.) Preparation of full ESIA study to be completed at feasibility and updated at the design stage,
ii.) The certificate for environmental compliance should be issued prior to the issuance of certificate of road completion,
iii.) The guidelines are expected to be used in conjunction with existing and future regulations and guidelines developed by the government in particular NEMA, and
iv.) Emphasizes on the environmentally sustainable guidelines that calls for health and Environmental quality objectives (ecosystem protection, clean air, avoiding mobility and mortality.

3.4.8 Codes, Specifications and Standards

The Standard Specifications for Road and Bridge construction has guidelines on environmental protection and mitigation. Standard Specification Clauses 116,117,125,135,137 address protection of the environment, with regard to water, health, safety and accidents, water supply, maintenance of the engineers' staff houses, offices, laboratories, and attendance upon the engineer and his staff. The provisions of these laws, standards and codes must not be contravened during project implementation, thus the provisions are largely supportive of EMCA 1999; must form part of the legal basis for environmental mitigation, avoidance, prevention, compensation, restoration and enhancement.

3.5 Legal Framework

3.5.1 The County Government Act

The Act established the County Government after the enactment of Kenya's new constitution of 2010. Part 11 of the Act empowers the county government to be in charge of functions described in Article 186 of the constitution (county roads, water and sanitation, health). Part XI of the Act vests the responsibility of planning and development facilitation to the county government in collaboration with the national government. This arrangement has been adopted for interventions in order to not conflict with provisions of the Kenyan Constitution.

Implementation of this project will also seek goodwill and approval of the County Governments of Nyeri and Nyandarua because the project will affect lives of populations within these counties.

3.5.2 Environmental Management and Coordination Act No 8, 1999 and the Subsequent Amendment Act No 5, 2015

The Environment Management and Co-ordination (Amendment) Act 2015 No 5 of 2015 was effective on the 17th June 2015 to amend some sections of the Principal Act (Environmental Management and Co-ordination Act 1999). The Amendment aligned EMCA Act 1999 with the Constitution of Kenya (2010) to include new structures that the Constitution of Kenya 2012 created particularly entrenchment of County Government in environment and natural resource management. EMCA is an act of Parliament that provides for the establishment of an appropriate legal and institutional framework for the management of the environment and for matters connected therewith and incidental thereto. The Act further aims to improve the legal and administrative co-ordination of the diverse sectoral initiatives in the field of environment so as to enhance the national capacity for its effective management. In addition, Act seeks to harmonize all the 77-sector specific legislation touching on the environment in a manner designed to ensure protection of the environment. As the principal environmental legislation in Kenya, EMCA sets the legal framework for environmental management basically as follows: -Part II of the Act 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 ensure the achievement, part VI of the same Act directs that any proponent of a new project, activity or operation should undertake an Environmental Impact Assessment (ESIA) and a report prepared for submission to the National Environmental Management Authority (NEMA), who in turn

may issue a license as appropriate; while projects already in place will undertake annual Environmental Audits (EA). Section 58 of the Environmental Law requires that notwithstanding any approval, permit or license under this Act or any other law in force in Kenya, any person being a proponent of a project, shall before financing, commencing proceeding with carrying out, executing or conducting or causing to be financed, commenced, proceed carried out, executed or conducted by another person for any undertaking specified in the second schedule to this Act, submit a project report to the Authority in the prescribed form, giving the prescribed information and shall be accompanied by the prescribed fee.

Section 68 and 69 of EMCA requires all on-going projects to conduct an EA with a view to finding out if the processes and activities have any negative impacts on the environment and to propose any mitigation measures to counter such impacts. EA are further expounded in Regulation 35 (1) and (2) of Legal Notice 101 of June 2003. Under EMCA 2015, NEMA has gazetted legal tools that govern how ESIAs are conducted and general environmental protection. These guidelines are captured in the Contracts for Construction to ensure that contractors are legally bound to undertake mitigation alongside general construction work. Under EMCA, NEMA has gazetted legal tools that govern conduct of ESIAs and general environmental protection.

3.5.3 L.N 101: Environmental Impact Assessment and Audit Regulations, 2003 and 2016 Amendments

Environmental impact Assessment (ESIA) is a tool for environmental conservation and has been identified as a key component in new project implementation. At the national level, Kenya has put into place necessary legislation that requires ESIA be carried out on every new project, activity or programme (EMCA), and a report submitted to the National Environmental Management Authority (NEMA) for approval and issuance of relevant certificates. These Regulations provide procedures for conducting an ESIA study and detail the parameters to be evaluated during the study. It also provides guidelines on the payment of the ESIA license fees, conducting environmental audits and development of project monitoring plans. In particular, specifications of these guidelines indicate that no proponent should implement a project which can have a negative environmental impact. This ESIA report has been undertaken in accordance with the Environment (Impact Assessment and Audit) regulation 2003, which operationalizes the Environment Management & Coordination Act (EMCA) 1999 and its subsequent amendment, the Environmental Management and Coordination Act (Amendment), 2015. The report is prepared in conformity with the requirements stipulated in the Act and its amendment and the Environmental Impact Assessment and Audit regulations 2003 regulation7 (1) and the second schedule. The proposed project is subject to relevant provisions of these regulations and subsequently, the ESIA will be undertaken in accordance with the requirements.

The proposed project will require an EIA license from NEMA before commencement of any activity hence this assessment. Once an EIA license is issued the proposed project must comply with the requirements of the regulations that also include implementing the recommendations of the report, conducting continuous monitoring and annual audits.

3.5.4 L.N 121: Waste Management regulations, 2006

The Waste Management Regulations were promulgated on September 4, 2006 and became effective on July 1, 2007. These regulations are comprehensive and cover the management of various kinds of waste in Kenya. Generally, it is a requirement under the regulations that a waste generator segregates waste (hazardous and non-hazardous) by type and then disposes the wastes in an environmentally acceptable manner.

Under the regulation, it is a requirement that waste is transported using a vehicle that has an approved "Waste Transportation License" issued by NEMA. Wastes generated in Kenya must be disposed of in a licensed disposal facility. Such a facility will require annual environment audits to be undertaken by NEMA registered Lead Experts.

It is further a requirement under the regulation for a Proponent to install at their premises anti-pollution equipment for treatment of various types of wastes. The treatment options shall be approved by the NEMA in consultation with the relevant lead agency.

The regulation contains definitions of hazardous wastes in the Fourth Schedule. The regulation requires that prior to generating any hazardous waste, a proponent shall undertake an EIA and seek approval from the NEMA.

Labelling of hazardous wastes is mandatory under the regulation and the specific labelling requirements are provided in Rule 18. The treatment options for hazardous waste disposal provided in Rule 19 include incineration or any other option approved by the NEMA.

During the construction phase, the proposed project will generate various types of wastes. For the most part, it is expected that the wastes will be non-hazardous in nature and can be disposed of in accordance with the above regulations.

3.5.5 Water Quality Regulation, 2006

This regulation was promulgated on September 4th, 2006 and became effective on July 1, 2007. The regulation provides for the sustainable management of water used for various purposes in Kenya. For industries in Kenya, the regulation requires that proponents apply for an "Effluent Discharge License" annually for discharging processed wastewater either into the environment, aquatic environment, or public sewers.

For effluent discharges into the environment and aquatic environment, a Proponent needs to apply directly to the NEMA. For discharges into public sewers, a Proponent needs to apply for the license to the relevant county. The regulation contains discharge limits for various environmental parameters into public sewers and the environment.

These regulations will apply to the proposed project during the construction and operational phases. The contractor will be required to properly manage the effluent from construction activities in accordance with the above regulations prior to discharge into the environment.

3.5.6 Environmental Management and Coordination (Air Quality) Regulation, 2014

These regulations generally provide for prevention, control and abatement of air pollution to ensure clean and healthy ambient air. It also provides for the establishment of emission

standards for various sources, including as mobile sources (e.g., motor vehicles) and stationary sources (e.g., industries) as outlined in the Environmental Management and Coordination Act, 1999. It also covers any other air pollution source as may be determined by the Cabinet Secretary in consultation with the Authority. Emission limits for various areas and facilities have been set.

The Regulations prohibits the Proponent from:

i.) Acting in a way that directly or indirectly cause or may cause air pollution to exceed levels set out in the second Schedule to the Regulations
ii.) Allowing particulates emissions into the atmosphere from any source not listed in the six schedules of the Regulations.
iii.) Causing ambient air quality in controlled areas (listed in Schedule Thirteen) to exceed those stipulated under second Schedule.
iv.) Allowing (during construction and demolition) emission of particulate matter above the limits stipulated in second Schedule.
v.) Causing or allowing stockpiling or storage of material in a manner likely to cause air pollution.
vi.) Causing or allowing emissions of oxides of nitrogen in excess of those stipulated in the eleventh Schedule of the Regulation.

During construction period, the Contractor will ensure the compliance to emission of the air pollutants levels in adherence to the Ambient Air Quality levels specified in the regulations. During the construction phase, there will be the need for establishment of baseline levels of priority air pollutants set out in the second schedule of the regulation under Part I; General source pollutants and include; particulate matter, nitrogen oxides and Sulphur oxides. The limits included in the first schedule of the regulations.

3.5.7 Environmental Management and Coordination Act (Noise and Excessive Vibrations Pollution Control) Regulations, 2009

In In May 2009, the Minister for Environment and Mineral Resources promulgated the above regulations for management of environmental noise and excessive vibration as shown in Table 16. The general prohibition states that no person shall make or cause to be made any loud, unreasonable, unnecessary, or unusual noise which annoys, disturbs, injures, or endangers the comfort, repose, health, or safety of others and the environment.

The regulations further provide factors that will be considered in determining whether or not noise and vibration is loud, unreasonable, unnecessary, or unusual. For fixed installations, excessive vibration under these regulations is defined as any vibration that exceeds 0.5 centimetres per second (cm/s) at 30 m from the source.

Rules 13 and 14 of the regulations define the permissible noise levels for construction sites and are reproduced below. These noise limits will be applicable to the proposed project.

Table 3-1 Maximum Permissible Noise Levels – Construction Phase

Facility	Maximum noise level permitted (Leq) in average weighted decibels (dB(A))	
	Day	Night
i) Health facilities, educational institutions, homes for the disabled, etc	60	35
ii) Residential	60	35
iii) Areas other than those in (i) and (ii) above	75	65

NOTES:

1. Time frame:
Day: 6.01 am – 8:00 pm (Leq, 14 hours)
Night: 8:01 pm – 6:00 am (Leq, 10 hours)
Rules 5 and 6 of the regulations define noise levels for various types of activities that generate noise. The First Schedule of the regulations defines permissible noise levels to be complied with during the operational phase of a project and is reproduced in below table.

Table 3-2 Maximum Permissible Noise Level- Operational Phase

Zone		*Sound Level Limits (dBA) (Leq, 14h)*		*Noise Rating Level (NR) (Leq,14h)*	
		Day	*Night*	*Day*	*Night*
A.	*Silent Zone*	*40*	*35*	*30*	*25*
B.	*Places of Worship*	*40*	*35*	*30*	*25*
C.	*Residential*				
	Indoor	*45*	*35*	*35*	*25*
	Outdoor	*50*	*35*	*40*	*25*
D.	*Mixed residential (with some commercial and places of entertainment)*	*55*	*35*	*50*	*25*

NOTES:

1. Time frame:
Day: 6.01 am – 8:00 pm (Leq, 14 hours)
Night: 8:01 pm – 6:00 am (Leq, 10 hours)

The regulation further stipulates that a permit will be required during the construction and operational phase of a project if there will be equipment that will produce noise during this phase of the project.
However, if any appointed contractor expects to generate noise levels in excess of the limits given in the table above, that contractor shall apply for a noise permit from NEMA for the duration of exceedance. The Fourth Schedule of the regulations contains details of the application for a noise license while the Fifth Schedule provides a description of the noise permit that the NEMA will grant the main contractor
The contactor will ensure that no excessive noise and vibrations are made during the construction of the road. It envisaged that the construction works will involve use of heavy earthmoving equipment and trucks which can generate excessive noise and vibrations. Motor vehicles used during the construction of the proposed road must also adhere to the regulations which prohibit excessive noise. The provision of the act on motor vehicle states that no person shall operate a motor vehicle which produces any loud and unusual sound exceeding 84 dB(A) when accelerating. The Act also states that no person shall at any time sound the horn or other warning device of a vehicle except when necessary to prevent an accident or an incident.

Contractor will ensure that vibration levels do not exceed 0.5 centimeters per second beyond any source property boundary or 30 meters from any moving source. Noise permits may be required in blasting areas.

3.5.8 Environmental Management and Coordination Act (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006.

The Regulations requires proponents to conduct ESIA if their activities may have adverse impacts on ecosystems or lead to unsustainable use of natural resources or/and lead to introduction of exotic species. The regulation aims at increasing the coverage of protected areas and establishing new special status sites by providing guidelines for protecting endangered species. Section 5 of the regulation provides guidelines on Conservation of threatened species and Part III of the regulation guides on the access to genetic materials. The Section states that, the Authority shall, in consultation with the relevant lead agencies, impose bans, restrictions or similar measures on the access and use of any threatened species in order to ensure its regeneration and maximum sustainable yield.
Documentation on the regulation states that project activities can only be carried out upon presentation of a comprehensive EIA report and licensing by NEMA. The regulations also empower lead agencies in the conservation and natural resource management to keep and update an inventory on the endangered species in the country. Safeguarding the ecosystem resources in accordance with the EIA License during the project implementation phase ensures compliance with these regulations.

3.5.9 Environmental Management and Coordination Act (Fossil Fuel Emission Control) Regulations, 2006

The regulation provides for the elimination or reduction of emissions generated by internal combustion engines to acceptable standards. The regulations provide guidelines on use of clean fuels, as well as use of catalysts and inspection procedures for engines and generators. These

regulations are triggered in that the proponent will use vehicles and equipment that depend on fossil fuel as their source of energy. This regulation when implemented is going to eliminate or reduce negative impacts air quality.

3.5.10 The Forest Conservation and Management Act, 2016

This is an Act of Parliament to give effect to Article 69 of the Constitution with regard to forest resources; to provide for the development and sustainable management, including conservation and rational utilization of all forest resources for the socio-economic development of the country and for connected purposes.

64. (1) notes that except under a license or permit or a management agreement issued or entered into under this Act, no person shall, in a public or provisional forest;

a) Fell, cut, take, burn, injure or remove any forest produce

c) Erect any building or livestock enclosure, except where the same is allowed for a prescribed fee;

d) Smoke, where smoking is by notice prohibited, or

e) Clear, cultivate or break up land for cultivation or for any other purpose;

The Proponent and contractors will adhere to mitigation measures outlined in the ESMP in regard to vegetation clearance and the provisions of this act will be observed

3.5.11 The Wildlife Conservation and Management Act, 2013

Wildlife Conservation and Management Act was enacted to regulate, conserve, and ensure sustainable management of wildlife resources in Kenya. Passed in 2013, the Act came into force in 2014 with several changes in the way wildlife resources are managed in the country. Section 4 of this Act states that its implementation shall be guided by the following principles:

- Wildlife conservation and management shall be devolved, wherever possible and appropriate, to owners and managers of land where wildlife occurs;
- Conservation and management of wildlife shall entail effective public participations;
- Wherever possible, conservation and management of wildlife shall be encouraged using an ecosystem approach;
- Wildlife conservation and management shall be encouraged and recognized as a form of land use on public, community and private land;
- Benefits of wildlife conservation shall be derived by the land user in order to offset costs and ensure the value and management of wildlife do not decline;
- Wildlife conservation and management shall be exercised in accordance with the principles of sustainable utilization to the benefit of present and future generations;
- Benefits accruing from wildlife conservation and management shall be enjoyed and equitably shared by the people of Kenya.

The Wildlife Conservation and Management Act consolidate the previous laws relating to the protection, conservation, and management of wildlife in Kenya. This Act is administered by the Government of Kenya through the Ministry responsible for the matters relating to wildlife in conjunction with other relevant government agencies – most importantly, the Kenya Wildlife Service (KWS). Since the project area is within a wildlife zone, The contractor is expected to adhere to the provisions of this act.

3.5.12 The Water Act, 2016

The Water Act 2016 was enacted on 20th September 2018. The Act seeks to provide for the regulation, management and development of water resources, water and sewerage services; and for other connected purposes. The Act confirms that every water resource is vested in and held by the national government in trust for the people of Kenya.

Section 134 of the Act makes it an offence to throw or convey or cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive or unwholesome matter or thing to water resources in such a manner to cause, or likely to cause pollution of the water resources.

The Water Act mandates that a permit is required for any of the following purposes: (a) any use of water from a water resource, except as provided by section 37; (b) the drainage of any swamp or other land; (c) the discharge of a pollutant into any water resource; and (d) any other purpose, to be carried out in or in relation to a water resource, which is prescribed by Regulations made under this Act to be a purpose for which a permit is required.

A permit is not required: (a) for the abstraction or use of water, without the employment of works, from any water resource for domestic purposes by any person having lawful access to the water resource; (b) for the abstraction of water in a spring which is situated wholly within the boundaries of the land owned by any one landholder and does not naturally discharge into a watercourse abutting on or extending beyond the boundaries of that land; or (c) for the storage of water in, or the abstraction of water from a reservoir constructed for the purpose of such storage and which does not constitute a water course for the purposes of this Act.

The Road construction activities will need bulk supply of water for mixing and curing concrete, suppressing dust, cleaning and maintenance of equipment, among others. The Act promotes water resources management through soil and water conservation, protection, development and utilization of water resources. The construction of the project road will have to apply water resource management measures since the project area has several lakes and small streams.

The Act vests provision of water and sanitation services with the county governments through Water Services Providers (WSPs) whose operations must be in accordance with a Service Agreement entered between each WSP and Water Services Regulatory Board (WASREB).

The Act stipulates that a permit shall be required in all cases of proposed diversion, abstraction, obstruction, storage or use of water, with minor exceptions relating to use for domestic purposes (Section.36). Section 158 makes it an offence to pollute such waters. Similarly, under section 169, it is an offence to throw or convey polluting matter into a body of water.

The proposed road project will source water for construction activities from local rivers and streams and therefore abstraction permit must be acquired from WRA. Disposal of pollutants into the river will also be avoided by construction workers..

3.5.13 Climate Change Act, 2016

This is an Act of Parliament enacted to provide for a regulatory framework for enhanced response to climate change, to provide for mechanism and measures to achieve low carbon

development. Part IV Section 15 provides on how Climate change considerations should be integrated in every public-sector entity. A public entity is expected to observe the Act together with provisions of the National Climate Change Action Plan. The National Climate Change Action Plan Section 4.3.1 (d) has specified how the road infrastructure sector can contribute towards the achievement of low carbon climate resilient sustainable development.

Construction vehicles and equipment as well as vehicles using the road during operation period are likely to generate gaseous pollutants (CO, CO2) that can impact on local climate. Measures will be provided in the Environmental Management Plan for ameliorating potential adverse impacts of the project on the climate.

3.5.14 The Public Health Act (Cap. 242)

Part IX Section 115 of the Act states that no person or institution shall cause nuisance or conditions liable to be injurious or dangerous to human health. Any noxious matter or waste water flowing or discharged into a watercourse is deemed as a nuisance.

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 conditions liable to cause injuries or just are dangerous to human health.

Part XII Section 136 states that all collections of water, sewage, rubbish, refuse and other substance which permit or facilitate the breeding or multiplication of pests shall be deemed a nuisance. The Act addresses matters of sanitation, hygiene and general environmental health and safety which is directly related to road project and associated activities.

The activities and operations of the proposed project can be detrimental to human and environmental health and safety in the absence of appropriate measures. For example, waste, dust, noise and air emission generated from these activities of the proposed project can directly or indirectly have adverse impacts on human and environment.

It is therefore recommended that measures be taken in accordance to these Acts in order to safeguard the health of the workers and the public at large during project implementation and after commissioning.

3.5.15 National Transport and Safety Authority Act, 2012

The National Transport and safety Authority (NTSA) was established in 2012 with the objective of harmonizing the operations of the key road transport departments and help in effectively managing the road transport sub-sector and minimizing loss of lives through road accidents. Some of its key mandates are the development of road safety strategies and facilitating education of the general public on road safety.

The project will adhere to NTSA's road safety rules, standards, and motor vehicle licensing requirements. In addition, all vehicles using the road will be required to adhere to these set rules and regulations.

3.5.16 The Physical and Land Planning Act, 2019

The Section 16 of the Physical and Land use Planning Act provides for the preparation of plans on any land within the jurisdiction of a County Government with the purpose of improving the land and providing for the proper physical development of such land and securing suitable provision for transportation, public purposes, utilities and services, commercial, industrial, residential and recreational areas, including parks, open spaces and reserves, and also the making of suitable provision for the use of land for building or other.

Section 56 of this Act of parliament empowers the county governments to reserve and maintain all land planned for open spaces, parks, urban forests and green belts as well as land assigned for public social amenities. Section 57 requires development consent to be obtained from the county executive committee before any development is undertaken within the county.

The Developer will need to seek approval for the construction of the temporary camp (s), while KeNHA will be required to discuss its development plans (road designs) with the respective County Physical Planning Officers and liaise with the local governments in development control along the corridor.

3.5.17 Public Procurement and Disposal Act, 2005

This Act establishes procedures for procurement and the disposal of unserviceable, obsolete or surplus stores and equipment by public entities to achieve the following objectives -

a.) to maximize economy and efficiency
b.) to promote competition and ensure that competitors are treated fairly
c.) to promote the integrity and fairness of those procedures
d.) to increase transparency and accountability in those procedures, and
e.) to increase public confidence in those procedures
f.) to facilitate the promotion of local industry and economic development.

3.5.18 Kenya Road Act- (Cap 399) No 2 of 2007

This is an Act of Parliament that provides for the establishment of the Kenya National Highways Authority, the Kenya Urban Roads Authority and the Kenya Rural Roads Authority with clear and separate mandates. Part II of the Act establishes the various Roads Authorities in Kenya and outlines their functions.

Section 8 and 9 of the Act provides for the dedication, conservation or alignment of public travel lines including construction of access roads adjacent to lands from the nearest part of a public road. Section 10 and 11 allows for notices to be served on the adjacent land owners seeking permission to construct the respective roads. Already public meetings were held during public consultations and notifications to this effect issued.

Section 23 of the Act outlines procedures for acquisition of land for the purpose of the Authority's development while Section 24 (1) allows any authorized employee of an Authority to enter upon any land and survey such land or any portion thereof for the purposes of the Authority's development activities. Section 24 (2) provides that where any damage to land is

caused by reason of the exercise of the powers conferred by this section, the owner or occupier of the land shall be entitled to compensation therefore in accordance with this Act.

By undertaking this project, the project proponent is exercising his mandate and, therefore, has the powers and duties to construct, upgrade, rehabilitate and maintain roads under its control.

3.5.19 HIV/AIDS Prevention and control Act (Act No. 14 of 2006)

Part 11, Section 7 requires HIV and AIDs education in the work place. The government is expected to ensure provision of basic information and instruction on HIV and AIDs prevention and control to; Employees of all Government ministries, Departments, authorities, and other agencies; and, Employees of private and informal sectors. The information on HIV/AIDs is expected to be treated with confidentiality at the work place and positive attitudes shown towards infected employees and workers.
During the road project implementation, the contractor is expected to create awareness to the employees and the local communities on the issues related to HIV/AIDs.

3.5.20 The Work Injury Benefits Act (WIBA), 2007

It is an act of Parliament to provide for compensation to workmen for injuries suffered in the course of their employment.
It outlines the following;

- Employer's liability for compensation for death or incapacity resulting from accident;
- Compensation in fatal cases
- Compensation in case of permanent partial incapacity;
- Compensation in case of temporary incapacity;
- Persons entitled to compensation and methods of calculating the earnings;
- No compensation shall be payable under this Act in respect of any incapacity or death resulting from a deliberate self-injury;
- Notice of an accident, causing injury to a workman, of such a nature as would entitle him for compensation shall be given in the prescribed form to the director.

The construction activities and operations may pose safety and health risks to construction workers. The contractor will need to abide by all the provisions of WIBA when handling injuries reported in the course of implementation of the proposed project.

3.5.21 The Physical and Land Use Planning Act 2019

Section 16 of the Physical and Land use Planning Act provides for the preparation of plans on any land within the jurisdiction of a County Government with the purpose of improving the land and providing for the proper physical development of such land and securing suitable provision for transportation, public purposes, utilities and services, commercial, industrial, residential and recreational areas, including parks, open spaces and reserves, and also the making of suitable provision for the use of land for building or other.

Section 56 of this Act of parliament empowers the county governments to reserve and maintain all land planned for open spaces, parks, urban forests and green belts as well as land assigned

for public social amenities. Section 57 requires development consent to be obtained from the county executive committee before any development is undertaken within the county.

3.5.22 The Land Acquisition Act, Chapter 295 Laws of Kenya, 2012

The Act provides for the compulsory or otherwise acquisition of land from private ownership for the benefit of the general public. Section 3 states that when the Minister is satisfied of the need for acquisition, notice will be issued through the Kenya Gazette and copies delivered to all the persons affected. Full compensation for any damage resulting from the entry onto land to do things such as survey upon necessary authorisation will be undertaken in accordance with section 5 of the Act.

Likewise, where land is acquired compulsorily, full compensation shall be paid promptly to all persons affected in accordance to sections 8 and 10 along the following parameters:

- Area of land acquired;
- The value of the property in the opinion of the Commissioner of land (after valuation);
- Amount of the compensation payable;
- Market value of the property;
- Damages sustained from the severance of the land parcel from the land;
- Damages to other property in the process of acquiring the said land parcel;
- Consequences of changing residence or place of business by the land owners; and
- Damages from diminution of profits of the land acquired.

Part II of the Act allows for the temporary acquisition of the land for utilisation in promotion of the public good for periods not exceeding five years. At the expiry of the period, the commissioner of Land shall vacate the land and undertake to restore the land to the condition it was before. Any damages or reduction of value shall be compensated to the landowners.

The implementation of the project will involve land acquisition and this will be done in accordance to this Act.

3.5.23 Land Control Act (Cap. 302)-Revised edition 2012

This law provides for the control of transactions in agricultural land, especially the machinery of the Land Control Boards. However, of interest in this report is the consideration in granting or refusal of consent by the Board based on the impact the transaction is likely to have on the maintenance or improvement of standards of good husbandry within the specific agricultural area.

The Act controls transactions in land including sale, transfer and lease, the proponent will abide by this act during the land acquisition and compensation period

3.5.24 The Lands Act, 2012 and Land Laws (Amendment) 2016

Part II Section 8 of Land Act, 2012 provides guidelines on management of public land by National Land Commission on Behalf of both National and County Governments. This law in Section 8(b) stipulates that the Commission shall evaluate all parcels of public land based on

land capability classification, land resources mapping consideration, overall potential for use, and resource evaluation data for land use planning.
Land Laws (Amendment), 2016 amends land laws including Land Act 2012 to align them to with the Constitution to give effect to Articles 68(c)(i) and 67(2)(e) of the Constitution, to provide for procedures on evictions from land, and for connected purposes.

The proponent will follow this legislation in regards to land acquisition in the project area.

3.5.25 National Land Commission Act No.5 of 2012

This Act provides with respect to the administration, structure, operations, powers, responsibilities and additional functions of the National Land commission established by article 67 of constitution and for certain aspects of management and administration of land in accordance with the principles of land policy set out in Article 60 of the constitution and the national land policy. Pursuant to Article 67(2) of the constitution, the functions of the commission include;

a) To manage public land on behalf of the national and county governments;
b) To recommend a national land policy to the national government;
c) To advise the national government on a comprehensive programme for the registration of title in land throughout Kenya;
d) To conduct research related to land and the use of natural resources, and make recommendations to appropriate authorities;
e) To initiate investigations, on its own initiative or on a complaint, into present or historical land injustices, and recommend appropriate redress;
f) To encourage the application of traditional dispute resolution mechanisms in land conflicts;
g) To assess tax on land and premiums on immovable property in any area designated by law; and
h) To monitor and have oversight responsibilities over land use planning throughout the country.

As noted previously, the development of the proposed roads will require acquisition of land on some sections of the project roads. The National Land Commission will therefore play a very important role in the land acquisition process. The proponent should liaise with the National Land Commissions County Offices of Nyeri and Nyandarua counties on issues regarding land to ensure compliance with these provisions of the act.

3.5.26 Traffic Act (Cap. 403)

Section 42 Part 1 forbids any driver to drive a vehicle at a speed exceeding fifty kilometers per hour on any road within the boundaries of any trading centre, township, municipality or city: The highway authority is expected to erect and maintain traffic signs as prescribed so as plainly to indicate to drivers entering or leaving such roads or areas where the fifty kilometers per hour speed limit restriction begins and ends.

The contractor will have several construction vehicles ranging from heavy vehicles such as lorries for transportation of construction materials to medium vehicles such as pick-ups used

by the construction staff. The usage of these vehicles should be adherence to these regulations. All construction vehicles should be driven at the recommended speed.

3.5.27 The Occupation Safety and Health Act, 2007

This Occupational Safety and Health Act (OSHA) was enacted to provide for the health, safety and welfare of persons employed in workplaces, and for matters incidental thereto and connected therewith.

Part II of the Act provides the General Duties to which the occupier must comply with respect to health and safety in the workplace. Such duties include undertaking safety and health (S&H) risk assessments, S&H audits, notification of accidents, injuries and dangerous occurrences. A number of sections under this part shall be applicable to the proposed project.

Part IV deals with the enforcement provisions that Directorate of Occupational Safety and Health Services (DOSHS) has under the Act. It discusses the instances when Improvement and Prohibition Notices can be issued as well as the powers of Occupational S&H officers. This part of the Act will be mandatory for the occupier to comply with for the proposed project.

Part V of the Act requires all workplaces to be registered with the DOSHS. This part will be applicable for the proposed project as the Occupier will have to apply for registration of their project with the DOSHS on completion of the construction phase and before the operational phase of the project.

Part VI of the Act lists the requirements for occupational health provisions which include cleanliness, ventilation, overcrowding, etc. This section of the Act will apply to the Occupier during the operational phase of the project.

Part VII of the Act contains provisions for the safe operation of machinery and includes all prime movers and transmission equipment. Additionally, this part includes the safe operation of cranes, chains, ropes, lifting tackles, pressure vessels, and their statutory examination by DOSHS Approved Persons. This part of the Act will apply to the proposed project during the construction and operational phases.

Part VIII of the Act contains provisions for general safety of a workplace, especially fire safety. This part of the Act will apply to the proposed project during the design, construction, and operational phases.

Part X of the Act deals with the General Welfare conditions that must be present during the construction and operational phase of the project. Such conditions include first aid facilities, supply of drinking water, accommodation for clothing, ergonomics, etc. This part of the Act will apply to the proposed project during the construction and operational phases.

Part XI of the Act contains Special Provisions on the management of health, safety, and welfare. These include work permit systems, PPE requirements and medical surveillance. Some sections of this part of the Act will be applicable to the proposed project during the construction and operational phase.

Part XIII of the Act stipulates various fines and penalties associated with non-compliance with the Act.

It includes those fines and penalties that are not included in other sections of the Act and will be important for the Occupier to read and understand the penalties for non-compliance with S&H provisions.

All Sections of the Act related to this project, such as provision of protective clothing, clean water, and insurance cover will be observed to protect all from work related to injuries or other health hazards.

The project shall be registered as a work place for regular inspections from DOSH inspectors. A healthy and safety committee shall be established to undertake implementation of all the provisions of the law.

3.5.28 Employment Act, 2007

This is an Act of parliament that applies to all employees employed by any employer under a contract of service. It requires that employee recruitment, contract and grievance management, disciplinary measures and retrenchment and termination of service should be rational, fair and just.

Employment of children in the following forms is also prohibited in the following sections of the Act:

53. (1) notwithstanding any provision of any written law, no person shall employ a child in any activity which constitutes worst form of child labour.

56. (1) No person shall employ a child who has not attained the age of thirteen years whether gainfully or otherwise in any undertaking

(2) A child of between thirteen years of age and sixteen years of age may be employed to perform light work which is:

a) Not likely to be harmful to the child's health and development; and

b) Not such as to prejudice the child's attendance at school, his participation in vocational orientation or training programmes approved by Minister or his capacity to benefit from the instructions received.

The contractor will need to follow the requirements of the Act during employment, especially by being just and fair on recruitment, contract management, remuneration, and termination of service, as they are straight forward.

3.5.29 Mining Act, 2016

The purpose of these regulations is to regulate the licensing and permitting of mineral rights and issuing permits in accordance with the Act. The Act applies to various types of minerals including construction and industrial minerals specified in First Schedule. The construction minerals specified in the Act and which are going to be used in the proposed project are: stones, gravel, sands and soils.

Section 104 of the Act specifies the requirements which the Cabinet Secretary will consider when granting the mining license. Chief among these requirements is environmental impact assessment license, social heritage assessment and environmental management plan.

A mining license grants a qualifying person or company the exclusive right to develop a deposit, extract, process, beneficiate and dispose of a mineral or minerals, including from mine dump or mine waste and tailings and to conduct further exploration activities within the license area according to an approved programme for mining operations.

A mining permit grants an eligible person or a corporate body the exclusive right to carry out small-scale mining operations in the permit area according to an approved mining permit programme.

The Act obligates the license holder to ensure:

a) the sustainable use of land through restoration of abandoned mines and quarries;
b) that the seepage of toxic waste into streams, rivers, lakes and wetlands is avoided and that disposal any toxic waste is done in the approved areas only;
c) that blasting and all works that cause massive vibration is properly carried out and muffled to keep such vibrations and blasts to reasonable and permissible levels in conformity with the Environmental Management and Coordination Act; and
d) that upon completion of prospecting or mining, the land in question shall be restored to its original status or to an acceptable and reasonable condition as close as possible to its original state.

The Contractor will need to comply with the Act by obtaining construction materials/minerals from licenced dealers. The possible material sources identified during material investigation undertaken for the proposed project are presented in 2.9.3. The contractor may consider obtaining the materials from these existing sources or from new sources. In the event the contract decides to source the materials from their own new sites, then it should obtain mining licence as well as other licenses specified in this Act such as EIA Licence and comply with permitting requirements therein.

3.5.30 Valuer's act, Cap 532

The valuation practice in Kenya is governed by the Valuers Act Cap 532, which provides for a Valuers Registration Board that regulates the activities and conduct of registered valuers. Valuers in Kenya are registered upon application to the Board and are required to be full members of the Institution of Surveyors of Kenya (ISK). The Act governs the formation and composition of valuation practices including the qualification of partners and directors in charge of valuation. The Board also deals with discipline and complaints in respect to valuation practice.

The project proponent will comply with the Act by ensuring that registered / certified land valuers are involved in the proposed acquisition of private land for the proposed road realignment which will be carried out in line with the provisions of this law.

3.5.31 Sexual Offences Act No. 3 of 2006

This is a comprehensive law that criminalizes a wide range of behaviors including rape, sexual assault, defilement, compelled or induced indecent acts with child imbeciles or adults, gang rape, child pornography, child trafficking, child sex tourism, child prostitution, exploitation of prostitution, incest by male and female persons, sexual harassment, deliberate transmission of HIV or other life threatening sexually transmitted disease, stupefying with sexual intent, forced sexual acts for cultural or religious reasons among others. The Act also has orders for medical treatment for victims including free HIV prophylaxis, emergency pregnancy pill and counselling. The Act provides stiff penalties in which most of the crimes attract minimum of ten years imprisonment which can be enhanced to life imprisonment.

Implementation of a project creates changes in a community in which it is implemented and is has potential to can cause shifts in power dynamics between community members and within households. For instance, male jealousy is a key driver of Gender Based Violence (GBV) which can be triggered by labor influx on a project when workers are believed to be interacting with community women. Hence, abusive behavior can occur not only between project-related staff and those living in and around the project site, but also within the homes of those affected by the project.

3.5.32 Children Act, 2001

Part 2 of the Act denotes the rights of the children and their welfare shall be protected from child labor and armed conflict i.e. Every child shall be protected from economic exploitation and any work that is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral or social development.
The Act also notes that a child shall be protected from sexual exploitation and use in prostitution, inducement or coercion to engage in any sexual activity, and exposure to obscene materials.

Sensitization to the community on the need to ensure the protection of children has been done and will continue throughout the project cycle. In addition, the contractor will sensitize workers against abuse and exploitation of children.

3.5.33 Licenses and Permits Required

The subsidiary legislation under the EMCA is partially monitored through the use of permits and licenses. Subsequently all licenses and permits required during the construction phase shall be the responsibility of the individual contractors and their agents. During the operational phase, all permits and licenses required to operate the project will be the responsibility of the proponent.

Before the contractor mobilizes to the site, there are certain permits that he will need to put in place. Some permits may be obtained during construction since they will be determined as need arises. Table 3-5 overleaf lists the environment-related permits required for this project.

Table 3-5 : Project Permit and License Requirements

No.	Relevant activity	Statute	Permit and License Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Date of Acquisition	Duration
Pre-Construction Stage							
1	Construction and operation of the road	Environmental Management and Coordination Act (EMCA) Cap 387, Rev 2018	Need to submit ESIA report to obtain EIA license	NEMA	KeNHA	Upon approval of ESIA report	Max 90 Days from date of submission of ESIA Report
2	Construction activities	Occupational Safety and Health Act (OSHA), 2007	Need to apply registration of premises	DOSHS	Contractor	Before commencement of construction	1 – 4 weeks
3	Setting up of construction camp sites	Environmental Management and Coordination Act (EMCA) Cap 387, Rev 2018	Need to submit Project report for the Camp Sites to obtain EIA License	NEMA	Contractor	Before commencement of construction	1– 1.5 months
4	Water abstraction from Surface water sources in the area (Rivers etc.)	Water Act, 2016	Need to obtain permission to abstract water	WRA	Contractor	Before commencement of construction	1 – 1.5 months
5	Drilling of boreholes to supply water to the contractor	Environmental Management and Coordination Act (EMCA) Cap 387, Rev 2018	Need to submit Project report to obtain EIA license	NEMA	Contractor	Before commencement of construction	1 – 1.5 months
		Water Act, 2016	Need to obtain permission to abstract water	WRA	Contractor	Before commencement of construction	1 – 1.5 months
6	Storage, transport and disposal of ordinary domestic and office waste	Environmental Management and Coordination Act (EMCA) Cap 387, Rev 2018	Need to obtain waste license through submission of Waste Management Plan	NEMA	Contractor	Before commencement of construction	1 – 1.5 months
7	Storage, transport and disposal of hazardous waste	Environmental Management and Coordination Act (EMCA) Cap 387, Rev 2018	Need to obtain hazardous waste license through submission of Waste Management Plan	NEMA	Contractor	Before commencement of construction	1 – 1.5 months
8	Effluent Discharge	The Environment Management and Coordination (Water Quality) Regulations 2006	Need to obtains Effluent Discharge License (EDL)	NEMA	Contractor	Before commencement of construction	Annual

No.	Relevant activity	Statute	Permit and License Requirement	Competent Authority	Responsible Agency for Obtaining Clearance	Date of Acquisition	Duration
Construction stage							
1	Extraction of rock aggregates and murram from quarry	Environmental Management and Coordination Act (EMCA) Cap 387, Rev 2018	Need to obtain material extraction permit	NEMA	Contractor	Before extraction works	Max 1 month
		-	Need to purchase material extraction rights	County Government	Contractor	Before extraction works	Max 1 month
2	Blasting of construction site bedrocks (if required)	Mining Act, 2016	Need to obtain blasting permit	Mines and Geology Department in Ministry of Environment and forestry	Contractor	Before blasting works	Max 1 month
3	Emission of excessive noise/vibration (if required)	Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009	Need to obtain permit to emit excess noise/vibration	County Government Nyeri and Nyandarua	Contractor	Before excessive noise/vibration works	2 days
4	Food handling in the campsite	Public Health Act	Obtain Food Handler Certificate	County Government	Contractor	Before handling of food in the campsite	6 months
5	Workplace registration	Occupational Safety and Health Act, 2007	Apply for Registration of a Workplace	DOSHS	Contractor	Before utilizing the campsite	Annual

3.6 Institutional Framework

3.6.1 Ministry of Transport and Infrastructure

The Ministry of Transport and Infrastructure has the overall responsibility for the provision of an efficient road network in Kenya. The Ministry provides the regulatory framework, co-ordination, oversight, supervision, liaison with other state agencies and any services necessary for the smooth functioning of the roads sub-sector.

The Ministry of Transport and Infrastructure will be responsible for requesting funds from the National Treasury for compensation of the Project Affected Households (PAHs) who will to be physically and economically displaced as a result of the Project.

3.6.2 National Environment Management Authority (NEMA)

The National Environmental Management Authority is the supreme regulatory and advisory body on environmental management in Kenya. NEMA is required to coordinate and supervise the various environmental management activities being undertaken by statutory organs with a view to promoting their integration into development policies, programmes, plans and projects that provide sustainable development and a safe and healthy environment to all Kenyans. The key functions of NEMA through the National Environment Council include:

- Responsibility for policy formulation and direction for the purposes of the Act;
- Setting national goals and objectives and determining policies and priorities for the protection of the environment;
- Promotion of cooperation among public departments, local authorities, private sector, non-governmental organizations and such other organizations engaged in environmental protection programmers; and perform such other functions as are assigned by the Act.

KENHA was established by the Kenya Roads Act 2007. It is an autonomous road agency. The functions of KENHA include the management, development, rehabilitation and maintenance of all National Urban Truck Roads.

The key functions of KENHA include:

- Constructing, upgrading, rehabilitating and maintaining roads under its control;
- Controlling urban roads reserves and access to roadside developments;
- Implementing road policies in relation to urban roads;
- Ensuring adherence by motorists to the rules and guidelines on axle load control prescribed under the Traffic Act CAP 403 and any Regulations under the Act;
- Ensuring that the quality of road works is in accordance with such standards as may be defined by the CS;
- In collaboration with the Ministry responsible for transport and the Police Department, oversee the management of traffic and road safety on urban roads;
- Monitoring and evaluating the use of urban roads;
- Planning the development and maintenance of urban roads;
- Collecting and collating all such data related to the use of urban roads as may be necessary for efficient forward planning under this Act;
- Preparing the roads works programmes for all urban roads;

- Liaising and coordinating with other road authorities in planning and on operations in respect of roads;
- Advising the CS on all issues relating to urban roads; and
- The CS may direct perform such other functions related to the implementation of this Act as.

3.6.3 National Environment Complains committee

The National Environmental Complaints Committee (NECC) was established under Section 31 of the Environmental Management and Co-ordination Act, 1999.It is an important institution in the assessment of the condition of the environment in Kenya. It plays an important role in the facilitation of alternative dispute resolution mechanisms relating to environmental matters. The NECC makes recommendations to the Cabinet Secretary and thus contributes significantly to the formulation and development of environmental policy.

3.6.4 National Environment Tribunal

The National Environmental Tribunal is a quasi-judicial tribunal established pursuant to the provisions of the Environmental Management and Co-ordination Act, 1999 (EMCA). Its mandate generally is to hear any disputes regarding the exercise of power by the National Environmental Management Authority (NEMA).

3.6.5 Water Resource Authority

Water Resources Authority (WRA) is a state corporation established under Section 11 of the Water Act, 2016. It is mandated through delegated Authority on behalf of the National government to safeguard the right to clean water by ensuring that there is proper regulation of the management and use of water resources, in order to ensure sufficient water for everyone now and in the future.

3.6.6 National Transport and Safety Authority

The National Transport and safety Authority was established through an Act of Parliament; Act The objective of forming the Authority was to harmonize the operations of the key road transport departments and help in effectively managing the road transport sub-sector and minimizing loss of lives through road crashes.

- Registering and licensing of motor vehicles,
- Conduct motor vehicle inspection and certification,
- Regulate public service vehicles (PSVS),
- Advise the Government on national policy with regard to road transport sector,
- Develop and implement road safety strategies,
- Facilitate the education of members of the public on road safety,
- Conduct research and audits on road safety,
- Compile inspection reports relating to traffic accidents,
- Establish systems and procedures for, and oversee the training, testing and licensing of drivers,
- Formulate and review the curriculum of driving schools, and
- Coordinate the activities of persons and organizations dealing in matters relating to road safety.

3.6.7 Kenya Roads Board.

Kenya Roads Board (KRB) is a State Corporation established under the Kenya Roads Board Act, 1999. Its mandate is to oversee the road network in Kenya and coordinate its development, rehabilitation and maintenance funded by the KRB Fund and to advise the Minister for Roads on all matters related thereto.

3.6.8 National Lands Commission (NLC)

National land commission derives its mandate from the constitution of Kenya, the National Land Policy (2009) and acts of parliament, namely the national land commission (NLC) Act, the Land Act and the Land Registration Act, all of 2012. The broad mandate of the National Land Commission can be categorized as provided for in the constitution;

- Manage public land on behalf of the National and County Government;
- Recommend a national Land policy to the National Government;
- Advice the National Government on a comprehensive program for the registration of title in land throughout Kenya;
- Conduct research related to land and use of natural resources and make recommendations to appropriate authorities;
- Initiate investigations on its own initiative or on a complaint, into present or historical land justices and recommend appropriate redress;
- Encourage the application of traditional dispute resolution mechanisms in land conflicts;
- Assess tax on land and premiums on immovable property in any area designated by law;

Monitor and have oversite responsibilities over land use planning throughout the country.

3.6.9 Ministry of Environment and Forestry-Mines and Geology department

The Department was started on 1st January, 1933 through the Mining Ordinance of 1933. and it will have authority over all matters involving mining and quarry safety.

3.6.10 Directorate of Occupational Safety and Health Services (DOSHS)

DOSHS is responsible for the enforcement of Occupational Safety and Health Act (OSHA), 2007 and associated regulations. DOSHS undertakes workers' safety and health inspections at its own initiative or upon receiving reports on any associated issues and requires that all construction sites be registered with the Directorate.

The project construction site will be registered with this authority as workplaces before the commencement of the construction works and the safety management plans, training and emergency preparedness, done in accordance with the relevant guidelines issued by DOSHS.

3.6.11 The Environment and Land Court

The Land and Environment Court is established under the Environment and Land Court Act, 2011 (No. 19 of 2011). It is empowered by law, given the status of the High Court and has the jurisdiction to hear and determine disputes, actions and proceedings concerning acquisition of land as well as matters pertaining to the environment.

3.6.12 County Governments

The Constitution of Kenya, 2010 under chapter one article 6 has provided for the creation of a decentralized system of government that has devolved the Legislature and the Executive arms of government into 47 Political and Administrative Counties. The primary objective of decentralization is to devolve power, resources and representation down to the local level. To this end, various laws have been enacted by Parliament to create strategies for the implementation framework and the adoption on which objectives of devolution can be achieved including, but not limited to the County Government act No.17 of 2012, Urban Areas and Cities Act, No. 13 of 2011, National Government Co-ordination Act, No. 1 of 2013, and National Government Coordination Act, No. 1 of 2013.

The Fourth Schedule of the Constitution of Kenya 2010 Part 2 (3) provides for devolved environmental functions to be undertaken by the County Governments and includes; control of air pollution, noise pollution, and other public nuisances.

Nyeri and Nyandarua Count Government will be responsible for the issuance of trade licenses needed for the project, issuance of temporary facilities construction plan approvals, monitoring environment protection within the project, and general development control along the project Roads

3.6.13 The Treasury

The only role will be to make available financial resources for the compensations of Project Affected Households (PAHs) who are going to be physically and economically displaced as a result of the project.

4 PHYSICAL, ENVIRONMENTAL AND SOCIAL CONDITIONS

This Chapter of the report covers the biophysical and social conditions in the project area. Gathering of baseline data is necessary to meet the following objectives:

- To *understand* key biological, physical, ecological, social, cultural, economic, and political conditions in areas potentially affected by the proposed project;
- To *provide* data to predict, explain and substantiate possible impacts;
- To *understand* the expectations and concerns of a range of stakeholders on the proposed development;
- To *inform* the development of mitigation measures; and
- To *benchmark* future socio-economics changes/ impacts and assess the effectiveness of mitigation measures.

4.1 Physical Characteristics

4.1.1 Climatic Conditions

Abardare forest

Aberdare forest is situated along the Equator within the four counties (Kiambu, Muranga, Nyeri and Nyandarua) of central Kenya. Its climate is generally characterized by two rainy seasons - from April to May, and October to November. Rainfall varies with altitude and exposure to the dominant wind from the Indian Ocean, but reaches a maximum of around 2,600 mm annually on the south-eastern slopes and drops to less than 900 mm a year on the northern and south-western lee slopes. The climate of each side of the forest is different from each other as shown below.

a) **Western side:** this side has reduced rainfall of about 1400mm at the forest boarder to less than 700mm in the Valley of Malewa River.
b) **Northern side**: this side has 3 to 4 dry months in a year with three different rainfall peaks in a year (March-May, July-August and November)
c) **Southern side:** This side has average annual temperature of 18˚C and average rainfall of about 989mm

The Moorland experiences mean minimum daily temperatures of -2˚C and mean maximum daily temperature to 27˚C.

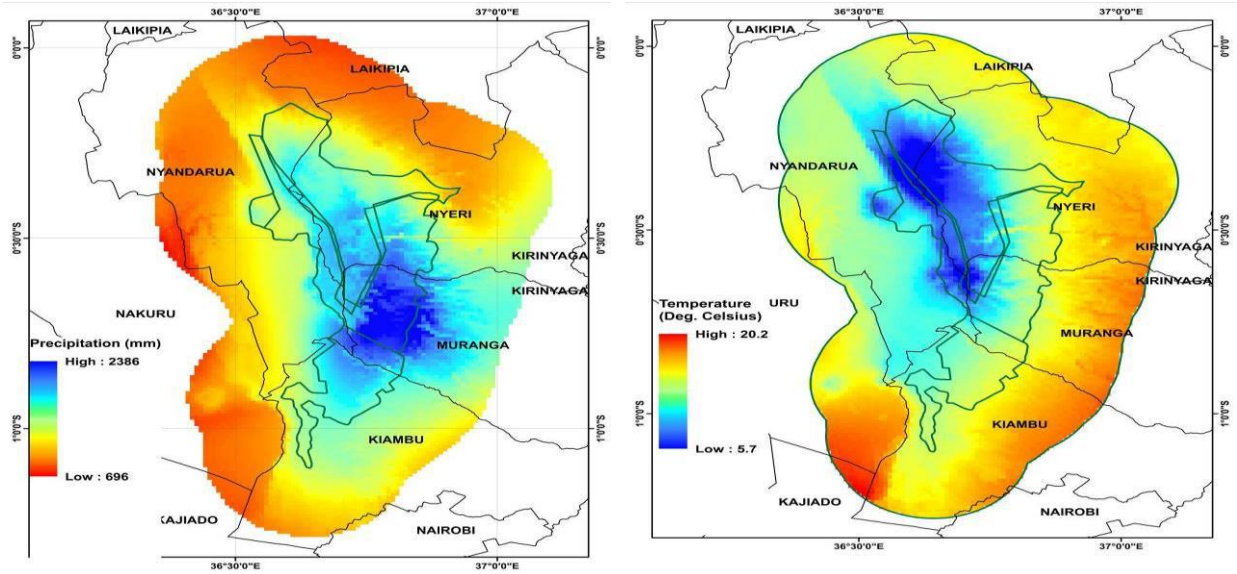
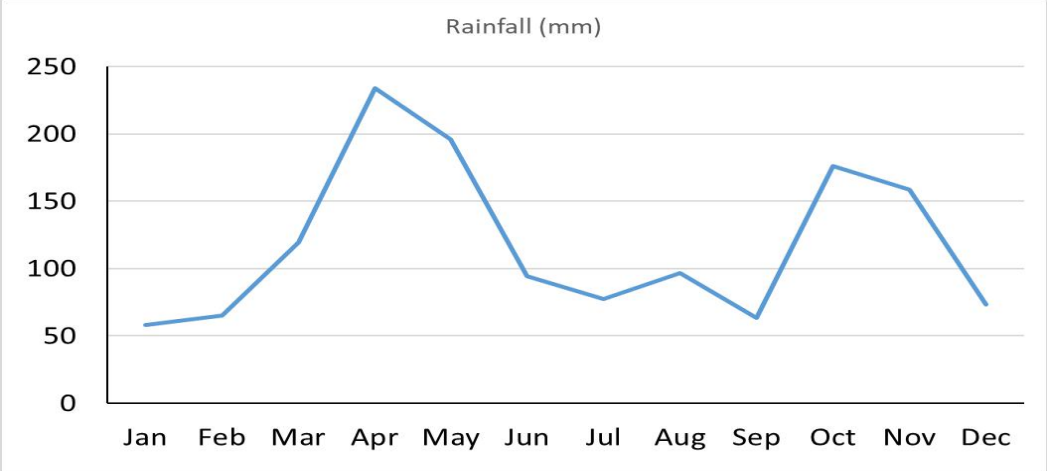


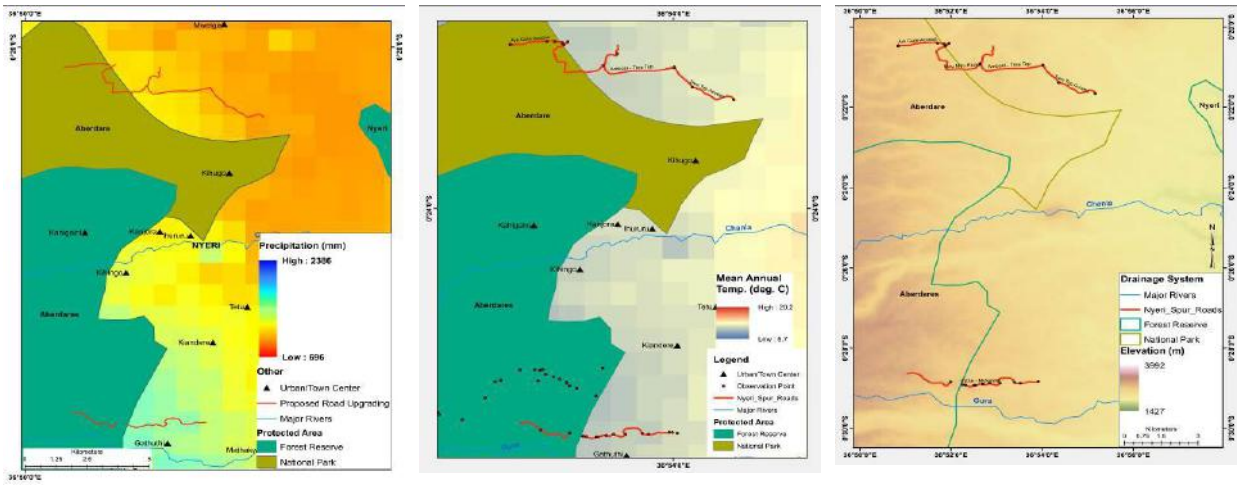
Figure 4-1 The mean annual precipitation, mean annual temperature, and major drainage system of aberdares



Nyeri County

The climate of the study area is generally characterized by two rainy seasons - from April to May, and October to November. The Nyeri Spur Roads occur on the eastern side of Aberdare Forest which is characterized by variation of climate with the altitude, this side falls within the tropical moderately cool regime with Mean temperature range between 10.3°C- 25.8°C, lowest to highest respectively. July and August have the lowest temperature. Rainfall distribution is influenced by the Inter-tropical convergent zones (ITCZ) of air masses of southern and Northern Hemisphere. It has equatorial type of climate (wet and humid) with rainfall of 1400-2200mm and extended wet season. The topography of the project area has an average elevation of 2000m occurring on the eastern side. Rivers on the wider landscape on which the proposed Nyeri Spur Roads are located derive their waters from the Aberdare Forest. Most of these rivers/streams drain into the Tana

River; they include Chania, Gura, Magura, Gikururu, Karuru, Thika, Karimu, North Mathioya, South Mathioya, Maragua and Amboni (Honi).



Mean Annual Precipitation Mean Annual Temperature Major drainage system

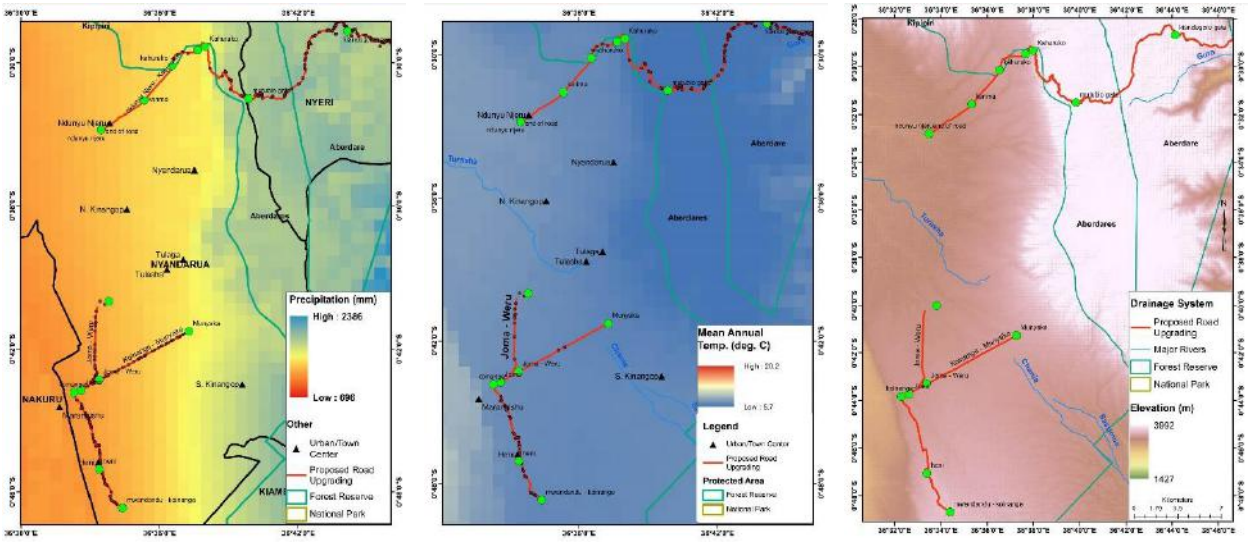
Figure 4-2 Physical factors: The mean annual precipitation, mean annual temperature, and major drainage system in Nyeri County (eastern side of the Aberdare Forest.

Nyandarua Spur Roads

The areas within which the Nyandarua road clusters are situated are characterized by two rainy seasons - from April to May, and October to November. The mean annual rainfall reaches 900 mm a year on south-western lee slopes. The rainfall amount ranges from 700mm in the Valley of Malewa River to 1400mm at the forest boarder. The average elevation for the project area is 2555m with minimum range of 2497m in Weru to maximum elevation 2672m in Mwendandu.

The northern side of the project area descends gradually from the Oldonyo Lesatima peak towards Nyahururu with numerous steep valleys, high peaks and isolated hills. It is generally described as a flat ramp slightly tilted to the East. The Oldonyo Lesatima is characterised by undulating hills, deep incised river valleys and remnants of volcanic vents and sheets. The southern side descends steeply from Kinangop peak towards the Northern part of Murang'a.

The major rivers from the forest drain into Malewa River. These rivers have numerous tributaries joining them as they flow downstream from the Aberdare Forest draining into the Lake Naivasha. The rivers draining into Lake Naivasha Basin include; Malewa, Wanjohi, Kitiri, Turasha, Kaheho, Sugurui and Pesi.



Mean annual precipitation | Mean annual temperature | Major drainage system and elevation

Figure 4-3 Physical factors: The mean annual precipitation, mean annual temperature, and major drainage system in Nyandarua County (western side of the Aberdare Forest

4.1.2 Topography (elevation and slope)

The Aberdare Forest is located within the Aberdare Ranges which stretches over 125 kilometers from Nyahururu in the North to Limuru in the South. It is the third highest mountain in Kenya with altitude of 2000m on the eastern side and 4001m on the northern side. It has two main peaks Oldonyo Lesatima (4001m) on the north and Kinangop (3906m) on the south.

The northern side descends gradually from the Oldonyo Lesatima peak towards Nyahururu with numerous steep valleys, high peaks and isolated hills. It is generally described as a flat ramp slightly tilted to the East. The Oldonyo Lesatima is characterised by undulating hills, deep incised river valleys and remnants of volcanic vents and sheets. The southern side descends steeply from Kinangop peak towards the Northern part of Murang'a. The moorlands of the area comprise of undulating hills, bogs, clear mountain streams and numerous waterfalls. Several rivers originate from the slightly sloping ground in the water bogs.

In general, the topography is diverse; from the highest point's canyon like V-shaped valleys to gentler river valleys separated by steep hills and rocky outcrops. The forest zone slopes further down gently to the undulating plains of the northern side and parts of the lower salient.

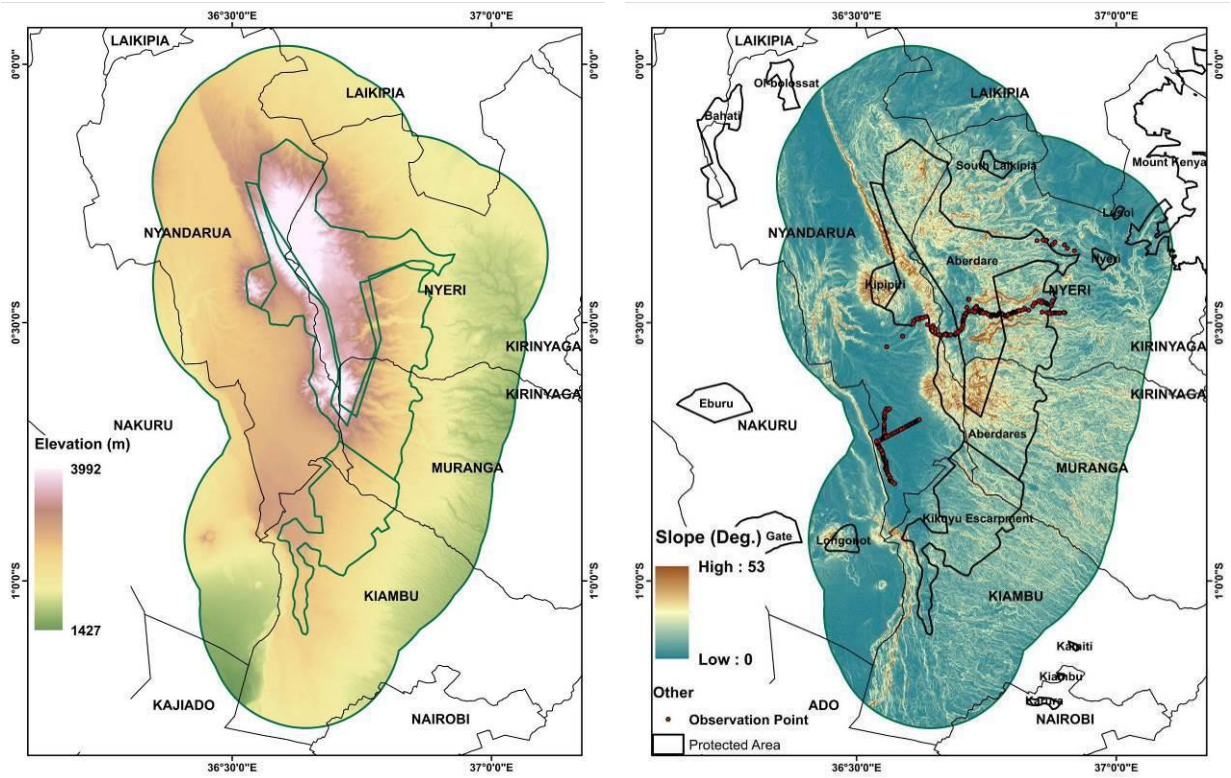


Figure 4-4 Topographical representation of the project area

4.1.3 Drainage features

The Aberdare is an important water catchment zones in Kenya. Its water feed four out of six Kenya's drainage basin. The major rivers from the forest are; Tana, Athi, Ewaso Nyiro and Malewa River. These rivers have numerous tributaries joining them as they flow downstream within the Aberdare Forest to form four River basins (Tana, Athi, Ewaso Nyiro and Lake Naivasha). Rivers flowing to Ewaso North Basin include; Engare ongibit and Ewaso Narok. The rivers draining into Lake Naivasha Basin include; Malewa, Wanjohi, Kitiri, Turasha, Kaheho, Sugurui and Pesi. The rivers draining into Tana basin include; Chania, Gura, Magura, Gikururu, Karuru, Thika, Karimu, North Mathioya, South Mathioya, Maragua and Amboni (Honi). The rivers draining to Athi river basin include; Thika, Chania and Ruiru River.

The moorlands and afro-alpine zones have numerous water bogs marking the source of streams and rivers down the slopes. Aberdare range supplies water to Nairobi through Sasumua and Ndakaini dam. Together with Mt Kenya, they contribute 70% of the country's hydro-power produced by Tana River. The forest has numerous constructed water intakes that supplies water to the adjacent communities for both domestic use and agricultural purposes.

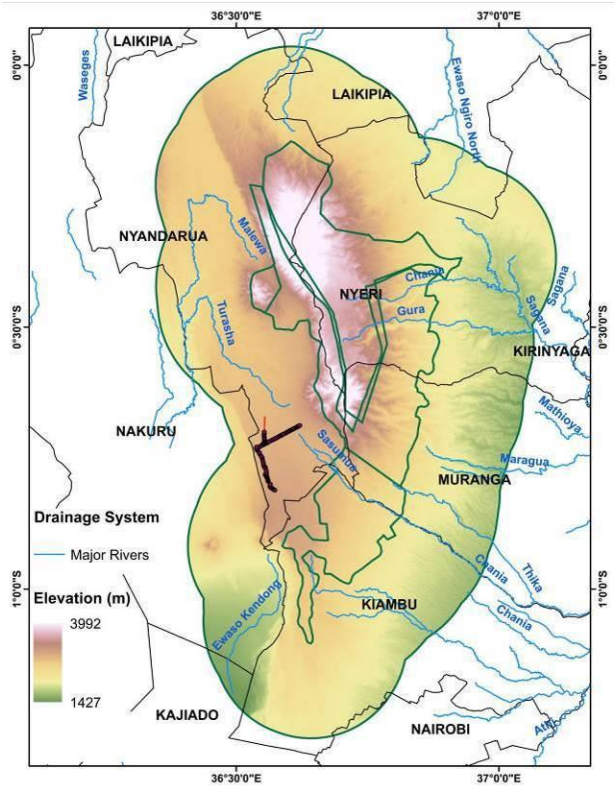


Figure 4-5 Drainage system representation of the project area

4.2 Social Economic Status

The socio-economic baseline draws on a range of primary data collected for the purpose of the ESIA for the proposed Project, and publicly available secondary data (where available). A combination of research methods was utilised to collect both quantitative and qualitative data and included:

- Review of secondary data;
- Key Informant Interviews (KII) with various stakeholders;
- Focus Group Discussions (FGDs);
- Barazas (stakeholder consultation meetings)
- Questionnaires

The project roads traverse through two counties Nyeri and Nyandarua counties. The summary for the socio-economic baseline is presented below.

4.2.1 Demography

The county has a population of 845,863 (male - 49% and female - 51%), according 2019 census. Majority of the people living in Nyeri County are from the Kikuyu Community most of whom are predominantly farmers growing tea and coffee as cash crops alongside food crops such as maize, beans, assorted vegetables and sweet potatoes. On the other hand, Nyandarua county has the county has a population of 638,289 (male - 49% and female - 51%), according 2019 census. The major economic activities in the County include farming, quarrying and trade. Agriculture is the backbone of Nyandarua's economy due to the fertile soils

and favorable climate. It is considered the food basket of Kenya because of its high production of potatoes, cabbages, carrots, peas and milk that are sold in Nairobi and most other towns in the country.

4.2.2 Administration

Administratively Nyeri is divided into 8 sub-counties namely Kieni East, Kieni West, Mathira East, Mathira West, Nyeri Central, Mukurweini, Tetu and Nyeri South. The proposed Maumau roads are located in two sub-counties Tetu and Kieni East. Nyandarua county is divided into 5 sub-counties Ol Kalou, Ol'Joro Orok, Ndaragwa, Kipipiri and Kinangop. The proposed roads in Nyandarua county falls under the Kinangop and Ol'Joro Orok sub-counties.

4.2.3 Education and Literacy Levels

Nyeri county has a total of 765 schools; 571 public and private primary schools and 194 private and public secondary schools. For Primary Education, the County has a total enrolment of 141,243 comprising of 72,227 boys and 69,016 girls. The County has a secondary school gross enrolment of 31,242 boys and 31,959 girls. There are 49 youth polytechnics with a total population of 3882 trainees. The Technical, Vocational Education and Training (TVET) in Nyeri County consists of public and private institutions. The public TVET institutions are; one national polytechnic i.e., the Nyeri polytechnic and two technical training institutes namely Mathenge and Mukurweini. The county hosts a number of private/faith-based TVET institutions.

Nyandarua county has a total of 603 schools; 453 public and private primary schools and 150 private and public secondary schools. For Primary Education, the County has a total enrolment of 151,165, where 128298 are in public primary schools and 22427 are in private schools. Nyandarua county has a secondary school enrolment which stands at 60,021, comprising of 53,974 in public schools and 6,047 in private schools. In this enrolment, 28,303 are boys while 31,718 are girls. The County has twenty-four (24) public youth polytechnics and 4 technical training institutes, namely Nyandarua Institute of Science and Technology (NIST), Leshau, Kinangop, and Kipipiri Technical Training Institutes. In addition, there is the Aberdare Teacher Training College. The County also has Animal Health Industry Training Institute (AHITI) at Ol'Joro Orok.

4.2.4 Health and Health Care Services

Nyeri county is well equipped with health facilities, there are 118 public health facilities, including a beyond zero mobile clinic and a hospice for care of the terminally ill distributed as follows: one (1) county referral hospital (level V); four (4) county hospitals (level IV); 25 health centers (level III); 88 dispensaries (level II); 251community units (level I).

The county also hosts several private health facilities providing a wide range of health services and distributed as follows; four (4) private level IV hospitals; one (1) nursing home; three (3) faith-based organization hospitals; 16 Faith Based Organization health centres and dispensaries; and 228 private clinics.

Nyandarua county has 207 health facilities of which 73 of these are public health facilities. There is a county referral hospital; J.M. Kariuki Memorial Hospital, a County hospital at Engineer and one faith-based hospital; North Kinangop.

4.2.5 Livelihoods and Economic Profile

The predominant economic activity in Nyeri is Agriculture. The local population is involved in growing tea and coffee as cash crops alongside food crops such as maize, beans, assorted vegetables and sweet potatoes. The County is also renowned for horticultural farming. Other agricultural activities which act as a source of income include dairy farming and fish keeping. There are also a number of light industries, tea and coffee factories providing a market and employment to the residents.

The major economic activities in Nyandarua County include farming, quarrying and trade. Agriculture is the backbone of Nyandarua's economy due to the fertile soils and favorable climate. It is considered the food basket of Kenya because of its high production of potatoes, cabbages, carrots, peas and milk that are sold in Nairobi and most other towns in the country.

4.2.6 Transport and Road network

The county is easily accessible by road from Nairobi and other neighbouring towns. It also has three airstrips namely Mweiga on the Nyeri-Nyahururu highway, Nyaribo on the Nanyuki-Nairobi highway about 15km from Nyeri town and the Nanyuki near Nanyuki Town. The County headquarters is located in Nyeri Town which is easily accessible from all the eight sub counties.

The County has 3,092.73 km of classified roads of which, 478.25 km are bitumen, 2,492.85 km are gravel and, 121.63 km are earth surface. During the rainy season the earth surface roads are not usable.

Road transport is the primary/dominant mode of transportation in Nyandarua County, with a total road length of approximately 3,400kms. Earth roads account for 78% of the total road network (2,651 Km), while the bitumen roads constitute only about 7% (224 kms) and gravel roads account for 15% (525 kms) which indicates that there are challenges of mobility within the County.

The current road network comprises of hierarchical road classifies as B, C, D, E, F and G classes. The major roads traversing the County are Nyahururu-Nyeri (B21), Ol'Kalou-Miharati-Engineer Road (formerly C now B20) and Ol' Kalou-Nyahururu road (formerly C77, now A4). The existing road network is largely shaped by human settlement pattern, as well as internal and external growth nodes. There are also numerous Class D and E roads within the County.

4.3 Biodiversity Characteristics of the project area

4.3.1 Mammal Diversity

Field assessment of mammal species along the proposed road-upgrading alignment in the protected area recorded an estimated 21 species out of 72 species known to occur in the Aberdares. Both sections are dominated by the Elephant and Buffalo populations, including Bushbucks and Waterbucks. The rapid sampling that was conducted revealed very few mammal species along the proposed roads. However, The Aberdare Forest recorded higher number of species of mammals due to high concentration of species population in the park. Observation made on the proposed spur roads in Nyeri recorded an estimate of 19 species while and in Nyandarua recorded 11 mammal species. Species that were commonly observed were the White-tailed Mongoose observed crossing the road, Four-striped Grass Mouse observed on grass patches in the adjacent

farms, and the East African Mole Rat which was noticed by its burrowing activities in the paddocks and fallow areas along the road. Other species were recorded from local accounts; these include the Common slender mongoose. The occurrence of Bat species was accounted for by the local residents who revealed a record of 7 species within the proposed spur roads in Nyeri.

4.3.2 Birds Diversity

The Aberdare Forest and its environs host an estimated total of 418 bird species. This estimation combines information from the literature reviews, existing database and field observations. The species recorded in Nyeri spur roads accounts for 106 bird species while in Nyandarua spur roads recorded 85 bird species. Out of these bird species, two species are listed as Endangered (EN) under the IUCN red list of threatened species, two are Vulnerable (VU), and four species are Near Threatened (NT). The distribution hotspot for bird's species occurs in the Eastern side of the National Park, and extend outside in the inhabited area where project is located. Only one bird species, is listed as Endangered; the Grey crowned Crane (*Balearica regulorum*) was observed in both Nyeri and Nyandarua spur roads. Nyandarua spur roads have more wetland habitats adjacent to the roads. These include several small water points (ponds, pools, waterpans and natural wetlands along streams) observed in most farms adjacent to the road.

4.3.3 Invertebrate Diversity

The diversity of invertebrates along the proposed road alignment varies relatively. The estimated diversity in the Aberdare Forest is 130, Nyeri 101 and 77 invertebrate species occurring along the proposed Nyandarua spur roads. All these invertebrate species are listed as Least Concern under the IUCN Red List of Threatened Species. However, literature review has shown presence of the Montane Dancing Jewel (*Platycypha amboniensis*) which is Critically Endangered has a limited extent of occurrence and area of occupancy along the montane forest streams of the Aberdares.

4.3.4 Plant Diversity

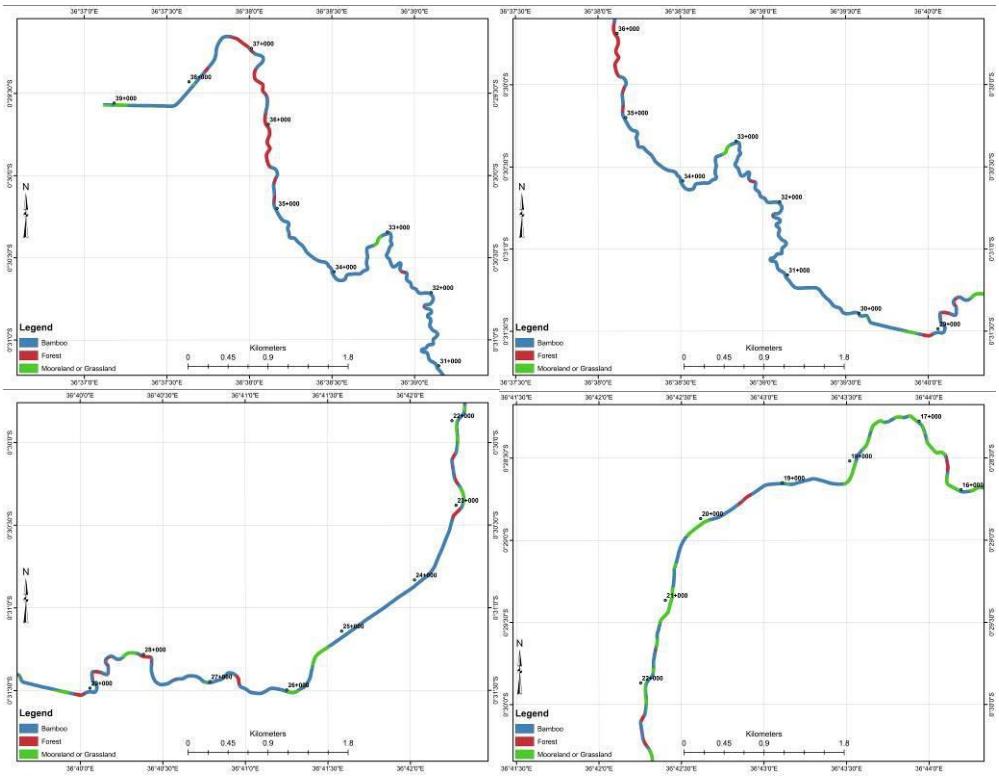
The Aberdare Forest and its environs has an estimated 1260 species of plants. However, during the survey, a total of 199 were identified occurring along the proposed road in the forest, 95 species recorded along Nyeri spur roads and 166 species of plants estimated for the proposed Nyandarua spur roads. The park area is already infested with Alien Invasive Plant Species such as *Cirsium vulgare* that currently scattered along the road in the protected area. This also occur in the Nyeri and Nyandarua spur roads including other invasive species such as *Parthenium hysterophorus*, *Carduus chamaecephalus, Opuntia monacantha*, *Acacia mearnsii*, *Caesalpinia decapetala*, *Lantana camara*, and *Datura stramonium*. Most of the plant species assessed are listed under Least Concern (LC); while only one species, *Jacaranda mimosifolia*, is Vulnerable (VU) in the IUCN Red list of Threatened Species. This species was sited along Amboni – Ark Gate; however, situated off the fence running along the road reserve.

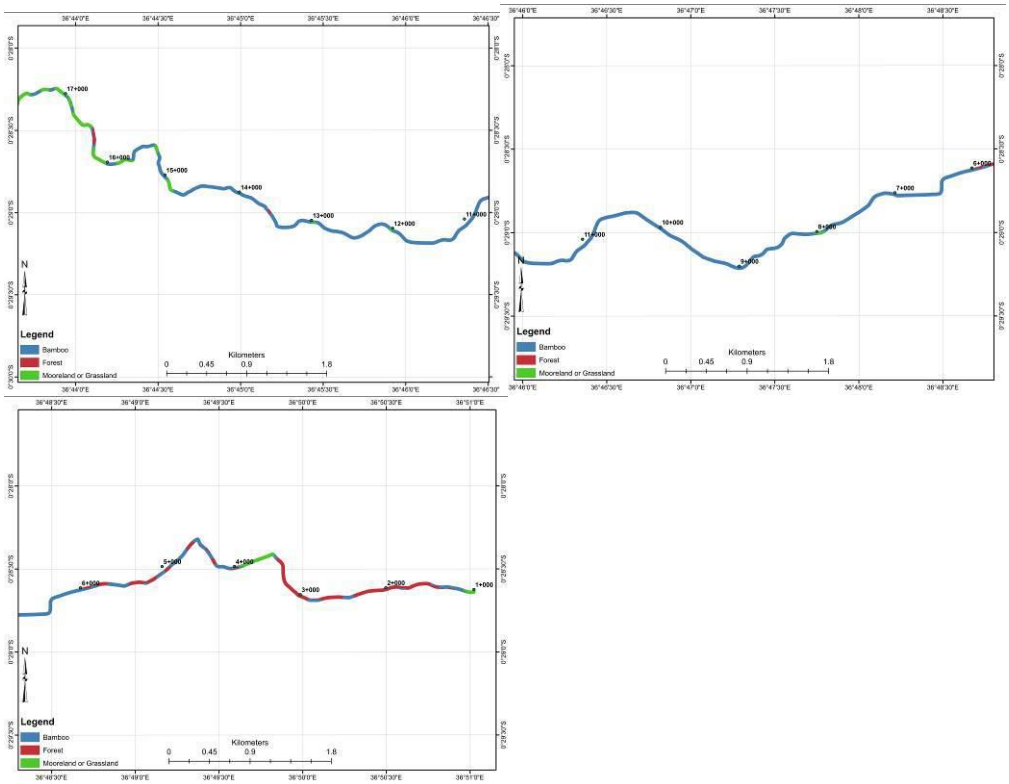
1.1.1.1 Vegetation cover and the above-ground carbon

An approximated area of 156 hectares along the existing road is under the project footprint; while an area for the current existing road is estimated at 52 hectares. Around 104 hectares of vegetation is lying on areas that will potentially be cleared. Out of this, 75 hectares of bamboo will be destroyed, 14 hectares of forest, and another 14 hectares of mooreland will potentially be destroyed. In terms of distance stretch along the proposed road, total stretch

of 28 km of the proposed road in the protected areas is aligned to bamboo vegetation zone. The total length of the proposed road aligned to the forest areas (indigenous and exotics) is 5km and another 5 km of the road aligns in the moorelands.

The three main land cover land use has an enormous amount of the above-ground carbon/biomass. The forest area has an estimated biomass ranging from 85 – 169 Mg ha^{-1}. The Bamboo area has an estimated mean biomass of 86 Mg ha^{-1} with the lowest range of 65 to 114 Mg ha^{-1}. Mooreland has an estimated mean biomass of 19 Mg ha-1; biomass in the land use ranges between 7 to 32 Mg ha^{-1}. Thus, the proposed road alignment passes through an area with an estimated total biomass of 5,662 Mg ha^{-1}; mooreland 177 Mg ha-1, bamboo 4,300, and Forest has 1185 Mg ha-1.





4.3.5 Herpetofauna Diversity

The wider Aberdare landscape has an estimated 28 species of herpetofauna. The spur roads in Nyeri and Nyandarua recorded 21 species. Species recorded in the forest has about five herpes species are currently listed in the IUCN Red List of threatened species. Two species are vulnerable (VU) and three are Near Threatened (NT).

4.3.6 Biodiversity hotspot

Higher biodiversity hotspot in the Aberdare areas occur within the National Park from central are to Mutubio Gate. These are areas with relatively higher species richness in the protected areas. In Nyeri side, higher hotspot occurs in Amboni – Tree Top – Njegu section of the proposed spur road. While in Nyandarua, areas with relatively higher hotspot occur between Koinange – Munyaka.

4.3.7 Ecosystem Services

Our discussion with stakeholders identified the following major ecosystem services in all the areas where Mau Mau Lot 4 roads are proposed to be constructed. These ecosystem services are broadly grouped into three major categories: provisioning services, regulation services and cultural services.

Provisioning services: major provisioning services identified in the areas were; crop farming for both commercial and subsistence, dairy farming, harvesting of fodders and grazing of the animals in the forest reserves, harvesting of construction materials (timber, sand and building stones), production of the biofuels (charcoal, firewood and biogas), water harvesting from the nearby streams and pipes, harvesting of traditional medicine and fishery in some areas

Regulation services: all the stakeholders noted that the area receives a lot of regulatory services from their environment, this is observed through; Good air quality in the region, minimal effect of climate change (temperature and rainfall pattern have not changed greatly), minimal soil erosion experience in most areas, continuous flow of clean water from the Aberdare hills into the nearby streams, natural pollination of their crops by the birds and bees in the forest.

Cultural services: the stakeholders stated that Mugumo and Mukuyu tree are both sacred in the area. they also stated that the Aberdare national park act as tourist attraction site to both locals and internationals hence should be continuously be accessible even during construction.

5 CONSULTATION AND STAKEHOLDER ENGAGEMENT

5.1 Introduction

This Chapter describes the process and activities in public consultation that were undertaken to ensure that relevant stakeholders and the public are informed about the project and are involved in the identification of key issues and impacts of the proposed Ihithe- Ndunyu Njeru Road project.

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively.

Stakeholder engagement and public consultation are an integral aspect of successful decision making in the ESIA process and implementation of projects, plans and programmes. It is central to all other aspects of environmental and social performance. It is the basis for building strong, constructive, and responsive relationships that are essential for the successful management of a project's environmental and social impacts (IFC, 2012). The key focus of meaningful consultations is equity and inclusivity, i.e., ensuring that all groups (including those that are disadvantaged or vulnerable) are embraced within the consultation process on equal terms, and that all groups are given the capacity to express their views with the knowledge that these views will be properly considered (AfDB, 2013).

Poor stakeholder relations present risks to the successful implementation of projects, while constructive engagements offer benefits of improved risk management and better outcomes on the ground.

The process of engagement presupposes that the relevant stakeholders and interested public have access to timely and accurate information on the environment and the proposed development and are therefore able to offer informed views on the proposals.

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

In the Kenyan context the need for public involvement in project development is enshrined in the Constitution of Kenya, 2010. This requirement is also provided for in the EMCA, 1999, the Environmental (Impact and Audit) (Amended) Regulations, 2019, and is one of the guiding principles of the National Environment Policy, 2013.

Public participation ensures that communities and stakeholders are part and parcel of the proposed development(s). It presupposes that the public has access to timely and accurate information on the environment and the proposed development(s), and therefore assures that the developments are sustainable, and resources are also used sustainably.

It has also been demonstrated successfully that projects that go through this process acquire a high level of acceptance and accrue benefits to a wider section of society.

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

5.2 The Legal Context of Public Participation

5.2.1 The national policy and legal framework

The following section outline the Kenyan Policy and Legal requirements on public consultation and participation, and stakeholder's engagement.

5.2.1.1 7.2. The Constitution of Kenya 2010

Article 10 outlines the national values and principles of governance which include democracy and participation of the people, human dignity, equity, inclusiveness, social justice and human rights including non-discrimination and protection of the marginalized.

Article 33 guarantees the freedom of expression including the freedom to seek, receive or impart information or ideas. Hence, every person should feel constitutionally empowered to share information and ideas during public participation processes.

Article 35 provides for every citizen's right of access to information held by the state, and information held by another person and which is required for the exercise or protection of any right or fundamental freedom. This includes information required for effective public participation to take place.

Article 69 1(d) encourages public participation, in the management protection and conservation of the environment. Under guiding values and principles of the Land Act, every public officer must ensure democracy, inclusiveness and participation of the people in matters related to Land. Also, people should participate in determining critical land matters for instance determining the economic viability of minimum and maximum acreages in respect of private land for various land zones in the country.

Article 174(c) provides that one of the objects of the devolution of government is to give powers of self-governance to the people and enhance the participation of the people in the exercise of the powers of the state and is making decision affecting them.

5.2.1.2 The County Government Act

The legislation is based on Chapter Eleven of the Constitution. It provides for the powers, functions and responsibilities of County governments.

Section 87 of the Act provides for citizens' participation based on timely access to information, data, documents, and other information relevant or related to policy formulation and implementation.

5.2.1.3 The Environment and Management and Coordination Act

The EMCA ,1999 (Revised 2015) acknowledges that public participation is important in the development of sustainable policies, plans and processes for the management of the environment. The act therefor requires for public participation in the development of national and county Environment Action Plans. The environmental (Impact and Audit) Regulation 2003 (Amended

2018) developed under the Act also provides for public participation in the conduct of Environmental Impact Assessments.

5.2.2 International standards

5.2.2.1 IFC's Performance Standard (PS) 1: Assessment and Management of Environmental and Social Risks and Impacts

PS1 requires effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them. PS1 states that when affected communities are subject to identified risks and adverse impacts from a project, the proponent is required to undertake a process of consultation in a manner that provides the affected communities with opportunities to express their views on project risks, impacts and mitigation measures, and allows the proponent to consider and respond to them. It further requires that the extent and degree of engagement required by the consultation process should be commensurate with the project's risks and adverse impacts and with the concerns raised by the Affected Communities.

5.2.2.2 World Bank Environment and Social Framework (ESF)

The World Bank Environment and Framework became effective in October 1,2018. It makes important advances in areas such as labor, non-discrimination, climate change mitigation and adaptation, biodiversity, community health and safety, and stakeholder engagement – including expanding the role of public participation and grievance mechanisms. The ESF enhances the World Bank's commitment to sustainable development through ten Environmental and Social Standards (ESS) that are designed to support Borrowers' environmental and social (E&S) risk management. The ESF enhances the World Bank's commitment to sustainable development through ten Environmental and Social Standards (ESS) that are designed to support Borrowers' environmental and social (E&S) risk management. ESS 1, 5 and 10 are applicable to this RAP study.

5.2.2.2.1 The World Bank Group's Environment and Social Standard (ESS) 1: Assessment and Management of Environmental and Social Risks and Impacts

The ESS requires Borrower/Project proponent to engage with and provide sufficient information to stakeholders throughout the life cycle of the project, in a manner appropriate to the nature of their interests and the potential environmental and social risks and impacts of the project.

5.2.2.2.2 ESS10: Stakeholder Engagement and Information Disclosure

ESS 10 recognizes the importance of open and transparent engagement between the Borrower and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation

5.3 Benefits of Public Consultation

5.3.1 Benefits to the developer

The developer is likely to benefit from local knowledge

- Costs may be saved as key issues are identified by the public and studies are focused on key issues as opposed to a broad range of issues
- Measures to reduce adverse impacts and enhance benefits will be identified with stakeholders

- Relations with the communities in the vicinity of the development are likely to be improved
- Delays in decision making may be reduced because of good participation early in the process
- The public are unlikely to raise objections to the project; and
- The developer's image and reputation are likely to be enhanced.

5.3.2 Benefits to the public

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

5.3.3 Benefits to decision makers

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

5.4 Public Consultations in the Project Area

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

5.4.1 Objectives

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

- To inform the local people, leaders and other stakeholders about the proposed road project and its objectives;
- To sensitize the community about the project and potential impacts on people and livelihoods';
- To promote Project ownership by the beneficiaries in order to minimize conflicts during project implementation;
- Obtain opinions and suggestions from the directly affected persons on the Project impacts and appropriate measures to mitigate them;
- Obtain opinions and suggestions on the Project Concepts, Designs, etc. and therefore minimize conflicts and delays in implementation;
- To facilitate the development of appropriate and acceptable impact mitigations;
- To increase long term Project sustainability and ownership;
- To reduce problems of institutional coordination, especially at the different Governments levels; and

- Map the stakeholders that should be consulted during implementation of the project.

5.4.2 Engagement methodology

To complete the public consultation exercise, a systematic approach was implemented that consisted of a reconnaissance visit to the project area, review of relevant documentation, conducting interviews, and administration of questionnaires to the project stakeholders.

5.4.2.1 Reconnaissance visit

Project site visits were carried out on 16th December 2021 and 7Th January 2022 on the road sections. During these visits, would-be project stakeholders covering government institutions, individual households and the neighbouring communities were identified.

5.4.2.2 Literature review

A review of relevant information including the project's Feasibility Study Report, Kenya National Bureau of statistics Census data 2019, County Data Sheets for Nyeri and Nyandarua counties, County integrated Development plan (CIDP) 2018-2022 for Nyeri and Nyandarua counties was done to provide a background on the project and area, and a basis for collection of additional information to fill identified gaps.

5.5 Stakeholder consultation

The stakeholder engagement exercise commenced in February 2022 the consultation begun by paying courtesy call to the National government administration in Nyeri and Nyandarua counties to assistance in mobilizing and planning for the public participation meeting. The meetings were conducted between 28th February 2022 and 4th March 2022 at various venues.

5.5.1 Stakeholders' identification and analysis

The following were identified as the Project stakeholders:

1. The Community:

a) Nyeri county

1 The residents of Tetu sub-county
2 Nyeri town Sub- County
3 The residents of Kieni West sub county

b) Nyandarua County

4 North Kinango Sub- County
5 South Kinangop Sub- County

2. Institutional stakeholders:

These are government institutions whose main role is to control and / or safeguard the utilisation of resources

1. National government administration in
2. County Government of Nyeri
3. Kenya Power and Lighting Company
4. County government of Nyandarua
5. National government Administration in Nyandarua County
6. Kenya Wildlife Service

7. Kenya Forest Service

In this study, the relevance of a stakeholder is defined by whether the stakeholder is directly or indirectly affected by project activities. For instance, stakeholders expected to be directly affected by activities accruing from the proposed road project are viewed as more 'important' as they are likely to experience first-hand, the associated impacts.

5.6 Stakeholders' consultation

Stakeholders were consulted through the following methods:

- Public pariciption meetings
- Workshops and written submissions
- Key informant interviews
- Questionnaires

5.6.1 Public participation meetings

Public consultation meetings were held in Nyeri and Nyandarua counties, 3no in Nyeri county and 5no public meetings in Nyandarua county. The meetings were conducted between 28th February 2022 and 4th March 2022 at various venues. The meetings were preceded by mobilization through the National Government. These sessions were used for sensitization, information sharing and soliciting comments from the participants as well as enhancing project ownership among the stakeholders who were mainly local community, businessmen farmers and leaders.

Table 5-1 Public participation meeting schedule

Date	Location	Road section	Sub county	Number of Participants
28th March 2022	Kihuyo Centre	Arc Gate-Njengu	Nyeri town Sub-County	33
1st March 2022	Assistance Chiefs Office in Amboni	Njengu-Treetop-Amboni	Kieni West Subcounty	106
	Ihithe Shopping Centre	Ihithe-Kiamutiga-Mukarara	Tetu Sub County	
2nd March 2022	Kahuruko Centre	Ndunyu Njeru Kahuruko-Engineer Location	North Kinangop Sub-County	178
	Weru Hall	Ndunyu Njeru Kahuruko-Engineer Location	North Kinangop Sub-County	71
3rd March 2022	Njoma Centre	Njoma-Koinange- Githabai Location	South Kinangop Sub-County	46
	Munyaka	Munyaka in Njabini Location	South Kinangop Sub-County	38
4th March 2022	Heni Centre	Heni Mwendandu in Magumu	South Kinangop Sub County	127

Table -5-2: Issues discussed in Public Meetings

Kihuyo	• The residents of Kihuyo raised concern on the ongoing implementation of Maumau Lot 3 road in the area, they requested that the new road considers culverts for each household, • They raised concerns of flooding on the almost compete road and requested that the design considers the concerns of flooding and storm water. • The residents requested that the project design consider acquiring wayleave for storm water and avoid directing the water on private land
Amboni	• There were concerns on the impacts of the road crossing through the Aberdare forest and what measures would be taken during the operation off the road to ensure wildlife safety. • The residents were concerned what would happen to the utilities such as water pipes laid on the road. • The residents were concerned of the impacts on private land and what would happen to the affected properties on the road reserve.
Ihithe	• The residents appreciated the proposed project stating it will improve trade and accessibility to markets, schools, government institution as well as access the neighboring county of Nyandarua and Nakuru. • The residents requested the design team to consider having safe crossing areas in the market centers and consider NMT facilities. • The residents requested the design team to ensure they acquire storm water ways/drains to ensure the storm water isn't directed into farms or homesteads. • The community requested that the local people are considered for employment during project implementation.
Kahuruko	• The residents were appreciative of the proposed road project. • They requested inclusion of other stakeholders such as OAK, NEMA KFS and KWS to ensure quick implementation of the proposed project. • There were concerns of a section of the road that is currently under implementation by KeRRA on the proposed road, the community requested that the km that have been covered by KeRRA be transferred to other sections on other roads to ensure the community receives maximum benefit on the Maumau Lot4. • The community requested that once the road is implemented and crosses the Aberdare Forest the KWS charges should be dropped for the travelers to ensure the access is affordable to all.
Weru	• The residents were concerned what measures will be considered to ensure the construction will be well implemented and the quality of work will be good considering the rainy weather in the area. • The residents requested that the road design considers foot paths and safe crossing area at the market centres and schools. • The resident requested that the contractor ensure rehabilitation of excavated areas for raw materials to ensure safety
Njoma	• The residents requested that the road design consider provide access culverts at each homestead • The residents requested for compensation of private property that might be affected during construction. • Locals requested for consideration on available employment opportunities.
Munyaka	• The residents were concerned of safety of the local people and workers on the project during the project implementation, they proposed safety measures to be considered near schools and provide safe crossing areas in the town centers • They raised concerns on air pollution during construction

	• The locals requested that consideration on employment opportunity for the local people during project implementation. • The community requested that the contractor source raw materials locally to ensure maximum benefit of the local community.
Heni	• The residents were concerned of the impacts on the existing utilities, they mentioned there are water pipes crossing various points of the road section, they requested for the contractor to liaise with the community leadership to ensure less destruction of the utilities. • The residents mentioned some of the areas are prone to flooding, they requested the designing team to ensure they consider these areas during the design to ensure the road will not be washed away during rainy season. • The residents were concerned of the extent of the road and what would happen to encroachment on private land and impacts of private property and graves

Table -5-3 Public participation photo plate

Public participation meeting Kihuyo

Public participation meeting at Amboni




Meeting at Ihithe

Kahuruko

Weru

Njoma

Munyaka

Heni

5.6.2 Workshops

the consultant undertook workshop with institutional stakeholders. The institutions were reached to provide their input into the ESIA report. Two workshops were undertaken virtually, and one was undertaken with the technical team in Nyeri.A summary of the delibeartions are listed on table 5-4 below.

Table 5-4 Summary

organisation	Comments/submission
Water resource Authority -Upper Tana Sub Basin area	▪ Ensure all the phases of the project no pollution takes place to the water resources. ▪ During construction, no dumping of soils in the riparian areas ▪ For all instream works the road contractor to acquire permit before initiating them, this includes all diversions and bridges ▪ For water abstractions permit is required as per abstraction point even in the same river. ▪ To ensure all water resources are protected. i.e wetands, springs, dams etc.
Kenya Forest Service	▪ KeNHA to undertake a comprehensive ESIA, identify all the possible impacts on Aberdare forest with its intrinsic values during the planning, construction and operation phases ▪ The ESIA Study Report to provide adequate mitigations measures through out the project cycle. ▪ The ESIA should develop an environment management plan and a monitoring plan that detail the actions required to effectively implement the mitigation measures identifiedthrought out the project cycle ▪ Review all the relevant national policies, laws and institutional framework related to the road project including the regional and

	international protocol and treaties that Kenya is a signatory to infor the validation process of the proposed project ▪ Provide viable alternative routes for the proposed road to enable stakeholders to determine the cost-benefit analysis and arrive at the most cost effective route that takes into consideration environmental and social concerns for decision making; ▪ Carry out adequate public participation for all the stakeholders to receive their concerns and comments for incorporation into the report especially the private sector and NGOs with interest in conservation and management of the ecosystem ▪ Kenya forest representative was concerned on how the project design would resolve the issue of mist that would lead to accidents within the road section crossing the forest. ▪ The project proponent will abide by the provisions of Forest Conservation and Management Act, 2016 (The document has been provided as an annex on this report as submitted by KFS)
Nyandarua county government	▪ The team mentioned that the proposed road would ease connectivity between Nyandarua and Nyeri counties. ▪ They enquired whether the issues raised by NEMA in 2008 had been resolved to ensure the project is approved for implementation ▪ The county representatives requested for further consultations and engagement on the proposed project in all phases.
KWS	▪ Proposed that a socio-economic study needs to be undertaken to determine the impact of the project vis a vis the impacts on the water catchment value as well as the value of the park. ▪ Raised concerns on the steep gradient of the forest terrain which would necessitate deep cuts leading to major environmental impacts within the forest. ▪ Concerns on increased traffic within the forest and the impact to the wildlife. ▪ The KWS representative proposed that the impacts should be addressed in the ESIA report.
Rhino Ark	▪ The Rhino Ark representative stated that KeNHA should provide a justification to the development of the road project. ▪ He was concerned what would be the arrangement on the road use, he queried whether KWS will introduce charges to access the road within the park area. ▪ The Rhino Ark representative stated that the national spatial plan (2015) planned for a period of 30 years provided protection of the forests from development except for purposes of eco-tourism. He requested for clarification as to why the road was proposed to be developed in the forest which is not in line with 2015-2045

	National Spatial Plan and the Management plan established for the Aberdare Forest under the wildlife management and conservation (2015).

5.6.3 Key informant interviews

Key informant interviews were undertaken with various organisation representatives in the project area. A summary of the responses from the interviews are listed in table 5-5 below

Table -5-5 Summary responses from KII

Name of the respondent	Organisation	Comments
Solomon Mwangi (Munyaka)	Solo Dairy	The proposed project will improve transportation of milk from farms to the factory and hence reduce the cost of transport and increase profits to the farmers. Proposed considerations for safe crossing areas for pedestrians. Proposed provision of road signage Proposed training for bodaboda riders on road safety to reduce accidents during construction
Solomon Kuria Ndegwa (Joma)	Pastor Church of God	The proposed road will increase trade and reduce the cost of road transport. General benefits to the local community through access by good roads to government offices, school's churches and markets. Proposed to have culverts and mitigation of flooding on the road in areas of Mbogani in Joma town. Proposed consideration of PWD friendly user road during the design by ensuring they consider NMT that is accessible to PWD using assistive devices.
Esther Wang'ondu (Ihithe Boys)	Ihithe Boys	Stated that the road project will improve accessibility in the area especially accessibility to schools and government institutions. Requested the design to consider proper signage near schools Provision of diversions during construction. Provide employment to the local people during project implementation.
Naomi Murage	Preshama feeds	Stated that the road project will create more business opportunity in the area and have overall development of the economy. Proposed that the proponent to have continuous engagement with the communities during project implementation. Proposed provision of compensation on private property that may be affected by the road project.

Isaac Nderitu	Vet Marks Limited	Stated that the community will benefit from the road due to quick accessibility and transport of the farm produce. Proposed adherence of COVID 19 protocols and ensure community safety. Proposed sensitisation on HIV/Aids Proposed constant communication and liaison through community leaders to ensure the utilities such as water pipes have been identified to ensure continuous supply of water

5.6.4 Courtesy calls

Selected stakeholders namely the County Commissioners or their representatives, Deputy County commissioner's county government department representatives in Nyeri and Nyandarua County where the project traverses were consulted. The respective staff were consulted through either one-on-one or virtual online meetings. This cultivated their engagement in project activities and subsequent consultations during project implementation.

5.6.5 Field household survey through Questionnaires administration

This method was applied in collecting data on the respondents' perception of the proposed project, including the positive and/or negative impacts they expect from the proposed project and any recommendations for enhancement of to the project. This process was conducted 7th March 2022 to – 18th April 2022. A total of 241 questionnaires were administered in the two counties Nyeri 80 questionnaires and Nyandarua 161.

The majority of the route residents acknowledged that they were aware of the proposed development of the Ihithe-Ndunyu Njeru road project. In addition to this, they pledged their support for the full implementation/construction of the project acknowledging that the project will indeed have numerous positive impacts. They also noted negative social, economic and environmental impacts which will be mitigated through the stipulated mitigation measures available in this Environmental and Social Impact Assessment (ESIA) study report and its corresponding Environmental and Social Management and Monitoring Plan.

5.7 Socio-economic findings for the Proposed Ihithe-Ndunyu Njeru Road

5.7.1 Gender of the respondents

Gender is an important component in any social assessment. A total of 241 households were surveyed during the study. 161 households were surveyed in Nyandarua of which 71%(114no) were male and 29% (47no) were female, in Nyeri county 80 households were surveyed in 64% (51no) were male and 36% (29no) were female.

In the two counties male respondents were more than the female respondents. This in most cases will imply that men are the main decision makers in the households.

5.7.2 Age of the respondents

From the socio-economic findings, respondents interviewed in Nyandarua County were aged between 18-over 70 years 5% (8no) were aged between 18-35years 19%(31no) are aged between 36-50Years,38%(61no) were aged between 51-60 years while as 24% were aged between 61-70years and 14% 23no were over 70 years.

In Nyeri county the age of the respondents is as presented in table 5-6

Table -5-6; age of the respondents

Age	No of respondents	percentage
19-35 years	16	20%
36-50 years	28	35%
51-60 years	13	16%
61-70 years	17	21%
Over 70 years	6	8%

5.7.3 Household head

The survey findings show that the majority 76%(183no) of the respondents interviewed were the household heads while 18% (44 no) of the respondents interviewed were spouses to household heads and 6% (14 no) were children of the household head. This is as shown in the Figure 5-1 below.

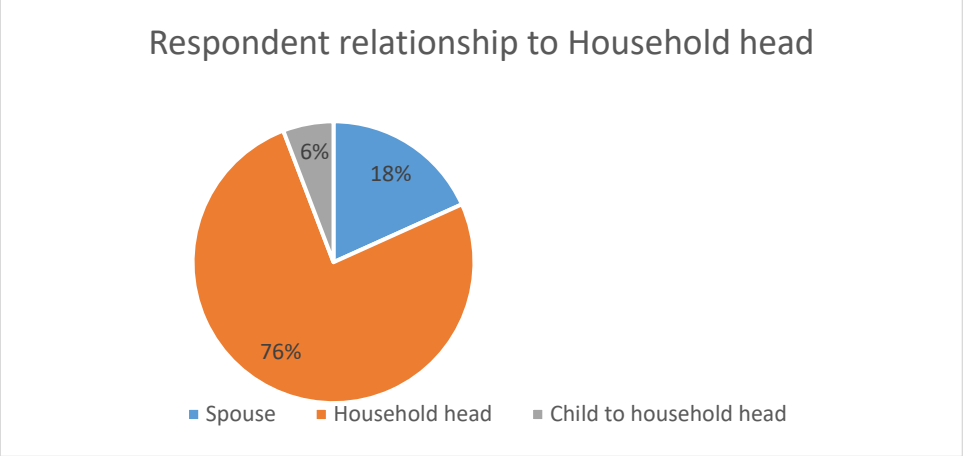


Figure 5-1;Respondents relationship to household head

5.7.4 Marital status

The survey shows that, the majority 60% of the respondents were married, 33% were single, 4% were widowed, 2% were separated and 2% represented other marital statuses.

5.7.5 Respondents' religious affiliation

The survey established that majority 95% were Christians, 2% were Muslims, 1% were of the traditional religion believers while as 3% belonged to other religious affiliations.

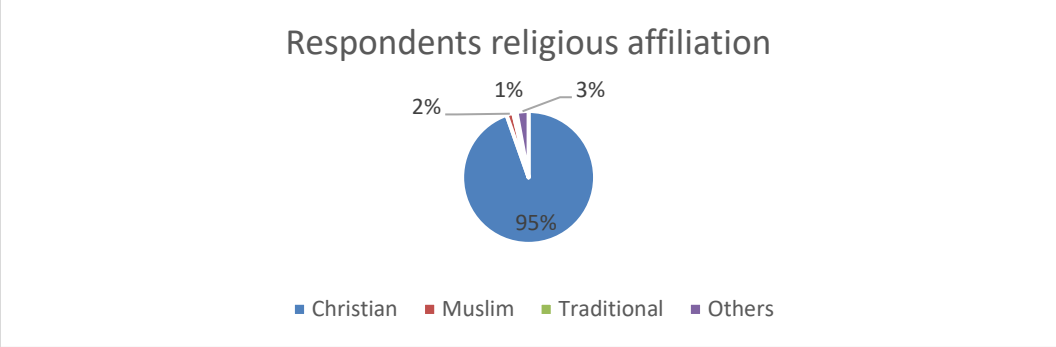


Figure 5-2; Respondents religious affiliation

5.7.6 Respondents level of education

The survey established that 36%(87no) of the respondents had attained secondary school education,5%(12no) had not accessed any form of education,34%(83no) had attained primary school level of education,16%(39no) had attained tertiary kevel of education,4%(10no) did not complete secondary school education while 1%(2no) had attained other forms of education as listed on figure 5-3 below.

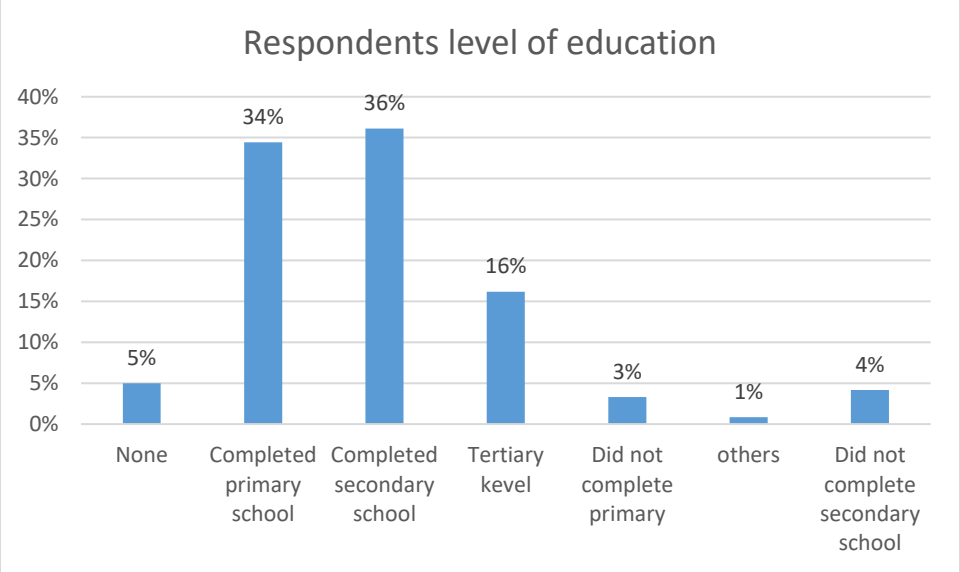


Figure 5-3; Respondents level of education

5.7.7 Type of livelihood

The survey shows that the main source of livelihood from the respondents in the two county's is farming with 68% of the respondents, trading at 4%, government employees at 7% private sector

employees and 4% depending on other activities to support their livelihood as indicated on figure 5-4.

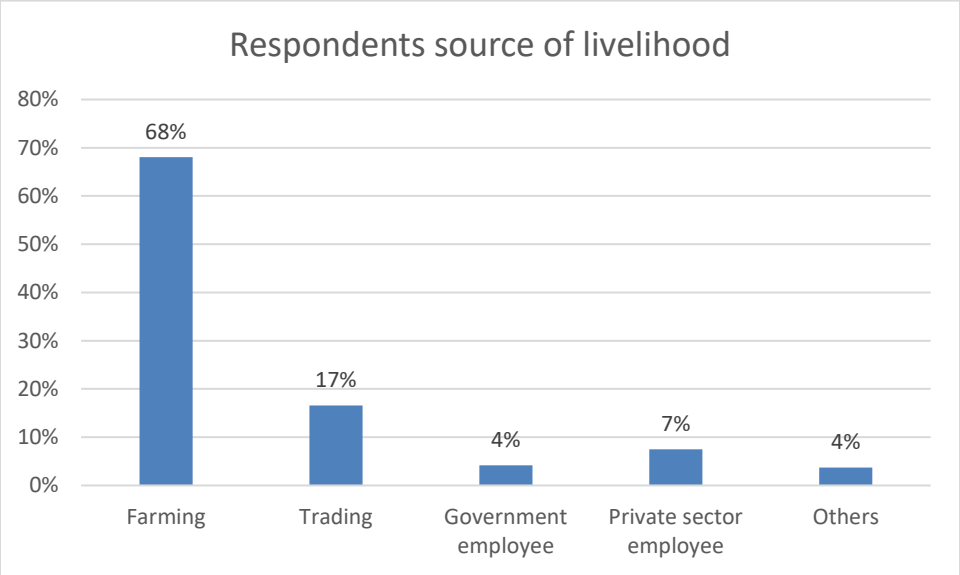


Figure 5-4; Respondents source of livelihood.

5.7.8 Average income

The respondent's monthly income is listed on table 5-7 majority of the respondent earn between kshs 5000-10,000 while the lowest earn below kshs 1000 5% of the respondents earn over kshs 50,000 per month.

Table -5-7; Respondents average income.

Amount earned per month	No of respondents	Percentage
0-1000	26	11%
1001-5000	52	22%
5001- 10000	68	28%
10001- 20000	44	18%
20001-50,000	39	16%
Over 50,000	12	5%

5.7.9 Household information

5.7.9.1 Energy sources

Cooking

The survey study established that majority of the household66%(158no) utilise firewood for cooking energy,24%(57 no) utilise charcoal 9% (21no) utilise Liquide petroleum gas and 1%(2no)

mentioned they utilise kerosene as a form of cooking energy. On probing the sources of charcoal and firewood they mentioned they collect firewood from their farm or buy charcoal from other regions, they mentioned that the Kenya Forest Services do not allow collection of firewood/cutting of trees from the Aberdare Forest.

Lighting sources

The survey findings established that47%(114no) use electricity as a source of lighting energy,18%(44no) utilise kerosene lamp,23%(55no) utilise battery lamp,2%(6no) utilise LPG lamp while 5%(13 no) use solar and 4%(9no) utilise other forms of lighting energy.

5.7.10 Water sources

Majority of the household 32% mentioned they depend on rainy water for use in their households as well as rivers and water pans, 14% indicated they depend on community borehole water 43% mentioned they depend on shallow wells while as while 11% have readily available piped water to the homestead.

Methods utilised by households for water safety

Table 5-8: Presents the measures taken by households to ensue water safety

Type of method	No of respondent	percentage
Nothing	89	36%
Boil	138	56%
Add bleach or chlorine	8	3%
Water filter	4	3%
Let it settle	5	2%

Table -5-9: Pictorial water sources

		
Water pan near the road project	Water tank along the road project	Borehole in Joma

5.7.11 Health

The survey established that the most common illnesses in the project area are as listed on table 5-10 with common cold being the most common illness.

Table 5-10:Type of illness

Type of illness	No of respondents	percentage	Other illnesses specified
Malaria	12	5%	
Diarrheal illness	15	7%	
Eye infection	12	5%	

Common cold	171	77%	
Skin infections	4	2%	
Terminal illness- indicate which ones	8	4%	cancer, hbp, amoeba

Health facilities; the respondent stated they have access to district hospitals as well as local health facilities and dispensaries, in Nyeri county the respondent mentioned they have access to Nyeri PGH hospital, Amboni health centre, Mweiga health centre and CDF Mweiga dispensary. In Nyandarua county the respondent stated they have access to health facilities in Munyaka, Githabai, Koinange, Weru and Munyaka, others stated they access health facilities at Naivasha.

Means of transport in accessing the health facilities.

The respondents stated that they challenge due to the bad condition of the roads especially during the rainy season, 48% of the respondents mentioned they use public means of transport,8% stated they walk to the health facilities while as 44% mentioned they utilise other means of transport such as bodaboda, taxi or hired vehicles.

Pictorial

5.7.11.1 Land tenure and land use

The survey established that the land tenure/ ownership in the project is private land, community land public land and leasehold.

Land use.

The respondents stated they use the land for crop farming and livestock keeping, others mentioned they utilise the land for residential and commercial. The type of crops grown in Nyeri county are potatoes, beans, cabbage kales coffee and tea. In Nyandarua county the crops grown are for commercial purposes they include potatoes, peas cabbage and kales some respondents mentioned they also grow cypress trees for commercial purposes.

		
Commercial tree farm along the project road	Crop farm on the road project	Nappier grass along the road project

Figure 5-5 photographic representation of land use in the project area.

5.7.11.2 Perception and anticipated impacts

98%of the respondents mentioned they support the implementation of the project 2% mentioned they did not support the project implementation in the section of the road crossing the Aberdare Forest citing loss of the rich ecosystem, vegetation and opening the forest to encroachers and poaching.

Those supporting the project implementation cited anticipated benefits such as ease of transportation of the farm produce

Current issues with the road

- Potholes
- Poor drainage system
- Difficult to navigate during the rainy season
- High cost of vehicle maintenance
- High cost of transport

Table -5-11;Impacts during construction phase

Anticipated social impacts during project implementation phase	Anticipated Negative impacts during construction	Proposed measures to mitigate negative impacts
Employment opportunities to the local people	Accidents	Provide safety measures for workers and community safety
Increased business opportunities	Air pollution	Provision of watering the working areas
	Deforestation in section of Aberdare Forest	
Skills transfer during project implementation	Loss of crops along the road	Prior communication to enable farmers harvest crops on the road reserve.
	Loss of land due to road expansion	Provide compensation on private land
	Traffic congestion	Provide diversion to ensure continuous traffic flow
	Loss of trees within the forest	Ensure the vegetation cover lost is replanted or recovered
	Destruction of existing utilities water pipes and electricity	Ensure the contractor maps existing utilities and liaise with local leaders for guidance
	Influx in population	

Table -5-12;Impacts during operation phase

Anticipated social impacts during project implementation phase	Anticipated Negative impacts during construction	Proposed measures to mitigate negative impacts
General development and growth on the urban centres along the proposed road	Increased accident/over speeding vehicles	Ensure safety mechanism such as speed bumps
Ease means of transportation	Wildlife poaching	Ensure the forest is fenced to ensure the safety of the wildlife Increased KWS officers
Save time spent transporting horticulture/perishable goods	Encroachment of the Aberdare Forest	The government to put measures that will ensure the forest land is not encroached.
	Wildlife kills	Ensure mitigations that will control speed within the forest

5.8 Conclusion

The consultations exercise established that the community living in Nyandarua and Nyeri County's welcomed the proposed project, however they were concerned on the impacts of the road construction within the Aberdare Forest and encroachment of the biodiversity. They proposed stringent measures to be undertaken during implementation of the project to ensure mitigation of the adverse impacts. Their expectations were that the project would create employment opportunities, improve safety of road users, increase trade, and save time spent travelling from one entre to another and neighbouring counties. It will also prove access to businesses and access the counties of Nyeri and Nyandarua as well as shorten the distance to Naivasha (Nakuru County). The community and stakeholders engaged were in support of the proposed project.

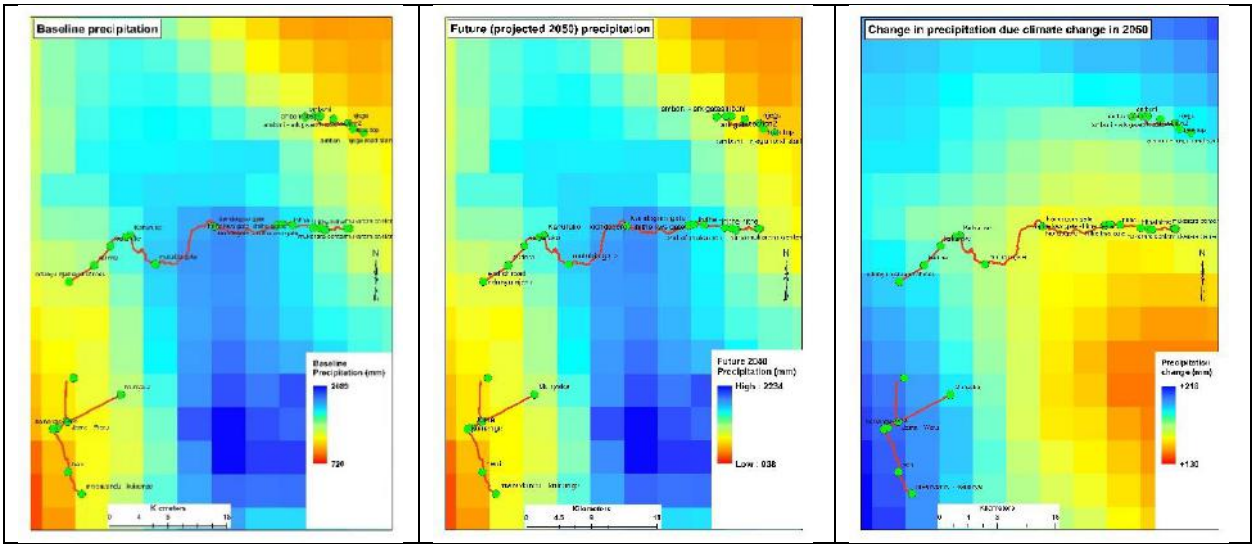
6 CLIMATE CHANGE AND ADAPTATION

6.1 Introduction

Road construction often cause changes in micro-climate that can lead to an increase in evaporation, heat stress, tree mortality, reduce groundwater storage, and forest fire risk, and decrease in the resilience of trees to climate change. Road constructions requires an adoption of the climate change Act 2016 and National Climate Change Action plan (2018-2022) to ensure the roads are climate-proofed.

6.2 Climate change screening

Baseline precipitation distribution in the projects areas are varied with the section between Kiandogoro and Mutubio gates receiving relatively high mean precipitation (over 1700mm) per annum. Precipitation in Nyandarua is relatively lower than the occurrence in Nyeri cluster road sections. The projection of precipitation based on RCP 8.5, 2085 shows projected increase in minimum and maximum distribution of precipitation in the region. The Nyandarua area will; however, experience higher increase in precipitation up by 218 mm while the montane areas in protected area will experience relative less increase in precipitation.



6.3 Potential Contribution of the Proposed Road to Climate Change

6.3.1 Greenhouse gases (GHG) emission

The use of fossil fuels on earth moving machines, tracks and other vehicles during construction of contribute to release of GHGs through exhaust. Carbon dioxide is the main gas emitted from combustion engines of vehicles, nitrous oxide and methane are however produce in little proportion. Very large amount will be released during the operation of the road when traffic

volume will be high. These gases can trap heat from the sun in the earth's atmosphere, causing the 'greenhouse effect' and climate change. Clearing of vegetation along the proposed road alignment will remove large amount of the above-ground carbon that will ultimately contribute in releasing carbon dioxide and methane gases.

6.3.2 Loss of carbon sequestration

Vegetation that will be removed from the landscape plays important role in carbon sequestration. Carbon sequestration is the process of storing carbon in a carbon pools. Vegetation absorb carbon dioxide from the air as they grow, and binding it into biomass. The proposal to construct the road will mean that vegetation that plays important role in carbon sequestration will be lost.

6.3.3 Agricultural intensification

Upgrading of the road will attract flow of agricultural goods from Nyandarua to Nyeri, Nanyuki and Isiolo. This will trigger massive production of agricultural and livestock products that will contribute to emission of carbon dioxide and methane gases. Intensification will include increasing agricultural resources such as fertilizers, pesticides, technologies, knowledge to increase the level of yield per unit of farmland or pasture. These are directly and indirectly associated with emission of GHGs

6.4 Potential impact of climate change on road infrastructure

Climate change affects roads mostly through flooding. Other that this, the roads are made impassable due to the difficult soil conditions. The common hazard noted mainly along the roads are related to:

- Flooding
- Washouts
- Scour
- Erosion
- Siltation/Debris
- Soil Conditions

6.4.1 Scours and erosion of roads

Potential increase of rainfall pattern is highly associated with change in climatic conditions. This would lead to increase in runoffs with high erosivity power that will likely cause erosion of the roads and its banks. This impact normally affects transport system and distribution of goods and services in the region. The depth of Scour is affected by soil conditions and water velocities. Increases in precipitation may increase water velocities, which could intensify the effects of scour. Erosion is similar to scour in that it is highly dependent on the soil conditions. Increases in temperature may lead to increased drying of soils and increased drought conditions. Dry soils subjected to excessive rainfall may be more prone to erosion (WB,).

6.4.2 Flooding and Washouts

Flooding has been identified especially in Nyandarua cluster roads. Increase in precipitation in the area may lead to more frequent, extreme flooding in the future. Climate change projections shows considerably higher increases in precipitation which will potentially increase flooding incidences in the area.

6.4.3 Siltation/Debris

Siltation is linked to erosion of upstream areas, and similar to erosion, siltation and debris may be increased by increases in temperatures and precipitation. Debris clogging of drainage structures can also be increased by increases in drought leading to dying off of vegetation, which is then washed downstream by increased flows

6.4.4 Soil Conditions

Soil conditions can be negatively impacted by increases in precipitation and increases in temperature. Increases in temperature can lead to increased droughts, which may lead to large variations in the soil conditions, which can in turn lead to cracking of the pavement surfaces. These same soils can also be impacted by increased flooding and moisture, leading to expansion of the soil and cracking and heaving of the road surface.

6.5 Climate Change adaptation strategy for the proposed road project

The main objectives of the climate change adaption component are to protect:

- road infrastructures from damages from impacts of climate change,
- local environment from destruction from erosion and flooding

Adaptation of the road to climate change is considered in the drainage structures design. This design provides reinforcement of the road structures from erosion and potential flooding. These interventions include:

6.5.1 Engineering design considerations:

6.5.1.1 Designing of minor drainage structures (pipe culverts)

Standard design will be adopted for access and cross pipe culverts. Similarly, to the box culvert, at locations where unstable ground is encountered the material will be removed and replaced with suitable material. In addition to the pipe culverts, catch water drains and mitre drains will be introduced along the road to enable the road to have adequate drainage.

6.5.1.2 Designing the erosion protection of drainage structures

Scour checks in the form of stone pitching, gabion works and other appropriate materials for arresting erosion of the sides and steep drains have been designed and detailed.

6.5.2 Ecological considerations:

- Planting of trees by offsetting impact of clearing trees and loss of biomass
- Improving water holding capacity of wetlands to mitigate against severe droughts

7 ANALYSIS OF PROJECT ALTERNATIVES

7.1 Introduction

Designing road projects involves a complex decision-making process whose objectives should be the implementation of the road design and its utilization in the narrowest sense, but also the facilitation of mobility, economic development of the area and improvement of the quality of life in a wider sense. All of this requires the consideration and understanding of many problems multi-criterial in nature, and decision making with regard to technical components, environmental constraints and the impact on society. This chapter discusses the fundamental options considered in the project design in the following criteria;

7.2 Alternatives to Project Routing

There are two main alternative routes to the proposed project.

c) Ndunyu Njeru through Olkalau-Nyahururu-Ndaragwa-ihururu - Nyeri town. (190km)
d) Ndunyu njeru-Njambini-Githuma-Othaya-Nyeri town. (155km)

The first route will take a road user 3hours 17 minutes to drive through and the second option 3 hours 46 minutes. The proposed road is the most viable option since the road user will drive through the section for 1 hour 30 minutes saving them money and time. The figure below illustrates the route options.

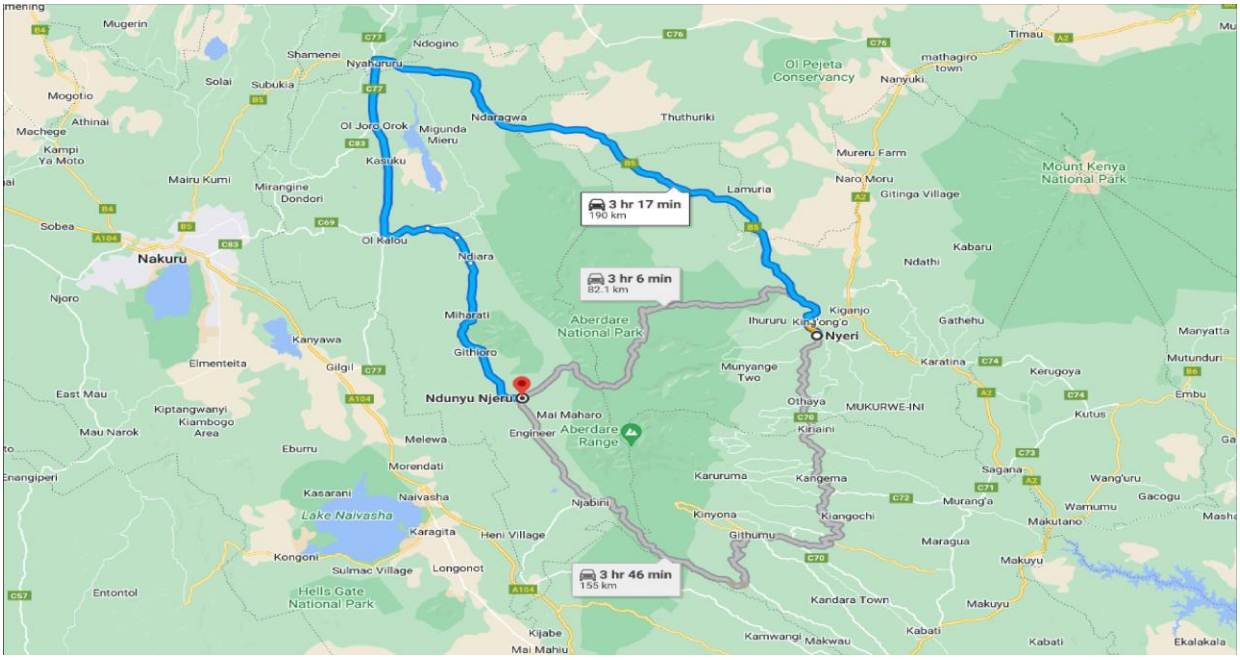


Figure 6-1 Alternative project routes

7.3 Pavement design options

In view of the material test results presented in the Materials Report, the axle loading and the analysis thereof, the consultant proposes the following pavement options as detailed in the table below for the various project road

7.3.1 Ihithe – Mutubio Gate

Design Parameters	***Proposed/Reviewed Pavement***			
	Pavement Option 1	***Pavement Option 2***	***Pavement Option 3***	***Previously Proposed Pavement***
Design Traffic Class	T4	T4	T4	T5
In-situ Sub-Grade Class	S1	S1	S1	S1
Design Sub-Grade Class	S4	S4	S4	S3
Design Sub-Grade Type	Improved	Improved	Improved	Improved
Design Life	20 Years	20 Years	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7	Type 8	Type 7
Cross-Section				
Ihithe - Kiandogoro	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Kiandogoro - Mutubio	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	
Earthworks (General Fill)	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 300mm below formation level) shall be soil class S2 (minimum CBR of 5% and a swell of less than 3% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for improved sub-grade shall be soil class S3 (minimum CBR of 10% and a swell of less than 1.5% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	125mm thick 4% Cement Improved Gravel (Base Quality). Type of cement is CEM I, 42.5N	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)
Base-Course	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)	125mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)	125mm thick Water Bound Macadam (Stone Class C, Stone Size 0/75mm)
Prime Coat	MC 30	MC 70	MC 70	MC 70
Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders	50mm (0/14mm) thick wearing course asphalt concrete

	sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	
Binder for Surface Dressing	80/100 cut back	80/100 cut back	80/100 cut back	N/A
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion	K1-70 cationic emulsion	Not provided

7.3.2 Mutubio Gate - Kahuruko

Design Parameters	***Proposed Pavement***		
	Pavement Option 1	***Pavement Option 2***	***Pavement Option 3***
Design Traffic Class	T4	T4	T4
In-situ Sub-Grade Class	S1	S1	S1
Design Sub-Grade Class	S4	S4	S4
Design Sub-Grade Type	Improved	Improved	Improved
Design Life	20 Years	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7	Type 8
Cross-Section	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Earthworks (General Fill)	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	125mm thick 4% Cement Improved Gravel (Base Quality). Type of cement is CEM I, 42.5N
Base-Course	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)	125mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)
Prime Coat	MC 30	MC 70	MC 70
Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated)	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated)	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated)

	single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19
Binder for Surface Dressing	80/100 cut back	80/100 cut back	80/100 cut back
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion	K1-70 cationic emulsion

7.3.3 Kahuruko – Ndunyu Njeru

Design Parameters	***Proposed/Reviewed Pavement***			
	Pavement Option 1	***Pavement Option 2***	***Pavement Option 3***	***Previously Proposed Pavement***
Design Traffic Class	T3	T3	T3	T5
In-situ Sub-Grade Class	S1	S1	S1	S1
Design Sub-Grade Class	S4	S4	S4	S3
Design Sub-Grade Type	Improved	Improved	Improved	Improved
Design Life	20 Years	20 Years	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7	Type 8	Type 7
Cross-Section	7.0m carriageway and 2.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	7.0m carriageway and 2.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	7.0m carriageway and 2.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Earthworks (General Fill)	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 450mm below formation level) shall be soil class S1 (minimum CBR of 5% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 300mm below formation level) shall be soil class S2 (minimum CBR of 5% and a swell of less than 3% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S4 (minimum CBR of 14%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 450mm, laid in three layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for improved sub-grade shall be soil class S3 (minimum CBR of 10% and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	175mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	125mm thick 4% Cement Improved Gravel (Base Quality). Type of cement is CEM I, 42.5N	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)
Base-Course	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)	125mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)	125mm thick Water Bound Macadam (Stone Class C, Stone Size 0/75mm)
Prime Coat	MC 30	MC 70	MC 70	MC 70

Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/14mm) thick wearing course asphalt concrete
Binder for Surface Dressing	80/100 cut back	80/100 cut back	80/100 cut back	N/A
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion	K1-70 cationic emulsion	Not provided

7.3.4 Ihithe – Kiamutiga – Mukarara (G24612/614/615/616)

Design Parameters	***Proposed Pavement***	
	Pavement Option 1	***Pavement Option 2***
Design Traffic Class	T4	T4
In-situ Sub-Grade Class	S2	S2
Design Sub-Grade Class	S3	S3
Design Sub-Grade Type	Improved	Improved
Design Life	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7
Cross-Section		
Njeng'u – Treetops Gate – Amboni	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Ihithe – Kiamutiga – Mukarara	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Earthworks (General Fill)	The quality of material for fill (up-to 300mm below formation level) shall be soil class S2 (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 300mm below formation level) shall be soil class S2 (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	175mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)
Base-Course	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)
Prime Coat	MC 30	MC 70
Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19

Binder for Surface Dressing	80/100 cut back	80/100 cut back
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion

7.3.5 Ark Gate Access Road (D1345)

Design Parameters	***Proposed Pavement***	
	Pavement Option 1	***Pavement Option 2***
Design Traffic Class	T5	T5
In-situ Sub-Grade Class	S2	S2
Design Sub-Grade Class	S3	S3
Design Sub-Grade Type	Improved	Improved
Design Life	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7
Cross-Section	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.0m carriageway and 1.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Earthworks (General Fill)	The quality of material for fill (up-to 300mm below formation level) shall be soil class S2 (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	The quality of material for fill (up-to 300mm below formation level) shall be soil class S2 (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	125mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)
Base-Course	125mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	125mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)
Prime Coat	MC 30	MC 70
Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19
Binder for Surface Dressing	80/100 cut back	80/100 cut back
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion

7.3.6 Mwendandu – Heni - Munyaka (E1766/L3785)

Design Parameters	***Proposed Pavement***	
	Pavement Option 1	***Pavement Option 2***
Design Traffic Class	T3	T3
In-situ Sub-Grade Class	<S1, Replaced with S2	<S1, Replaced with S2
Design Sub-Grade Class	S3	S3
Design Sub-Grade Type	Improved	Improved
Design Life	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7
Cross-Section	7.0m carriageway and 2.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	7.0m carriageway and 2.0m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Earthworks (General Fill)	Cut to spoil to 1m below formation level and backfill or fill 1m above the expansive clays/weak soils to 300mm below formation level with S2 quality material (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	Cut to spoil to 1m below formation level and backfill or fill 1m above the expansive clays/weak soils to 300mm below formation level with S2 quality material (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	200mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	175mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)
Base-Course	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)
Prime Coat	MC 30	MC 70
Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19
Binder for Surface Dressing	80/100 cut back	80/100 cut back
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion

7.3.7 Joma - Weru (L3782)

Design Parameters	***Proposed Pavement***	
	Pavement Option 1	***Pavement Option 2***
Design Traffic Class	T4	T4
In-situ Sub-Grade Class	<S1, Replaced with S2	<S1, Replaced with S2
Design Sub-Grade Class	S3	S3
Design Sub-Grade Type	Improved	Improved
Design Life	20 Years	20 Years
Standard Pavement Structure	Type 3	Type 7

Cross-Section	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required	6.5m carriageway and 1.5m shoulders on each side. The shoulders shall be widened by 0.5m on high fills where guardrails are required
Earthworks (General Fill)	Cut to spoil to 1m below formation level and backfill or fill 1m above the expansive clays/weak soils to 300mm below formation level with S2 quality material (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick	Cut to spoil to 1m below formation level and backfill or fill 1m above the expansive clays/weak soils to 300mm below formation level with S2 quality material (minimum CBR of 8% and a swell of less than 2% measured after 4-day soak) and compacted to 95% MDD (AASHTO T99) in layer not exceeding 150mm thick
Sub-Grade	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)	The quality of material for sub-grade shall be soil class S3 (minimum CBR of 10%, Minimum MDD of 1,400Kg/m^3 and a swell of less than 1% measured after 4-day soak). The thickness shall be 300mm, laid in two layers of 150mm thick and compacted to 100% MDD (AASHTO T99)
Sub-Base	175mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 3.5% Cement Improved Gravel (Type of cement is CEM I, 42.5N)
Base-Course	150mm thick 4% Cement Improved Gravel (Type of cement is CEM I, 42.5N)	150mm thick 2% Cement Treated Graded Crushed Stone (Stone Class B, Stone Size 0/40mm, Type of cement is CEM I, 42.5N)
Prime Coat	MC 30	MC 70
Surfacing	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19	50mm (0/19mm) thick wearing course asphalt concrete (SUPERPAVE) to cover the carriageway and shoulders sealed with 10/14mm (precoated) single seal surface dressing. Chippings for surface dressing shall be class 2. The coarse aggregate for the asphalt concrete shall satisfy the requirements contained in table 4.1 of ORN 19
Binder for Surface Dressing	80/100 cut back	80/100 cut back
Binder for AC	80/100 penetration grade bitumen	80/100 penetration grade bitumen
Tack Coat	K1-70 cationic emulsion	K1-70 cationic emulsion

7.4 Pavement cost options

Pavement options cost analysis for Ihithe-Ndunyu njeru proposed project is illustrated in the table below. Option one is recommended since it is the cheapest option.

Option 1-Recommended				
	AC	22,154.00	26,270.00	581,985,580.00
	Base	69,531.00	1,200.00	83,437,200.00
	Subbase	77,350.00	1,200.00	92,820,000.00
	Cement for subbase	3,898.44	26,320.00	102,606,940.80
	Cement for base	4,004.99	26,320.00	105,411,220.99
	Improved Subgrade	245,205.00	640.00	156,931,200.00
				1,123,192,141.79
Option 2				-
				-
	AC	22,154.00	26,270.00	581,985,580.00
	Graded Crushed Stone-Base	69,531.00	2,837.00	197,259,447.00
	Subbase	74,137.00	1,200.00	88,964,400.00
	Cement for subbase	3,736.50	26,320.00	98,344,806.34
	Cement for base	2,002.49	26,320.00	52,705,610.50
	Improved Subgrade	244,895.00	640.00	156,732,800.00
Option 3				**1,175,992,643.83**
				-
	AC	22,154.00	26,270.00	581,985,580.00
	Graded Crushed Stone-Base	66,456.00	2,837.00	188,535,672.00
	Subbase	70,847.00	2,837.00	200,992,939.00
	Cement for subbase	4,080.79	26,320.00	107,406,319.10
	Cement for base	1,913.93	26,320.00	50,374,711.30
	Improved Subgrade	244,275.00	640.00	156,336,000.00
				1,285,631,221.40

7.5 The 'No Project' Alternative

This option involves remaining on the status quo and conducting routine maintenance of the existing carriageway and road furniture. The no construct/ no project alternative will not achieve the objectives of the project since the project objectives will not be achieved.

Failure to construct and operate the roads will lead to the failure of achieving one of the Kenya's national long-term development policies that aim to transform Kenya into a newly industrializing, middle-income country, by providing a high quality of life to all its citizens by 2030 in a clean and secure environment. Socio-economic development will be hampered by poor accessibility to the

counties where the roads pass; waste of economic time while travelling - among other negative impacts - will be experienced. This is not a desirable alternative.

8 ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT AND MANAGEMENT

8.1 Method for assessing Environmental Impacts

8.1.1 Basis of Assessment

The methodology used in assessing impacts in this ESIA Report follows ESIA principles and also draws upon a number of guidance documents and legislation, including:

- Environmental Social and Impact Assessment and Environmental Audit Regulations, 2003;
- Draft Environmental Impact Assessment Guidelines (NEMA 2012)

8.1.2 Approach for assessing potential impacts

Figure 7-1 below illustrates the process used in assessing potential impacts of the proposed project. The process involved the following steps:

a) Prediction: What will happen to the environment as a consequence of the project?
b) Evaluation- will it have beneficial or adverse effects? How big is the change expected to be? How important will it be to the affected receptors?
c) Mitigation- if the impact is of concern, can anything be done to avoid, minimize, or offset the impact? Or to enhance potential benefits?
d) Assessment of Residual impact-After mitigation, is the impact still of concern?

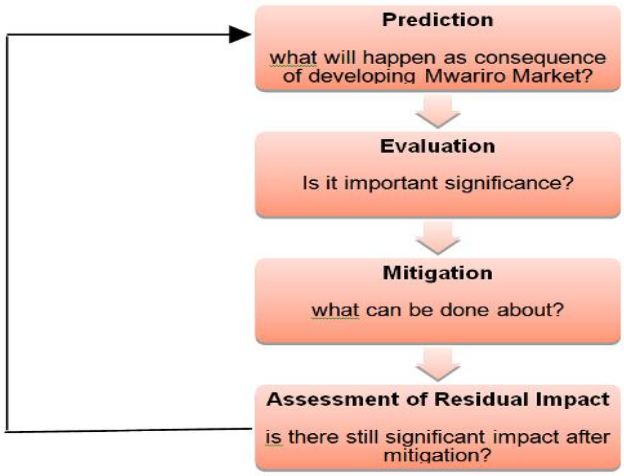


Figure 8-1: Impact Assessment Process

Impact was assessed with and without mitigation measures in place. The impact significance was assessed with the design controls in place. It is important to note that impacts without mitigation measures in place are not representative of the Project's actual extent of impact, and are included to facilitate understanding of how and why mitigation measures were identified.

8.1.3 Project Activities and Impact

The Proposed development of landfill has the potential to create a range of 'impacts' with regard to the physical, biological and human environment. In this report, the definition of a project impact was adapted from the ISO 14001: 2015, which is defined as**: "Any change to the environment [or social receptors], whether adverse or beneficial, wholly or partially resulting from an organization's environmental [or social] aspects."** For example, operation of heavy equipment (action) during construction which results in increased levels of ambient noise (impact). Impacts can be classified as direct, indirect and cumulative. They can be either positive or negative, although the relationship between them is not always straightforward. Definitions for each of these terms are provided in Table 7-1.

Table 8-1 - Definition of terms for various forms of impacts

Term	Definition
Impact Nature	
Positive impact	An impact that is considered to represent an improvement on the baseline condition or introduces a positive change
Negative impact	An impact that is considered to represent a deterioration of baseline condition or introduces a negative change
Impact type	
Direct Impact	Occurs as a result of activities undertaken in direct connection to the project
Indirect Impact	Occurs as a consequence of a direct impact (sometimes as part of a chain of events) and may be experienced at a point in space or time that is removed from the direct impact.
Secondary Impact	Socioeconomic and cultural changes which may be experienced at a point in space or time that is removed from both direct and indirect impacts.
Cumulative Impacts	Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.
Inter-related impacts	The impacts resulting from the inter-relationship of different topic-specific impacts upon the same receptor (e.g., where the impacts from noise and impacts from air quality affect a single receptor such as fauna).
Positive or negative impacts	Impacts can be either negative or positive. Positive impacts merit just as much consideration as negative ones, as international, national and local policies increasingly press for projects to deliver positive biodiversity outcomes. Positive impacts can be considered for all the definitions above.

For an impact to occur there must be an interaction between Project activity and a receptor. The **project activity** is defined as: A physical action or presence of infrastructure associated with the operation of Project plant, equipment or vehicles, or the actions of Project employees. While **receptor** represent someone or something that could be influenced by the Project, including human health, water resources, air quality, ecological habitats or species, cultural heritage assets, and the wider environment.

Project activities were identified through a review of the Project Description. Potential impacts were identified based on the details of Project activities and their potential interactions with the surrounding environment (and physical, ecological, and/or human receptors). This also required an understanding of the potential sources of impacts and impact pathways, and was supported by:

- An understanding of baseline conditions and potential receptors;
- The spatial and temporal extent of the Project Area of Influence;
- Information from stakeholders, including authorities, experts, and the public; and
- Professional knowledge and experience of comparable projects or developments.

8.1.4 Evaluation of Ecological Impacts

The evaluation of ecological impacts has taken into consideration measures the project is considering in the design together with those measures that would be expected as part of good international practice. To the extent possible, it is the severity of the residual impacts that is being evaluated, i.e., those that remain after mitigation measures have been applied. The residual impacts are assessed as described below.

8.1.5 Assessing Significance of Impacts

Significance of an impact is used in this assessment to express the consequence of an impact and is determined by considering the magnitude of the impact alongside the importance, or sensitivity, of the receptor or resource, in accordance with defined significance criteria. For example, construction activities can result in increased levels of noise, and potential disturbance to noise sensitive receptors (i.e., people or ecological receptors).

In this ESIA Report, the significance of the impacts is assessed by rating each variable numerically according to defined criteria as outlined in Table 7-2.

The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the **consequence** of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the **likelihood** of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix (Table 7-3), and it is determined whether mitigation is necessary using Table 7-4.

For some types of impact e.g., noise quality, there are empirical, objective and established criteria for determining the potential impact significance (e.g., if a standard is breached or a protected area is damaged). However, in other cases assessment criteria are more subjective and require professional judgment to a greater degree.

Table 8-2 - Criteria for assessing significance of impacts

Severity/Magnitude of Impact	Rating
Insignificant/non harmful	1
Small/ potentially harmful	2
Significant/slightly harmful	3
Great/ harmful	4
Disastrous/Extremely harmful	5

Spatial Scope/Geographic Extent of Impact	Rating
Activity specific	1
Area Specific	2
Whole Site	3
Regional/Neighbouring areas	4
National	5

Duration of Impact	Rating
One day to one month	1
One month to one year	2
One year to ten years	3
Life of operation	4
Post closure/permanent	5

Likelihood			
Frequency/duration of activity	Rating	Frequency of impact	Rating
Annually or less	1	Almost never/Impossible	1
6 monthly/temporary	2	Very seldom/highly unlikely	2
Monthly/infrequent	3	Infrequent/ unlikely/ seldom	3
Weekly/life of operation	4	Often/regularly/likely/possible	4
Post closure	5	Daily/highly likely/definitely	5

The definitions used in the impact assessment are given below:

- ***Frequency of activity*** refers to how often the proposed activity will take place.
- ***Frequency of impact*** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- ***Severity*** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- ***Spatial scope*** refers to the geographical scale of the impact.
- ***Duration*** refers to the length of time over which the stressor will cause a change in the resource or receptor.

Table 8-3 - Significance Rating Matrix

Likelihood (Frequency of Activity / Frequency of)	Consequence (Magnitude+ Geographic extent + Duration of the impact)														
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
7	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 8-4 - Positive/negative mitigation ratings and associated colour codes

Significance rating	value	Colour Code	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150		Propose mitigation measures	Maintain current management
High	100-120		Propose mitigation measures	Maintain current management
Medium high	77-105		Propose mitigation measures	Maintain current management
Low medium	52-75		Maintain current management	Improve current management
Low	25-50		Maintain current management	Improve current management
Very low	4-24		Maintain current management	Improve current management

8.1.6 Mitigation

It is expected that during design of the project, the proponent will undertake measures and provisions for impact mitigation. The measures should be established through the following hierarchy described in Box 1below.

Box 1: Hierarchy of Impact Mitigation

- **Avoid at source or reduce at source**- *Avoiding or reducing at source is designing the project so that a feature causing an impact is designed out (e.g., a waste stream is eliminated) or altered (e.g., reduced waste volume).*

- **In-situ mitigation** – This involves adding something to the design to abate the impact e.g., pollution controls.
- **Mitigation at receptor** – if the impact cannot mitigated/abated onsite then measures can be implemented off-site e.g., install double-glazed windows to minimize noise impact at nearby residences
- **Repair or restore**- some impacts could result in unavoidable damage to a resource (e.g., damage of agricultural land during construction. Restoration mainly proposes measures to restore the resource to its initial state.
- **Compensation**- where mitigation measures are not possible or fully effective, then compensation for the loss, damage and the general intrusion may be appropriate. The compensation may be "in-kind", such as planting of new woodlands elsewhere to replace what has been lost.

8.1.7 Residual Impact/Mitigated Impact

The **residual impact** is what remains following the application of mitigation and management measures, and is thus the final level of impact associated with the development of the Project. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this ESIA Report.

8.2 Potential project activities

8.2.1 Steps of Road Construction

There are five basic steps of road construction which has potential impact on environment; in particular, the ecosystem. These include:

- **Step 1 - Planning**: This is the initial step in any road construction project. It involves assessing the current and future traffic patterns and performing a cost-benefit study to ensure the road will serve its purpose. Layout drawings, funding, legal, and environmental issues are all sorted out during this initial stage of road construction to ensure the project runs smoothly without running into financial or legal problems

- **Step 2 - Setting Out:** Setting out refers to the process of transferring design proposals from drawings into the ground. It demarcates site boundaries, foundations, and other necessary structural parts

- **Step 3 - Earthworks:** It entails the deployment of a tractor shovel, grader, or bulldozer on site to remove the topsoil before scraping and grading the site to expose the underlying ground, often known as formation level.

- **Step 4 - Paving:** This road construction procedure begins once the subgrade has been prepared and drainage systems fitted. Paving can either be rigid or flexible depending on the precise requirements of a project

- **Step 5 - Quality Control:** After a road surface has been put in place, a series of quality tests must be performed before the road construction project can be deemed complete. This procedure involves checking to confirm drainage, grading levels and other aspects of the road are satisfactory.

- **Step 6 - Maintenance:** Over time, traffic and environmental effects will damage traditional road surfaces, which require rehabilitation. Life expectation of road construction and maintenance projects varies from country to country, but a standard expectation of several decades of service can be expected, with major rehabilitation efforts performed every ten years or so.

8.3 Impact Identification

During field observation the proposed Mau Mau Road networks were surveyed to identify potential environmental processes and social behaviour that would be affected negatively or positively along the proposed road network. Positive impacts and research on environment and social were conducted on issues listed below:

Positive impacts

- Employment and income generation
- Skill development
- Stimulation of local Economy
- Reduction of vehicle operation cost and travel time

Negative impacts

Environmental Issues

- Impact of road construction on behaviours of Species of conservation importance: Critically Endangered, Endangered, Vulnerable and Near Threatened Species;
- Impact of road construction on aquatic biodiversity; especially on streams and swamps and pool waters;
- Pit falling effect on some reptiles and amphibians, and rodents;
- Potential collision with low flying birds;
- Potential collection of live specimens of species;
- Impact of road construction on tree species and the above-ground carbon stock;
- Introduction of Alien Invasive Plant Species;
- Impact of road construction on potential erosion;
- Impact of road construction on potential flooding of farms; and
- Siltation of wetlands, earth dams, water pans, streams and fish pond occurring on downstream of the road.
- Human – Wildlife Conflict; especially between constructors and wildlife
- Impact of road construction on potential poaching for bushmeat and trophy
- Impact on climate change

Socio-Economic Issues

- Impacts to Exposure of Workforce to Poor Labour and Working Conditions;
- Increased transmission of HIV/AIDS and Other STIs;
- Impacts on Employment, Procurement and the Economy;
- Loss of Property and Livelihood Sources.

8.3.1 Positive impacts

8.3.1.1 Employment and Income Generation

The significant potential positive impact is employment creation during construction of the proposed road. In the construction works, employment will be generated both skilled and unskilled professionals at different levels directly and indirectly. This will benefit the locals and the country at large by improving livelihoods. Employment and income generation will also be at various parts/locations of the county directly and indirectly, particularly food vendors and from where materials such as borrow materials, construction sand, stones, cement among others will be brought/ transported.

8.3.1.2 Skill Development

During the construction phase the local community will have opportunities to work on the project under the supervision of well experienced personnel and during this period, they will get a chance to acquire new skills that they will use in the implementation of this project and can use in other similar projects in future.

8.3.1.3 Stimulation of the Local Economy

The construction phase of the project is characterized by an influx of new people into the project area. An increase in population will create a corresponding increase in demand for goods and services such as food for construction workers, housing, basic items and need for transport. This need will be filled by people living within the project area where local women will provide food vending services, homes will rent out spaces for the new population and shops will also benefit from increase of sales. All these avenues are bound to stimulate the local economy.

Construction phase will also stimulate local economy through procurement of construction material and provision of labor by the locals. This will lead into increased capital flow and demand for goods and services will increase.

8.3.1.4 Reduction of Vehicle Operating Costs and travel time.

The rehabilitation project will enhance the state of the road condition. This will lead to a multiplier impact of reduction of vehicle breakdowns thus reduced vehicle operation cost. The project road will reduce travel time as illustrated in chapter 6.

8.3.1.5 Enhancement Measures for Employment and Procurement of Goods and Services

In order to enhance this positive impact, the following management measures will be required:

- The Project will prioritize the employment of unskilled labor from the affected villages and towns in the first instance. The advertisements on the employment and procurement opportunities during construction phase should be placed at the chiefs' and ward administrators' offices for information. In the event that positions cannot be filled from within these villages and towns it should be advertised further afield (county-wide, then nationally).
- The Project should prioritize the procurement of goods and services from within the nearby Nyeri and Nyandarua towns among other areas along the project road. In the event that goods

and services cannot be procured from within the county, then preference should be given to national companies. This will not apply to the provision of specialized technical goods, which will be sourced from overseas, but applies rather to construction materials, such as cement, sand, aggregates, reinforcing steel, metal etc.

- The Project should develop a fair and transparent employment and procurement policy and processes that manage any potential nepotism or favoritism. The policy should include gender equality to avoid bias during the employment process. The policy should be shared with the nearby communities.
- The Proponent will include requirements for local employment in the contract that they establish with the contractor and require that the contractor recruits in accordance with the Proponent recruitment policy.
- The Proponent should ensure that all tenders are advertised

8.3.2 Negative impacts-Environmental

8.3.2.1 Impacts of infrastructural/road construction on biodiversity

Infrastructural development leads to the changes in the physical, chemical and biological characteristics of an area. The impacts on the biodiversity may be direct and indirect (Hajar et al., 2014), depending on the proximity to the area where the project is taking place. Direct impacts are the ones that directly result from the road construction process while the induced ones result from the anthropogenic activities that are made possible by the road construction say due to increased accessibility to the area. These impacts may further be positive or negative depending on the species affected and the general characteristics of a place. Positive impacts may result if the project changes the conditions of a place depauperate of biodiversity into conditions that favour species colonization and establishment and it can be negative if it results into a reduction in the species diversity. However, not all increases in species diversity or richness are positive, as some increases may have negative effects on the biodiversity in the long term say the establishment of invasive species. The nature of the habitat also determines the extent of these impacts for example, impacts on a forest are different from those on open habitats like grasslands and croplands while impacts on stagnant water bodies are different from those in flowing water bodies. The ecological effects of roads include habitat loss and disturbance, corridor, mortality, barrier and behaviour modification (Seiler, 2001). The effects can be broadly be looked at in terms of plants and animals as each of these major groups stands to be affected differently and there are other effects on the finer groups.

8.3.2.2 Impacts on vegetation

Deforestation is usually the first impact that results from physical developments and this is done for both the road site and the areas where construction materials like murram, stones and gravel are obtained (AWEMAC, 2017). This is because site clearing is usually the first step in these activities and this involves indiscriminate the clearing of vegetation. This is often followed by clearing of more land to establish human settlements due to the increased access to that are opened up by new road networks hence the loss of vegetation goes beyond the area to be occupied by the

road. Deforestation leads to ecological changes which have other far-reaching effects on the plant community in an area.

Though the immediate impact of deforestation is reduced vegetation cover, intermediate impacts will include change in the species composition in an area due to establishment of alien species such as colonising species, edge species and even invasive species (Li et. al., 2014). These new species and ecological interactions are induced by the sudden change in the accessibility to natural resources needed by the plants such as sunlight, water and nutrients (Parendes and Jones, 2000; Watkins et. al., 2003; Coffin, 2007) and also due to other human activities post road construction (Li et. al., 2014). The establishment of these new species may lead to further loss of species in the long term especially if the incoming species are more competitive than the native species.

These impacts have been found to vary with distance from the road, the road width, traffic, noise and the type of road, tarmac or rough (Li et. a., 2014) and the different plant groups (Hajar et. al., 2014). For example, the exposed nature of the environment by the roads will lead to growth of bigger trees with more leaves die to increased accessibility to sunlight. This would however mean reduced understorey vegetation such as herbs and saplings. Inside the forests, there is increased competition for sunlight and the trees are taller with narrower trunks and fewer leaves, allowing for light to reach the ground level, which then translates to more undergrowth (Murphy et. al., 2016). Since the herbaceous plants play key roles in the maintenance of the forest soil, it would mean more erosion will occur by the roadsides than within the undisturbed forests.

Guillan (2006) found road construction to supress the growth of native plant species. On the other hand, the vegetation richness along the roads has been found to be influenced by soil compaction, disorganisation and physical properties (Smith et. al., 2007) all of which stand to be affected by a road construction exercise. The increase in the number of species establishing by the roads has been attributed to increased flow of water, wind and movement of animals, both of which are dispersal agents for the seeds (Lonsdale and Lane, 1994) and good growth conditions brought by the open space, access to water, warmth and air (Parendes and Jones, 2000).

Other consequences of road construction to vegetation results from the increased accessibility to certain areas by man which will lead to increased exploitation of vegetation through logging, increased collection of plants for other uses such as medicinal plants and introduction of new plant species such as fruits trees.

8.3.2.3 Impacts on animals

There are three main ways through which roads affect animals. These are habitat loss, habitat inaccessibility due to movement barriers and direct mortality (Jaeger et al., 2005). The impacts on animals appear to vary not only with taxa but also the size of the animals. Small animals like insects and small bodied mammals appear to gain from roads (Johnson and Collinge 2004; Brock and Kelt, 2004; Coffin, 2007) because of the increased resource provisioning in form of more open spaces especially if the initial habitat was a forest. Roads also provide movement and migration corridors for some of these species, allowing them not only to increase their area of coverage, but also move into new habitats within their range (Laurance and Williamson, 2001).

Negative impacts on animals include change in behaviour as they adjust to accommodate the heavy presence of foreign beings and structures. Some large mammals are not tolerant of human presence and these will be forced to migrate deeper in their territories or even to new areas. In general, increased automotive activity in the roads will lead to increased accidents and animal losses due

to collisions between the autos and the wildlife. Such cases have been reported for snakes (Bernardino and Dalrymple, 1992), amphibians (Bouchard et al. 2009), reptiles (Andrews and Gibbons 2005; Row et al. 2007) and large mammals.

The term "road-effect zone" was coined by Forman and Alexander, (1998) and is used to refer to the distance from the edge of the road over which significant ecological effects can be detected. This zone is impacted by noise and chemical pollution from the roads, as well as the habitat destruction through land clearing to pave way for the infrastructural development. This has been found to vary both with taxa and species. For the amphibians for example, the road-effect zone was found by Eigenbrod et al. (2009) to vary from 250-1000m from the road and the impact is mostly negative. In the desert environments on the other hand, the roadside vegetation was found to provide suitable habitat for the small mammals like rats, mice and shrews (Bissonette and Rosa, 2009), pointing to the need to minimise disruption of these systems.

Some of the behavioural changes that have been associated with the road development is change in the frequency of voice used in acoustic communication by birds and frogs because of the anthropogenic noise from autos using these roads (Parris and Schneider, 2008; Hoskin and Goosem, 2010). Road developments have also altered the speed and rate of migration for amphibian species especially during their migrations. Since the amphibians migrate mostly during their breeding season (Channing and Howell, 2006), this effects are deemed to affect their breeding and subsequent recruitment. Another important effects of roads especially on primates is habituation to humans for example the baboons and other monkeys. As roads open up the remote countries, some of the animals that haven't been interacting with humans start to do so especially for the ones not likely to be hunted.

Roads have been recognised as agents of habitat fragmentation which principally leads to population segregation. An important consequence of this is reduced interactions (gene flow) among populations which might ultimately reduce the genetic diversity of these populations. The negative effect of this is reduced fitness of the subsequent generations thus increased predisposition to diseases, inflexibility in adaptation and loss of populations. Though these effects are bad to a species, they are worse if the species is a range restricted endemic which means it can easily edge closer to extinction. Negative effects of fragmentation have been reported in birds, mammals, amphibians and reptiles.

Since the use of roads increase with time, it is important to have in mind that some of these effects may not be felt immediately, but may be felt from intermediate to the long term. This of course can only be affirmed with timely data collection on the affected population in order to fill the paucity in data availability for decision making. Van der Ree et al., (2011) opines that the limited knowledge on how animals are affected by road constructions backed by limited data collection has been used as an excuse to allow for road constructions in many parts of the world. They therefore signpost to the need of continuous and long-term monitoring of wildlife even after such projects have been commissioned and done.

8.3.2.4 Impact on vegetation cover and the above-ground biomass/carbon

The total area of different land cover types to be cleared during the preparation stage of road construction will determines the amount of biomass that will be lost. An estimated road reserve area that will potentially be cleared is 104 hectares with about 5,662 Mg ha-1 of biomass to be

lost. Thus, the proposed road alignment has a potential of losing biomass of 4,300 Mg ha-1 in bamboo area, 1,185 Mg ha-1 in forest, and about 177 Mg ha-1 in mooreland.

Extent of impact: An estimated area running along the proposed road alignment. This cuts across the forest from Ihithe to Kahuruko.

Magnitude of impact: A lot trees will be lost hence huge amount of biomass will be removed from the environment

Duration of impact: Clearing will take place during preparation stage of road construction during construction phase of the project

Likelihood of impact: Road construction projects is associated with clearing in preparation of levelling and grading; hence, high likely to affect the above-ground biomass

Unmitigated impacts on vegetation cover and the above-ground biomass/carbon during construction phase	
Magnitude of impact	4
Extent of impact	4
Duration of impact	4
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	High (-108)
Recommendation	Propose mitigation
Comments/mitigation • Cleared trees should be kept within the forest and should be used in order to prolong period of carbon emission. • Sites should be identified for offsetting the loss of forest cover and biomass. This will require an adoption of compensation plan.	
Mitigated impacts on vegetation cover and the above-ground biomass/carbon during construction phase	
Magnitude of impact	4
Extent of impact	4
Duration of impact	3
Likelihood of impact	5
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-55)

8.3.2.5 Potential human-wildlife conflict in inhabited areas

During the construction of road, animals would avoid crossing areas with active movements of people, earth movers and trucks. This will cause diversion of point of crossing along the road. Such diversions might lead animal population to settlement areas or cultivated areas. This will basically cause human-wildlife conflict. Animals with tendency of walking long distance looking

for forages within a short period like elephants might be affected. Conflict would arise with other animals such as snakes with construction personnel. Killing of wildlife due to attack at night will likely to occur. Opening of electric fences in Kiandogoro area to allow for road expansion will likely create openings where wildlife will cross over to settlement adjacent to the area. This will cause severe destruction to crops, injuries and deaths due to physical confrontation. Working across landscape where some areas have concentration of animal population would solicite attacks from the animals. Chances of encounter of wild animals by constructors would occur in areas where the animal distribution is concentrated along the road alignment. Normally wild animals would keep off areas with such human activities. However, individual walking alone in the area would be highly prone to the attacks. Animals that are notorious to attack along the proposed road alignment are the elephants, lone buffaloes, leopard, snakes.

Extent of impact: human-wildlife conflict will occur in or near areas of project construction activities. The diversion of animal movement will take place in areas of active construction. This might take place in a distance of 1-5km.

Magnitude of impact: The magnitude will depend on the movement of some of the wild animals such as the elephant that normally have specific areas of crossings. Movement of a population of the species might be diverted to other areas.

Duration of impact: the impact will occur during construction phase of the project and will be shifting with the areas under construction

Likelihood of impact: when construction takes place during period when the animals are moving across the landscape especially during dry season, the population will likely to be affected

Unmitigated impacts on human-wildlife conflict during construction phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	2
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-56)
Comments/mitigation • Construction of the road should be conducted faster to minimize potential diversion of animal movements • Excavation of deep long channels should be avoided	
Mitigated impacts on human-wildlife conflict during construction phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	2
Likelihood of impact	4

Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-24)

8.3.2.6 Wildlife Poaching

Poaching will likely to occur in the area as an indirect impact of the proposed road project development during construction phase. Different animals would be poached for various reasons. Poaching for bushmeat which might target antelopes and other groups of herbivores. Another type of poaching would be for trophies; these are likely to target animals such as elephants for tusk, leopard for the skins and live animals such as the herpetofauna species. Some of these species are listed as threatened in the IUCN red list. These include the African Elephant, Buffaloes and Leopard. Poaching might be conducted by some clandestine constructor personnel or other people masquerading as road constructors in order to get opportunity for poaching. Due improved better road, poaching might continue during the operation phase of the road. Transportation will be faster hence poachers will easy strike and disappear with the target poaching products.

Extent of impact: The extent of poaching will begin from Ihithe to Ndunyu Njeru area. During construction, the extent would be limited to the area of active construction. However, during operation phase of the project the impact will cover the whole project area

Magnitude of impact: Wildlife will potentially be affected there is high concentration. This is where there are many animal populations.

Duration of impact: Poaching will be undertaken secretly and the impact during construction will depend on how long construction activities takes place in the above-mentioned areas. The impact is envisaged to continue throughout the operation life of the project.

Likelihood of impact: Wildlife concentrated areas are potentially affected by poaching. When there is access to such areas poaching would take place for bushmeat and or trophy. Poaching incidences are likely to occur where there is no control of poaching.

Unmitigated impacts of poaching during Construction Phase

Extent of impact	4
Magnitude of impact	4
Duration of impact	2
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-80)
Comments/mitigation • KWS should screen contractor personnel working in the project. • Contractor should work within the construction space of the road and designated construction camp.	

• KWS should screen contractor's construction plant, equipment, containers, etc. • Security in the region should enhance surveillance on vehicles • Strengthening law enforcement: This includes increasing patrols, conducting sting operations, and prosecuting poachers to the fullest extent of the law. • Providing alternative livelihoods to the local communities e.g prioritizing them on employment. • Patnership with the local communities in conservation efforts.	
Mitigated impacts of poaching during Construction Phase	
Extent of impact	3
Magnitude of impact	2
Duration of impact	2
Probability of impact	6
Risk = (Extent + Duration + Magnitude) x Probability	Low -42

Unmitigated impacts of poaching during Operation Phase

Extent of impact	4
Magnitude of impact	4
Duration of impact	4
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-90)
Comments/mitigation • Security in the region should enhance surveillance on vehicles • Local residents and conservancy wardens should be on high alert on potential poaching which will result from the improved road condition	
Mitigated impacts of poaching during Operation Phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	4
Probability of impact	3
Risk = (Extent + Duration + Magnitude) x Probability	Very Low -21

8.3.2.7 Impacts on Species of Conservation Importance

8.3.2.7.1 Barrier to movement of elephants to the river and dispersal foraging grounds

Movements of the elephants and other animals will be hindered temporarily across the proposed road alignment. The blockage will be caused by activities such as excavation of trenches, movement of earth moving machines, and noises made from personnel and engines. Elephants move across the landscape in search of forage, water and migration to breeding areas. Presence of elephant distribution was observed throughout the road from Kiandogoro (KFS gate) through to Mutubio (KWS gate) and slightly past this gate in the forest reserve area towards Kahuruko. Excavated trench beside the road will affect elephant population especially the young ones (calves). Traditionally, trenches or ditches have been used as barrier in controlling human-elephant conflicts. Constructed elephant barriers such as ditches/trenches normally consider the width and depth of the ditch that will prevent elephants from crossing. The ditches are normally wider than the strides elephant can make and deep to discourage it from getting into it. Commonly used dimensions of trenches are 3m wide at the top, 1 m wide at the bottom, and 2 m deep (Fernando et al., 2008).

Extent of impact: the extent of blockage or diversion of elephant movement will depend on the stretch of the road that is active on construction. This may range from 1 – 5km.

Magnitude of impact: A section of population of elephants will however, be affected causing diversion to their movements

Duration of impact: construction of the road section within a stretch of 1- 5 km might last for about 1 - 6 months. Hence it is envisaged to take place within a year

Likelihood of impact: there is high chance that elephant population movement will be affected in the above-mentioned areas. This depends on seasons of the year.

Unmitigated impacts on temporary blockage/diversion of elephant movements during Construction Phase	
Magnitude of impact	3
Extent of impact	4
Duration of impact	3
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-80)
Comments/mitigation • Construction of road should be conducted faster during dry season to allow for natural dispersal tendency of wildlife during wet seasons • Where trenches/channels are excavated and staying for long, crossing ramps should be put in place to facilitate crossings of their calves • Construction should be restricted between 8 am to 5 pm to avoid active movements and congregation periods along the road.	
Mitigated impacts on temporary blockage/diversion of elephant movements during Construction Phase	
Magnitude of impact	2

Extent of impact	3
Duration of impact	3
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-48)
Unmitigated impacts on temporary blockage/diversion of elephant movements during operation phase	
Magnitude of impact	3
Extent of impact	4
Duration of impact	3
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-80)
Comments/mitigation • Potential elephant crossing points should be secured to allow movement between the landscape • Crossing structure such as underpasses for the elephants and other wild animals should be constructed • Speed bumps should be introduced where visibility is interfered by topography and dense vegetations • Drivers should be warned using sign post of elephant crossing or congregation on the road in the evenings and at night • Driving at night should be prevented to avoid collision with elephants on the road	
Mitigated impacts on temporary blockage/diversion of elephant movements during operation phase	
Magnitude of impact	2
Extent of impact	2
Duration of impact	4
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-48)

8.3.2.7.2 Barrier to movement of Rhino

The Eastern Black Rhino is a Critically Endangered species under the IUCN red list of threatened species. Currently, the species is found in Kenya and the North Eastern side of Tanzania. Rhinos eyesight on motionless object is only sensitive within the range of 30m; it mainly relies on their strong sense of smell. The species is a browser and can live in a range of habitats including the tropical savanna and shrublands. Its main threat is illegal hunting (poaching) to supply the illegal international Rhino trade horn. Observation of Rhinos adjacent to the road did not realize even an

individual sighting this could be attributed to its highly sensitive to noise which makes them run away. However, there is an accounted information on presence of population of Black Rhinos in the Aberdare Ecosystem. The species normally faces difficulties in climbing steep gradients, heaps of soil, and trenches. This makes it vulnerable to projects that construct channels or trenches.

Extent of impact: Movements of Rhinos across the landscape from the north to the south (and vice versa) in the Aberdare ecosystem will be affected adversely

Magnitude of impact: There are few populations of Rhino hence movements of this population will potentially be affected

Duration of impact: The impact will occur throughout the operation of the road.

Likelihood of impact: Increase in traffic noise which will repel the animal away as it does not stay closer to high and interruptive noise levels

Unmitigated impacts on barrier to movement of Rhino during operation phase	
Magnitude of impact	5
Extent of impact	4
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-104)
Comments/mitigation • Crossing ramps should be put in place where temporary trenches are constructed • Avoid deep trenches as much as possible • Provide drinking water troughs and mud puddles away from the roads	
Mitigated impacts on barrier to movement of Rhino during operation phase	
Magnitude of impact	3
Extent of impact	3
Duration of impact	4
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-60)

8.3.2.7.3 Potential road kill of the Aberdare Cisticola

The Aberdare Cisticola is an endemic species to Kenya and is enlisted under IUCN red list of threatened species as an endangered (EN). The species is found in a natural habitat that occur in the subtropical or tropical high-altitude grasslands (above 3000m) which are currently threatened by habitat loss. In the Aberdares Ecosystem, frequent fires on the moorelands and grasslands are potential threat to the species habitat. The species is known to breed from January – May and August – November building a small nest of leaves and branches. Its main range is within the

mooreland where it flies at a lower level relative to the heights of mooreland vegetation (1 – 3 m high). However, it can perch on shrubs or trees with the height between 1 – 2m

Extent of impact: There is a potential area stretching for 5 km where road aligns on mooreland

Magnitude of impact: Most movements occur along the valleys. Hence potential collisions will mostly occur where mooreland valleys intersect the road alignment

Duration of impact: The impact will occur throughout the operation of the road.

Likelihood of impact: Low flying birds are normally hit by vehicles when crossing the road. This is likely to happen

Unmitigated impacts on potential road kill of the Aberdare Cisticola during operation phase	
Magnitude of impact	5
Extent of impact	4
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-104)
Comments/mitigation • Introduction of speed bumps specifically towards the mooreland valleys • Avoid clearing of tall vegetation on valleys to allow these birds to scale flight height higher than the height of cars. • Plant the indigenous shrubs and trees near the valleys to control the flight speed of the bird and allow this bird to scale its flight higher once the trees grow taller	
Mitigated impacts on potential road kill of the Aberdare Cisticola during operation phase	
Magnitude of impact	3
Extent of impact	3
Duration of impact	4
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-60)

8.3.2.8 Impact on aesthetic value

Road structure will cause visual intrusion to animals and tourist to the Aberdare Ecosystem. Interference with the topography by introducing deep cuts and fillings interferes landscape scenic beauty that is attractive as one move along the current road. This also includes structures introduced and being in disharmony with the topography and vegetation structures. The opening of canopy in some places along the road affects negatively the natural appealing of the canopy structures and moderation of sunlight which has a cooling effect. Littering by solid wastes along the road will also cause visual intrusion to tourist which will reduce consideration values for the Aberdare National Park and Forest Reserve. The introduction of the AIPS causes mismatch of

plant species where indigenous plants occur. This affect negatively the spectacularise of unique botanical formations.

- **Extent of impact:** Several areas will be under cut and fill especially on steep areas (cuttings) and valleys (fillings)
- **Magnitude of impact:** Cuttings normally leaves the limb of slopes ugly exposed while fillings on the valley raises the topography higher than normal
- **Duration of impact:** Visual intrusion will begin during construction but becomes more provoking during the operation phase of the project
- **Likelihood of impact:** A number of activities and changes are expected during the construction and operation phase of the project. Hence highly likely to be affected adversely

Unmitigated impacts on aesthetic value during operation phase	
Magnitude of impact	3
Extent of impact	3
Duration of impact	5
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	High (-110)
Comments/mitigation • Plant grasses, lianas and climbers on cut slopes • Level of road fillings on valleys should be synchronized with the gradient of the topography in the valleys • Trees should be planted near the road reserve to moderate on visual intrusions • Structures should be painted green colour • Control the spread of solid wastes in the protected areas • Control introductions and spread of AIPS	
Mitigated impacts on aesthetic value during operation phase	
Magnitude of impact	2
Extent of impact	2
Duration of impact	5
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-36)

8.3.2.9 Solid waste pollution

Solid waste management is a concern to environmental management and conservation in the developing countries. Solid waste pollution is a menace along our roads emerging from illegal dumping and careless throwing of solid wastes from Public Service Vehicles. During construction, most of solid waste littering will likely be caused by contractor personnel. Solid wastes from food wrappers and remains are likely to be generated by the personnel. While containers for vehicle lubricants will likely litter road sides during construction.

- ***Frequency of activity*:** Engagements of contractor personnel on the landscape will be site based. Site based activity will be mobile on the landscape
- ***Frequency of impact:*** Littering will always occur on sites where personnel stop for lunches or break from work
- ***Severity*:** Solid waste pollution will adversely affect aesthetic values of the protected areas. It will also attract vermins such as rats to the protected areas that will the ecology of rodents
- ***Spatial scope*:** The area to be affected during construction phase will around parking areas during lunches and short breaks from work
- ***Duration*:** Time of exposure of solid waste depends on duration of construction on site

Unmitigated impacts of solid waste pollution during construction phase	
Magnitude of impact	3
Extent of impact	3
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-80)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Contractor personnel should be educated on environmental awareness 2. Food containers such as lunch boxes should be used by personnel instead of food wrappers	
Mitigated impacts of solid waste pollution during construction phase	
Magnitude of impact	1
Extent of impact	1
Duration of impact	4
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-36)
Recommendation	Maintain current management or proposed mitigation measures

The introduction of PSV and other vehicles will likely cause introduction of solid wastes into the protected area which at the moment is void of the wastes. Passengers usually throw away empty water bottles and wrappers (for food) through the windows littering road sides with solid wastes.

- ***Frequency of activity*:** There will be very high traffic flow through the protected areas ranging from personal cars, trucks and Public Service Vehicles
- ***Frequency of impact:*** Vehicles using the road during operation phase will be responsible for littering along the road
- ***Severity*:** Solid waste pollution will adversely affect aesthetic values of the protected areas. It will also attract vermins such as rats to the protected areas that will the ecology of rodents
- ***Spatial scope*:** The entire stretch of the road will potentially be affected by dumping of the solid wastes
- ***Duration*:** Usage of road will be throughout the operation phase of the project

Unmitigated impacts of solid waste pollution during operation phase	
Magnitude of impact	3
Extent of impact	4
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-88)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Road users should be educated on environmental awareness on solid waste management. These include drivers and travellers 2. Dustbin should be placed at the entrance to the protected areas for emptying solid wastes 3. Warnings should be made on boards against throwing solid wastes through the windows 4. Public Service Vehicle should have dustbin for passengers to use for clearing their wastes	
Mitigated impacts of solid waste pollution during operation phase	
Magnitude of impact	1
Extent of impact	1
Duration of impact	4
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-24)
Recommendation	Maintain current management or proposed mitigation measures

8.3.2.10 Accidental oil spill from construction camps and equipment

Involvement of earthmoving machines and other vehicles will be bound to oil spillage from the engines and also during maintenance. The longer the construction period the more spillage and leakage of oil into the aquatic habitats, rivers and reservoirs. Road construction is associated with construction camp where oil and grease, fuel are stored and equipment maintained. Establishment of such camps will cause spillage of oils that will adversely affect the water resources.

- ***Frequency of activity*:** Construction camps is a facility that will stay until construction activities are completed. While maintenance of equipment, vehicles take place on weekly or monthly basis.
- ***Frequency of impact:*** Spillage of oil into water resources will take place during rainy season when runoffs would likely mobilize the spillage from the camps, maintenance activities
- ***Severity*:** Oil is associated with different hydrocarbons that has varying health impacts on aquatic life, wild animals, livestock and human. The higher the exposure the greater the impact.
- ***Spatial scope*:** The spread of oil pollutant is expected to occur on rivers in the upper catchments running down to the reservoirs or lakes.
- ***Duration*:** Exposure to oil pollution will be high during rainy seasons

Unmitigated impacts of accidental oil spill from construction camps and equipment during construction phase	
Magnitude of impact	3
Extent of impact	4
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-88)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Contractor should have well maintained engines and equipment to avoid accidental oil leakages 2. The contractor's equipment should be regularly serviced. 3. Construction camp should not be established within the Protected Areas (National Park and Forest Reserve) 4. Construction should be confined during dry seasons only to avoid rains washing oily equipment and machines 5. All Earthmovers, vehicles and equipment should be removed from the water tower before the onsets of rainy seasons	
Mitigated impacts of accidental oil spill from construction camps and equipment during construction phase	
Magnitude of impact	2
Extent of impact	2

Duration of impact	4
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-56)
Recommendation	Maintain current management or proposed mitigation measures

The completion of the proposed Mau-Mau Road (Ihithe – Ndunyu Njeru) will attract traffic flow. Some of the vehicles will characterize poorly maintained vehicles which might stall on steep areas. Repairing of such vehicles are associated with leakage of oil on roads that will be washed by runoffs into the streams, rivers and reservoirs. Aberdare Ranges is one of the largest Kenya Water Towers that serves millions of populations with water. Oil is associated with different hydrocarbons that would potentially jeopardize human health, aquatic life and wildlife. The potential pollution would also compromise the operations of the water companies that supply waters from the Aberdares.

- ***Frequency of activity*:** Vehicles will be using the road on daily basis for transportation of goods and people
- ***Frequency of impact:*** Spillage of oil into water resources will take place during rainy season when runoffs would likely mobilize the spillage from the roads
- ***Severity*:** Oil is associated with different hydrocarbons that has varying health impacts on aquatic life, wild animals, livestocks and human. The higher the exposure the greater the impact.
- ***Spatial scope*:** The spread of oil pollutant is expected to occur on rivers in the upper catchments running down to the reservoirs or lakes.
- ***Duration*:** Exposure to oil pollution will be high during rainy seasons

Unmitigated impacts of accidental oil spill from construction camps and equipment during operation phase	
Magnitude of impact	2
Extent of impact	4
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-80)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Trucks using the road should be have a good record of miniatous in order to be allowed to pass through the protected area section 2. Stalled vehicles should be towed away immediately from the protected areas to avoid incidences of oil leakages	

3. KWS and KFS should be equipped with monitoring vehicles and towing trucks for response to stalled vehicles	
Mitigated impacts of accidental oil spill from construction camps and equipment during operation phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-80)
Recommendation	Implement and manage the mitigation measures

8.3.2.11 Impact on conservation of the Grey-crowned Crane

Among the species of birds recorded, the Grey-crowned Crane is only species found listed as Endangered (EN) in the IUCN Red List of Threatened Species. The Grey-crowned Crane is a very sensitive to physical disturbance caused by human and development. They normally avoid areas with physical disturbance and would choose areas away from construction activities. Its population is currently declining due to conservation threats caused by loss and degradation of wetland breeding areas induced by changes in land-use and major project developments. It is also threatened by live-trapping for trade, egg-collecting and hunting in wetlands. Due to agricultural expansion to wetland habitats, their foraging and breeding areas are limited. Thus, this species is supported by few remaining wetlands that establish along the streams and on the upstream of culverts. They are also observed foraging on cultivated farms on reclaimed wetland areas. The occurrence of the Grey-crowned Crane was observed foraging on the artificial wetland along the proposed upgrading road Amboni – Njegu Road Section.

Extent of impact: most of physical disturbance by construction will occur approximately within a narrow buffer of 100m from the road.

Magnitude of impact: Distribution of the Grey crowned Crane along the proposed roads are limited hence only few will be disturbed

Duration of impact: This impact is envisaged to take place during construction phase of the project

Likelihood of impact: The Grey-crowned Crane are sensitive to physical disturbance from human activities. They will likely avoid foraging on wetlands near the roads.

Unmitigated impacts on conservation of the Grey-crowned Crane during construction phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	5

Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-88)
Recommendation	Propose mitigation measures
Comments/Mitigation Active feeding of the Grey-crowned Crane is mostly in the early morning and in the evening. construction on site should begin from 8am and ends at 4pm to allow the birds including other wetland birds to forage	
Mitigated impacts on conservation of the Grey-crowned Crane during construction phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	5
Likelihood of impact	3
Risk = (Extent + Duration + Magnitude) x Likelihood	Very low (-27)
Recommendation	Implement and manage the mitigation measures

8.3.2.12 Impact of road construction on aquatic biodiversity

The construction of road especially through drainage channel will likely to cause accumulation of runoff water in the upstream of the culverts. A reservoir or water pool will form on the upstream of the culverts during the operation of the road. This will establish an artificial wetland that would be colonized by aquatic macrophytes (emergent, submergent and floating species) and in turn it will be colonized by different aquatic invertebrates. The establishment of wetland will create a conducive habitat that will also attract wetland birds for foraging.

Extent of impact: The creation of artificial wetland habitats will be limited to the project footprint and especially where the roads intersect with drainage channels.

Magnitude of impact: This phenomenon will be observed on the upstream of culverts. The size of the wetland established will depend on the morphology of the valley (topography), and the level of culvert on the drainage bed.

Duration of impact: This impact will be observed throughout the lifespan of the project.

Likelihood of impact: Normally runoff water accumulates on the upstream of culverts. This is brought about by the design and layout of the culverts or due to colonization of the channel by aquatic macrophytes, sedimentation occur and followed by the accumulation of runoffs.

Figure 8-2Artificial wetland established on the upstream of raised existing road creating an aquatic (wetland) habitat colonized by aquatic macrophytes and utilized for foraging by birds (inset photo) along Amboni - Njegu Road Section

Unmitigated impacts of the proposed road construction on aquatic biodiversity during operation phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	5
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (+88)
Recommendation	N/A
Comments/mitigation Establishment of the proposed wetland should not cause flooding of adjacent farms in the upstream of the road	
Mitigated impacts of the proposed road construction on aquatic biodiversity during operation phase	
Extent of impact	N/A
Magnitude of impact	N/A
Duration of impact	N/A
Likelihood of impact	N/A

Risk = (Extent + Duration + Magnitude) x Likelihood	Very Low
Recommendation	Continue as planned

8.3.2.13 Potential collection of live specimens of Chameleon

Live collection of chameleons is a common practice for trade as pet globally. This practice has potentially affected population distribution of some species in this group. However, at the moment the three species of chameleons recorded during the survey; *Trioceros bitaeniatus*, *Trioceros jacksonii* and *Trioceros hoehnelii* are all listed under the IUCN Red List of Threatened Species as Least Concern (LC) and their population are stable. Most of chameleon species are enlisted under CITES in Appendix II due to potential live collection for trade as pet. Collection live specimens of Chameleon might be undertaken by some constructor personnel or other people masquerading as road constructors in order to get opportunity for collecting specimen for trade or use as a pet. The collection of live specimens of chameleon would potentially be undertaken by contractor personnel.

Extent of impact: During construction, the extent would be limited to the area of active construction. However, during operation phase of the project the impact will cover the whole project area

Magnitude of impact: Collection of live specimens will potentially occur along the road. This is where chameleons were observed.

Duration of impact: collection of live specimens will be undertaken during the construction period. The duration depend on how long construction activities will take place. Thus, the impact is envisaged to happen only during construction phase of the project.

Likelihood of impact: There is an attraction of live specimen collection for trade globally. Any network with the personnel is likely to trigger the incidence.

Unmitigated impacts of collection of live specimens of chameleons during Construction Phase

Extent of impact	4
Magnitude of impact	4
Duration of impact	2
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-80)
Recommendation	Propose mitigation measures
Comments/mitigation • contractor personnel should be educated on CITES in order to understand how to protect species from collection of live specimens	

• Environmentalist expert should be incorporated in the personnel team to monitor on incidences of collection of live specimens	
Mitigated impacts of collection of live specimens of chameleons during Construction Phase	
Extent of impact	3
Magnitude of impact	2
Duration of impact	2
Probability of impact	6
Risk = (Extent + Duration + Magnitude) x Probability	Low -42
Recommendation	Implement and manage the mitigation measures

8.3.2.14 Pitfalls resulting from excavation of trenches

The excavations of trenches or deep cuts along the roads for controlling runoffs will be carried out on different spur roads in Nyeri and Nyandarua. These excavations will potentially affect small mammals and reptiles and amphibians. Thus, deep excavated will potentially act as a pitfall, which will trap the animals as they move across the landscape. Animals that will potentially be affected are rodents (rats and moles), reptiles (snakes and lizards) and amphibians (toads and frogs).

Extent of impact: reptiles are distributed throughout the proposed road project area. Incidence of pitfall is likely to occur throughout the project area.

Magnitude of impact: most of reptiles will be affected when they are looking for forage or when on local movement.

Duration of impact: the effect of pitfall will take place during construction phase of the project.

Likelihood of impact: movement of these animals is common on the landscape and this makes chances of falling into the deep channels a high possibility.

Unmitigated impacts arising from pitfalls during trenching	
Extent of impact	4
Magnitude of impact	4
Duration of impact	2
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-90)

Comments/mitigation • The contractor to use fencing and barriers during construction period • Provide a temporary crossing over the trench to enable the small mammals, reptiles and amphibians cross easily before backfilling of soil is done. • Construction personnel should provide a ramp to enable trapped animals to get out and monitor trenches for animal rescue. • The contractor to use friendly construction designs and tecniques to minimize impact of trenches on animals.

Mitigated impacts arising from pitfalls during trenching	
Extent of impact	2
Magnitude of impact	2
Duration of impact	1
Likelihood of impact	3
Risk = (Extent + Duration + Magnitude) x Likelihood	Very low (-15)

8.3.2.15 Impact on introduction of Alien Invasive plant species (AIPS)

Alien Invasive Plant Species are introduced during road construction through seed propagules that stick on the wheels (between tyre threads) of vehicles, human shoes or clothes. Fear of AIPS is that they displace indigenous plant species and are does not provide good habitat and forage to animal species. In areas where AIPS is introduced the landscape in terrestrial habitat changes significantly with other plant species displaced or suppressed. AIPS are normally introduced during construction phase but are detected after construction activities of the project are over. Also, with increased traffic flow on the road, increased introduction and spread is envisaged to occur. It is normally essential to assess the impact of the project on AIPS in order to strategies how to control their spread in the forest.

Extent of impact: AIPS will potentially spread on the spur roads in Nyeri and Nyandarua. However, during operation phase of the project the impact will spread to areas with roads connected to the proposed road project and drainage systems crossing through the project area.

Magnitude of impact: large population of the AIPS will grow along the road and drainage systems connected to the project area. This will spread even to pasture lands.

Duration of impact: The spread of AIPS will be observed mostly during the operation phase of the project. The spread of AIPS will take place even post project life span.

Likelihood of impact: the spread of AIPS is associated with road construction project. This project will not be an exception of the dispersal of AIPS. Also, there is high chance that AIPS or opportunistic species will affect farmlands adjacent to the road.

Unmitigated impacts on introduction of iinvasive alien plant species during operation phase	
Extent of impact	4

Magnitude of impact	3
Duration of impact	5
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-96)
Recommendation	Propose mitigation measures

Comments/mitigation:

3. Equipment to be used should be decontaminated e.g., washing equipment to remove soil potentially carrying AIPS propagules before brought on site
4. Always avoid the top surface of the soil from borrow pit when excavating gravels for road reinforcements in order to avoid transporting AIPS propagules to new areas.
5. Since AIPS appears later after soil disturbance, aftermath proliferation of AIPS should be controlled by regularly reducing their population and recruitment by uprooting

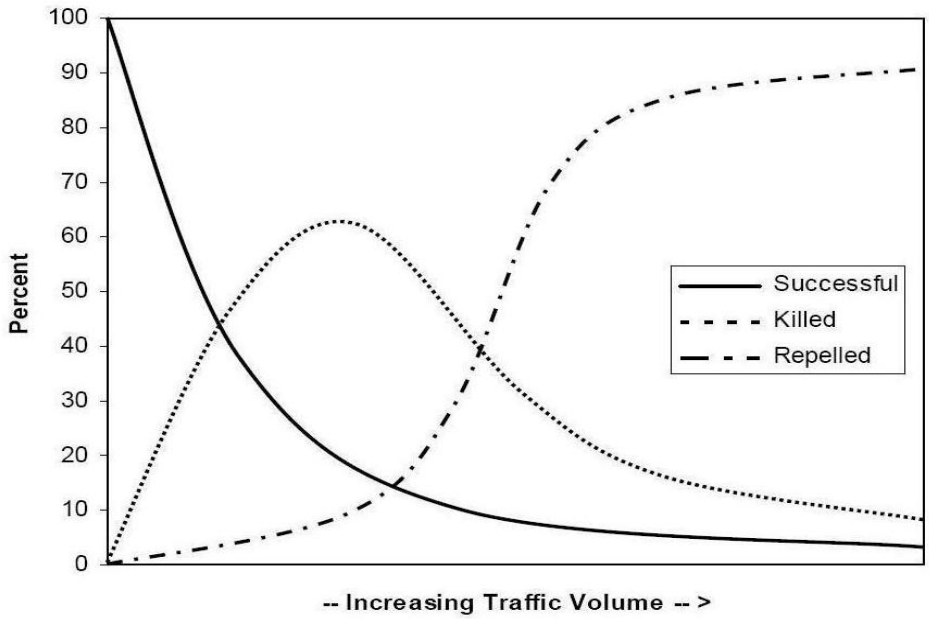
Mitigated impacts on introduction of Iinvasive alien plant species during Construction Phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	5
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-48)
Recommendation	Implement and manage the mitigation measures

8.3.2.16 Accidental killings of reptiles, amphibians, small mammals and low flying birds crossing the roads during operation phase

Accidental killing of animals is likely to occur during the construction and operation phase of the project. During the construction killing of would occur when excavating for expansion of the road. While crushing or collision with animals is likely to take place during construction and operation phase of the project. During the operation of the road, rodents; including rats, hare crossing the roads during the operation of road will be prone to killing by vehicles. Also, the low flying birds are likely to be hit by vehicles moving at speed during operation phase of the project. Road kills will be high in the initial period of operation since due to improved roads vehicles will be moving faster than usual. Sections of roads near the protected area of the Aberdare will be more prone to road killing incidences.

Habitat connectivity is the degree to which the landscape facilitates animal movement and other ecological flows. Habitat connectivity is important in maintaining biological diversity and population. Wild fauna requires movement from one place to another in search for food, protective security cover, and in response to seasonal variations. Impacts of road constructions have been studied indicating how the traffic volume affects an animal's ability to cross a road. When the traffic volume is low, most animals cross the road without problem. As traffic volume increases,

more are killed as they try to cross. It has been observed that with time, proportion of animals is increasingly repelled and they abandon their attempt to cross the road. Eventually this becomes the predominant response to a very busy road.



Source:http://www.wsdot.wa.gov/NR/rdonlyres/6FD6F8A9-A73D-49E5-A29B-1626B639FC7F/0/HabitatConnectivity.pdf

The proposed MNBR project construction will cause potential disruption of the contiguous habitats across the landscape. This implies the continuous flow of vegetations that create the unique habitat on the landscape will be disrupted. Thus, plant populations will be restricted on the either side of the road. Animal species that move along the vegetation flow across the landscape will also be affected with the disrupted vegetation flow.

Extent of impact: human-wildlife conflict will occur in or near areas of project construction activities. The diversion of animal movement will take place in areas of active construction. This might take place in a distance of 1-5km.

Magnitude of impact: The magnitude will depend on the movement of some of the wild animals such as the elephant that normally have specific areas of crossings. Movement of a population of the species might be diverted to other areas.

Duration of impact: the impact will occur during construction phase of the project and will be shifting with the areas under construction.

Likelihood of impact: when construction takes place during period when the animals are moving across the landscape especially during dry season, the population will likely to be affected.

Unmitigated accidental killings of reptiles and rodents crossing the road during construction phase	
Magnitude of impact	3
Geographic extent	3
Duration of impact	3

Likelihood of Impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-56)
Comments/mitigation	
Mitigated accidental killings of reptiles and rodents crossing the road during construction phase	
Magnitude of impact	2
Geographic extent	2
Duration of impact	2
Likelihood of Impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-24)

Unmitigated accidental killings of reptiles and rodents crossing the road during operation phase

Magnitude of impact	6
Geographic extent	3
Duration of impact	4
Likelihood of Impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-52)
Comments/mitigation	
Mitigated accidental killings of reptiles and rodents crossing the road during operation phase	
Magnitude of impact	2
Geographic extent	2
Duration of impact	4
Likelihood of Impact	3
Risk = (Extent + Duration + Magnitude) x Likelihood	Very Low (-24)
Comment/mitigation Measures. The contractor to employ proper methods of bush clearing and excavation to minimize this impact. Reducing speed limits in the project area. -Increase awareness: Educating Road users about the importance of being alert for small animals on the road and taking steps to avoid hitting them can help reduce the number of animal deaths -Create habitat corridors: Creating habitat corridors that connect natural areas can help small animals move around safely without having to cross roads -Technology such as animal detection systems and warning signs can help alert road users to the presence of small animals on the road, allowing them to take evasive action	

8.3.2.17 Potential flooding Incidences on farms

The topography in proposed Spur Roads has gradient that allow effective drainage of runoff waters without flooding. However, with the construction of the road across the drainage channels is likely to cause accumulation of runoff waters on the upstream of culverts or bridges constructed. Analysis of potential runoff water accumulation indicate the Amboni – Njegu road section will likely be flooded when effective passage of runoff waters is not well drained. Raising levels of these roads without proper consideration of drainages crossing the landscape will cause significant flooding on the upstream of the road. Other areas that might be affected by flooding are small occurring along the proposed road as indicate on the map (Fig. 7.3).

Extent of impact: Areas in upstream of the road that contours are in level with the road

Magnitude of impact: The whole of farmlands in the plain areas in the upstream of the road

Duration of impact: Impact will occur during the operation phase of the project
Likelihood of impact: Flooding occurrence depend on incidences of heavy rains which normally occur in this area. Hence, higher chances of occurring

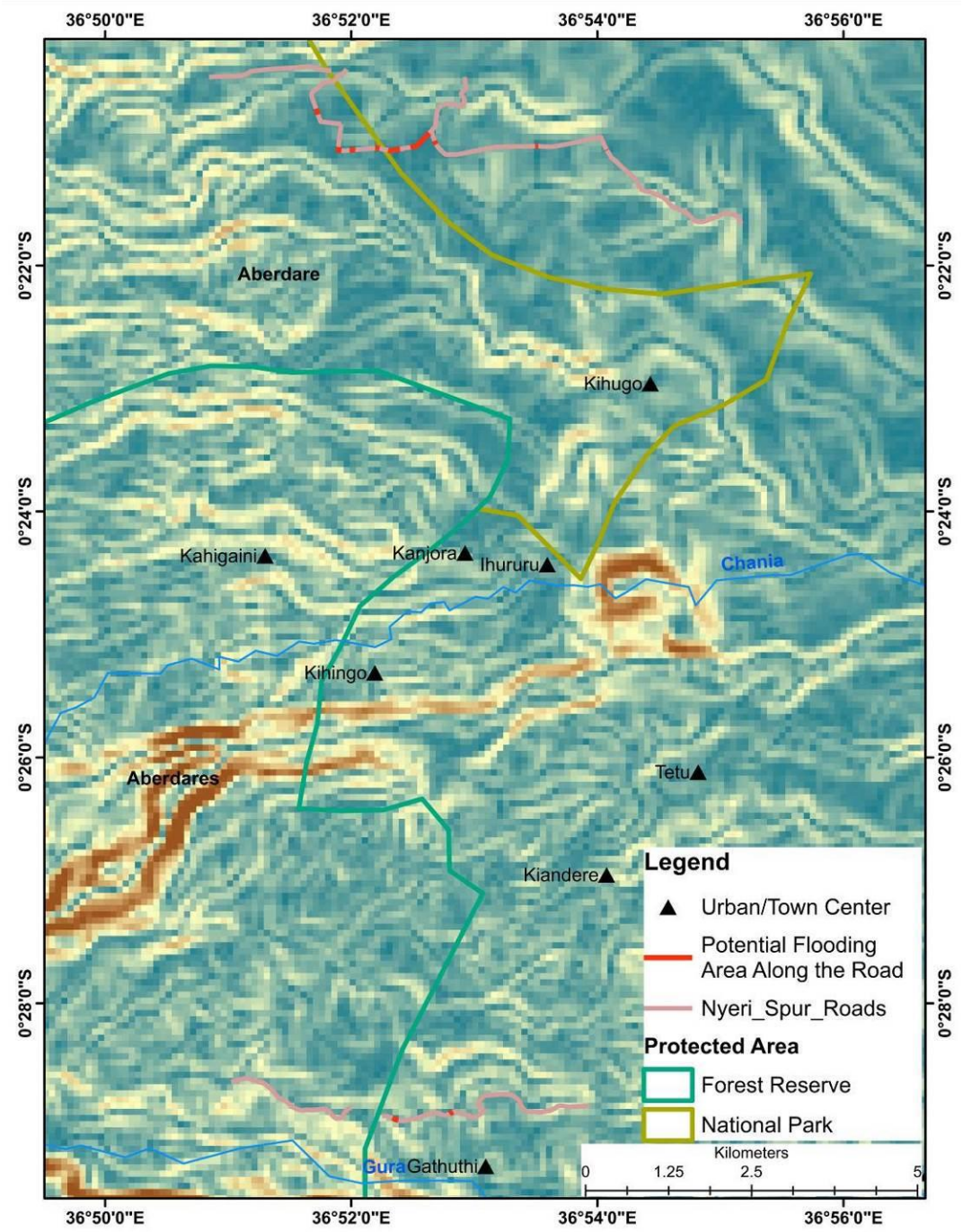


Figure 8-3 - Potential flooding areas in the wider landscape of Nyeri county

Unmitigated impacts of flooding on farmlands during operation phase

Extent of impact	4
Magnitude of impact	3
Duration of impact	5
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-96)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Drainages should be designed well in order to improve on movement of water across the road 2. Reduce high energy water in upstream of the road by designing several crossing channels across the road and through the farms. 3. Construct channels on downstream that outlet into streams or rivers 4. Reinforce the channel to resist potential erosion associated with runoff erosion 5. Drainages should be designed well in order to improve on movement of water across the road	
Mitigated impacts on aquatic life during Construction Phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	5
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-48)
Recommendation	Implement and manage the mitigation measures

8.3.2.18 Potential erosions of farmlands along the proposed roads.

8.3.2.18.1 Nyeri Spur Roads

The drainage of runoffs from upstream of the proposed road project can accumulate and form high energy water that can cause potential erosion on farms adjacent on downstream of the Nyeri Spur Roads. Occurrence of such incidence will cause damage by erosion soil for crop growing, destroy existing crops on farms. This consequently affect productivity of the land to sustain agricultural activities. Runoff waters running along the road in long gradient section would also destroy adjacent farms when not properly reinforced.

Extent of impact: The extent will cover from downstream of the road (e.g., culvert) to an outlet point in streams or rivers

Magnitude of impact: a lot of soils will potentially be eroded from the surface. Also crops will potentially be uprooted by the runoffs

Duration of impact: Impact will occur during the operation phase of the project

Likelihood of impact: The erosion will depend on the flooding incidences caused by heavy rains which normally occur in this area. Hence, higher chances of occurring

Unmitigated impacts of erosion on farmlands during operation phase	
Extent of impact	2
Magnitude of impact	3
Duration of impact	5
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Low medium (-96)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Reduce high energy water in upstream of the road by designing several crossing channels across the road and through the farms. 2. Construct channels on downstream that outlet into streams or rivers 3. Reinforce the channel to resist potential erosion associated with runoff erosion	
Mitigated impacts of erosion on farmlands during operation phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	5
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-48)
Recommendation	Implement and manage the mitigation measures

8.3.2.18.2 Nyandarua Spur Roads

Most areas the spur roads traverses in Nyandarua are on relatively plain areas. These are areas that are potentially prone to flooding. According to the indirect analysis of potential flooding areas based on slope analysis the road that is potentially affected by flooding is the Joma – Weru followed by Koinange – Munyaka (Fig. 7-4). Raising levels of these roads without proper consideration of drainages crossing the landscape will cause significant flooding on the upstream of the road. Small areas might experience flooding along Mwendandu – Koinange, towards Koinange area. While flooding would be experience around Ndunyu Njeru towards the junction to the main road.

Extent of impact: Areas in upstream of the road that contours are in level with the road
Magnitude of impact: The whole of farmlands in the plain areas in the upstream of the road
Duration of impact: Impact will occur during the operation phase of the project
Likelihood of impact: Flooding occurrence depends on incidences of heavy rains which normally occur in this area. Hence, higher chances of occuring

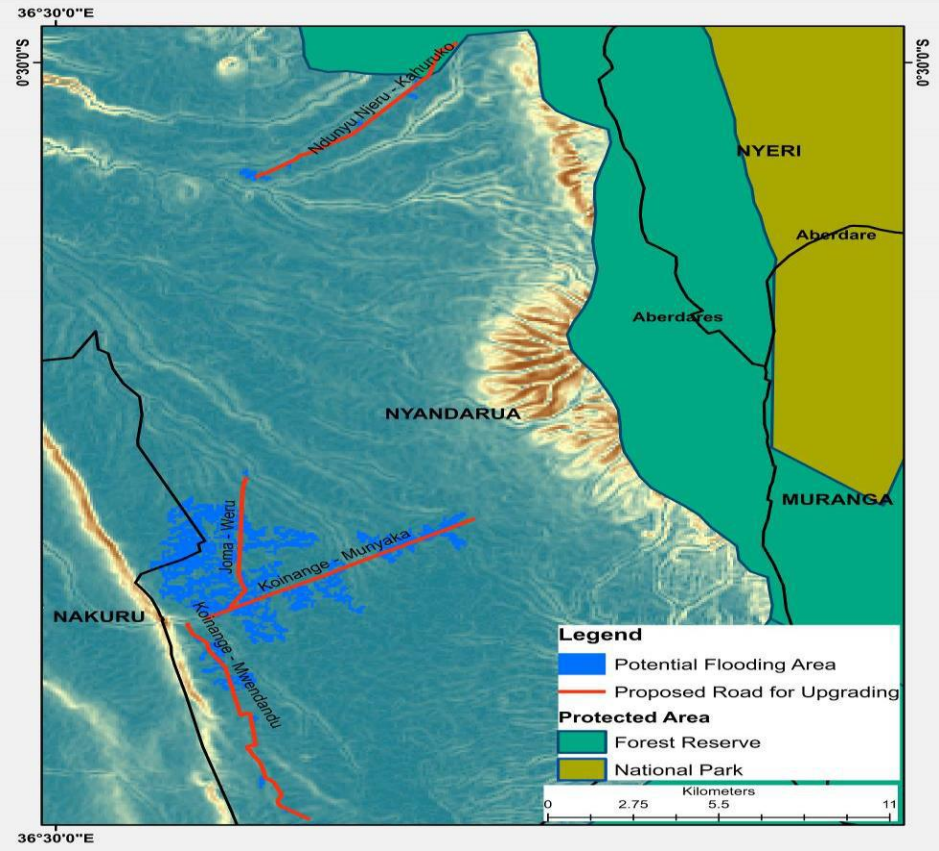


Figure 8-4 - Potentially flooded areas along the proposed spur roads in Nyandarua county

Unmitigated impacts of flooding on farmlands during operation phase	
Extent of impact	4
Magnitude of impact	3
Duration of impact	5
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-96)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. drainages should be designed well in order to improve on movement of water across the road	
Mitigated impacts on aquatic life during Construction Phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	5

Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-48)
Recommendation	Implement and manage the mitigation measures

8.3.2.18.3 Aberdare's-Erosion and Landslide

Erosion will be induced by the cut and fill activities on the upper slope of the road in steep areas. The cutting of the upper slope of the road will expose the landscape to extreme weather conditions that cause erosion and weathering processes. In loose soils or rocky areas, rock falls and erosions will likely be experienced during rainy season. Fills areas consist of compressed soil (gravel) materials that with time are eroded from the limbs of the road. Landslides are likely to affect transportation along the proposed roads whenever the disaster is not well monitored.

Magnitude of impact: Areas with deep soils will be affected adversely during rainy season

Extent of impact: This is likely to occur in all areas with steep slopes where cuttings and fill will be done

Duration of impact: The impact is envisaged to occur throughout the operation period

Likelihood of impact: Areas with loose soils and rocks always experience landslides and serious erosion

Unmitigated impacts of erosion and landslides during operation phase	
Magnitude of impact	5
Extent of impact	2
Duration of impact	5
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Very high (-108)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Disaster management plan should be developed by KWS and KFS for managing impacts of landslides 2. Warnings should be put on areas likely to experience the disaster 3. Planting of grasses should be done on areas with gentle slopes 4. Concrete holders should be constructed on deep loose soil areas	
Mitigated impacts of erosion and landslides during construction phase	
Magnitude of impact	2
Extent of impact	2
Duration of impact	1
Likelihood of impact	2
Risk = (Extent + Duration + Magnitude) x Likelihood	Very Low (-10)

Recommendation	Implement and manage the mitigation measures

8.3.2.19 Pollution of streams, rivers and Reservoirs by loose soils

Loose soils will be generated by excavation and grading activities during preparation stage of road construction. Piles of loose soils or gravels in the 'fill areas' can easily be eroded by runoff accumulation which end in streams and rivers and ultimately into the reservoirs. Thousands of tons of loose sediments are eroded from farms and deposited on riverbeds which are continuously disturbed by water current affecting the river water turbidity, Total dissolved substances (and Electric Conductivity), and pH. Changes in water quality normally affects the usage of the water for domestic purpose, and also upsets the aquatic habitats.

Magnitude of impact: Several tones of loose soils or gravels will be eroded and deposited on streams, rivers and reservoirs

Extent of impact: Loose soils or gravels can be transported as far as the reservoir downstream

Duration of impact: The pollution by loose soils will occur during construction phase wet season and continues through to the following season

Likelihood of impact: Areas with high rainfall will likely affect piles of soils or gravels whenever generated

Unmitigated impacts of pollution of streams, rivers and reservoirs by loose soils during construction phase	
Magnitude of impact	4
Extent of impact	5
Duration of impact	3
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-84)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Avoid generating piles of soils along the road 2. Cover piles of soils with waterproof materials to prevent erosion 3. Excess generated loose soils should disposed safely	
Mitigated impacts of pollution of streams, rivers and reservoirs by loose soils during construction phase	
Magnitude of impact	2
Extent of impact	2
Duration of impact	1
Likelihood of impact	2
Risk = (Extent + Duration + Magnitude) x Likelihood	Very Low (-10)

Recommendation	Implement and manage the mitigation measures

8.3.2.20 Draining of wetland habitats and poor resilience to climate change

Wetlands are unique habitats in the Aberdare which provide foraging resources for wetland birds and drinking water for the wild animals such as elephants, buffaloes, bushbucks among others. Wetlands along the roads were established when the existing bridges and box culverts were constructed creating reservoir on the upstream of the road. The proposed road upgrading project will potentially cause adverse drainage during road preparation activities. The preparation activities will involve excavation for construction of bridges or box culverts which will expand deepen the drainage channels at road crossings.

Wetland adjacent to the road occurring in Mooreland

Wetland adjacent to the road occuring in mixed Bamboo and indigenous forest trees

Figure 8-5 Wetlands along the project area

Magnitude of impact: The wetlands will be drained completely of water during preparation for road construction

Extent of impact: Wetlands attract birds from far and other wild animals for drinking during dry season.

Duration of impact: preparation of the channel at road crossings where wetland is situated will take place within a short period of time. However, construction might take long

Likelihood of impact: Preparation activities will open the channel at road crossing which will drain water held upstream of the road.

Unmitigated impacts of draining wetland habitats during construction phase	
Magnitude of impact	5
Extent of impact	4
Duration of impact	2
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-99)

Recommendation	Propose mitigation measures
Comments/mitigation: 1. Construct barrier before the road crossing to prevent water from wetland drained when channel is excavated for bridge construction	
Mitigated impacts of draining wetland habitats during construction phase	
Extent of impact	1
Magnitude of impact	1
Duration of impact	1
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-6)
Recommendation	Implement and manage the mitigation measures

Construction of bridges at two points is likely to destroy the current water holding capacity on upstream of the road. The holding capacity for the two wetlands currently support wildlife in the area. Allowance of free flow of water through the bridge by poor design will drain the wetlands during operation phase of the project. The impact of drainage on wildlife support will further be compromised by climate change that has reduced the amount of precipitation in montane areas. Hence, construction of bridges should consider improving resilience of these wetlands for support of wildlife.

Magnitude of impact: Wetland will not hold enough water during dry season when animal direly need water.

Extent of impact: Wetland birds and other wild animals that move to the wetland will be affected

Duration of impact: the impact will occur during all dry season in the Aberdare ecosystem

Likelihood of impact: resilience of wetland will be affected severely once water drainage is high

Unmitigated impacts of poor wetland resilience to climate change during operation phase	
Magnitude of impact	5
Extent of impact	4
Duration of impact	5
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very high (-140)
Recommendation	Propose mitigation measures

Comments/mitigation: 1. The base of channel at road crossing should be raised by 0.5m high in the two wetlands to increase water holding capacity in order to improve resilience to impact of climate change	
Mitigated impacts of poor wetland resilience to climate change during construction phase	
Magnitude of impact	1
Extent of impact	1
Duration of impact	1
Likelihood of impact	3
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-3)
Recommendation	Implement and manage the mitigation measures

8.3.2.21 Incidences of human – wildlife conflicts in protected areas

Movement of wildlife are contained in the fenced area of the Aberdare National Park and National Reserve. The fence that was constructed in the years 2005 – 2007 reduced human - wildlife conflicts that resulted in damages of crops by elephants, injuries or deaths to the residents. The construction of the road will tear off part of the existing electric fence in Kiandogoro area in order to allow for expansion of the road on the ridge. This will create porous fence from which wild animals such as elephants, wild pigs will cross over to the croplands. This impact is highly likely to occur when the electric fence will be ripped off for expansion of the road.

Another scenario of conflict will arise between the contractor personnel during construction of the road. Incidences of encountering wild animals by the personnel will likely to occur, especially in the morning or in the evenings when most wild animals cross the landscape. During the operation of the road, incidences of wildlife attacks and preventing vehicle movements at night will likely be recorded since most wild animals (especially herbivores) prefers congregating on or closer to the roads. This is because temperature is very low and wetness is high in vegetated at nights.

Extent of impact: human-wildlife conflict will occur within the protected area and in adjacent croplands

Magnitude of impact: Most of wild animals would move across the fence to adjacent croplands. Also, most vehicles moving at night will be affected by wild animal congregations on road.

Duration of impact: The impact will likely occur during construction phase until the operation phase of the project. However, nature of conflict will vary in the two phases of the project.

Likelihood of impact: based on the behaviours of the wild animals in the protected areas and the nature of activities along the proposed road. There is high likelihood that the impact will occur during the phases of the project.

Unmitigated impacts of incidences of human – wildlife conflict during construction phase	
Extent of impact	4
Magnitude of impact	3
Duration of impact	3
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (-90)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. A new layer of electric fence should be constructed away from the proposed road reserve before construction begins in Kiandogoro area. 2. Gates of the NP and NR should be closed to avoid wild animals moving out of the protected areas. 3. Contractor personnel should work in company of KWS security 4. Continous awareness creation at the project area on ways that communities can co-exist with wildlife.	
Mitigated impacts of incidences of human – wildlife conflict during construction phase	
Extent of impact	1
Magnitude of impact	1
Duration of impact	3
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-30)
Recommendation	Implement and manage the mitigation measures

8.3.2.22 Impact on aesthetic value

Road structure will cause visual intrusion to animals and tourist to the Aberdare Ecosystem. Interference with the topography by introducing deep cuts and fillings interferes landscape scenic beauty that is attractive as one move along the current road. This also includes structures introduced and begin in disharmony with the topography and vegetation structures. The opening of canopy in some places along the road affects negatively the natural appealing of the canopy structures and moderation of sunlight which has a cooling effect. Littering by solid wastes along the road will also cause visual intrusion to tourist which will reduce consideration values for the Aberdare National Park and Forest Reserve. The introduction of the AIPS causes mismatch of plant species where indigenous plants occur. This affect negatively the spectacularity of unique botanical formations.

- **Extent of impact:** Several areas will be under cut and fill especially on steep areas (cuttings) and valleys (fillings)

- **Magnitude of impact:** Cuttings normally leaves the limb of slopes ugly exposed while fillings on the valley raises the topography higher than normal
- **Duration of impact:** Visual intrusion will begin during construction but becomes more provoking during the operation phase of the project
- **Likelihood of impact:** A number of activities and chages are expected during the construction and operation phase of the project. Hence highly likely to be affected adversely

Unmitigated impacts on aesthetic value during operation phase	
Magnitude of impact	3
Extent of impact	3
Duration of impact	5
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	High (-110)
Comments/mitigation • Plant grasses, lianas and climbers on cut slopes • Level of road fillings on valleys should be synchronized with the gradient of the topography in the valleys • Trees should be planted near the road reserve to moderate on visual intrusions • Structures should be painted green colour • Control the spread of solid wastes in the protected areas • Control introductions and spread of AIPS	
Mitigated impacts on aesthetic value during operation phase	
Magnitude of impact	2
Extent of impact	2
Duration of impact	5
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-36)

8.3.2.23 Impact on Climate change

The project could increase atmospheric temperatures and by extension climate change due to the greenhouse gas emissions. During construction there will be greenhouse gas emissions from construction vehicles and plant due to the combustion of fuel that the machines use.

With the aim of sustainability and avoiding adverse environmental, social and climate impacts and risks, it's in order to take into consideration of the probable and foreseeable impacts of climate change, including utilizing the potential to adapt to climate change. Climate change could have undesirable impacts to the project and vice versa.

Impact Significance

Using the significance matrix, the overall impact significance of Climate change will be **Moderate.**

Mitigation Measures

- To mitigate this the workers should be trained on management of air pollution from vehicles and machinery.
- All construction machinery shall be maintained and serviced in accordance with the legal requirements and the contractor's specifications.

8.4 Socio-economic Impact

8.4.1.1 Labor and Working Conditions

The project site is predominantly in a rural setting and the population distribution on the proposed roads s scarce near the forest and dense near the urban centers. The number of employees to be engaged in the various project phases has not yet been established. Nonetheless, the construction of the proposed road projects is expected to create direct employment opportunities across different skills levels, from unskilled to highly skilled labour, as well as, indirect employment opportunities.

The Kenya labour laws are aligned to international labour laws including the core ILO conventions of which Kenya has ratified the following:

- Right to Organise and Collective Bargaining Convention, 1949 (No. 98);
- Forced Labour Convention, 1930 (No 29);
- Abolition of Forced Labour Convention, 1957 (Mo 105);
- Minimum Age Convention, 1973 (No 138);
- Worst Forms of Child Labour Convention, 1999 (No 182); and
- Equal Remuneration Convention, 1951 (No 100); and Discrimination (Employment and Occupation) Convention, 1958 (No 111).

Impacts on labor and working condition will occur during the construction phase of the project and will run throughout the project implementation period.

Extent of impact: The impact is only relevant for the workforce (mainly contractors) all of whom will be at a local level (although they may come from elsewhere in Kenya or globally).

Magnitude of impact: The impact is only relevant for the road construction workforce (including the main contractors) all of whom are at a local level (although they may come from elsewhere in Kenya). Receptors to this impact may include those contracted or subcontracted to work on the Project. Receptors with heightened sensitivity may include employees who are ignorant of the requirements of OHS standards or limited choices regarding employment options

Duration of impact: Labour will be sourced during construction and will depend on how long construction activities takes place in the above-mentioned areas. The impact is envisaged to end with the completion of the construction works on the project.

Likelihood of impact: Impact is likely to recur / occur intermittently and potentially for prolonged periods of time.

Unmitigated impacts of labour and working conditions.

Extent of impact	3
Magnitude of impact	3
Duration of impact	2
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (32)
Recommendation	Implement and manage the mitigation measures

Comments/mitigation

- The Project should develop and implement an Occupational Health and Safety Management System in line with good industry practice. These systems should include consideration of hazard identification, risk assessment and control, use of Personal Protection Equipment (PPE), incident investigation and reporting, reporting and tracking of near misses, incidents etc. The management system should also include emergency response plans. Roles and responsibilities should be clearly defined.
- In contract documents for the Contractor, KeNHA should make explicit reference to the need to abide by Kenyan law, international best practice and the ratified ILO conventions and KeNHA policies in relation to health and safety, labour and welfare standards.
- In selection of a Contractor, KeNHA should refer to past performance in similar assignments as an indicator of future performance with respect to worker management, worker rights, health and safety as outlined in Kenyan law and international standards.
- Regular checks by KWTA should be undertaken to ensure the relevant labour laws and occupational health and safety plans are adhered to at all times.
- All project workers should, as part of their induction, receive training on health and safety
- KeNHA will put in place mechanism to ensure no employee or job applicant is discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation.
- All workers will have contracts which clearly state the terms and conditions of their employment and their legal rights. Contracts will be verbally explained to all workers where this is necessary to ensure that workers understand the provisions. Contracts must be in place prior to workers reporting to duty for the first time. The contract document will be enhanced by the Code of Conduct that will be provided by the Proponent.
- The Proponent and the Contractor will put in place a worker grievance redress mechanism accessible to all workers, whether permanent or casual, directly or indirectly employed. The Proponent worker grievance mechanism shall be open to the Contractor workforce in the event that their grievance is not adequately resolved by their direct employer. The Proponent will then have the authority to act to resolve this grievance.

➢ All project workers should have access to training on communicable diseases and STDs and community interactions in general. This training will be developed in collaboration with local health institutions. ➢ Contractor should ensure that all the laborer's are over 18 years of age .	
Mitigated impacts of labour and working conditions Construction Phase	
Extent of impact	3
Magnitude of impact	2
Duration of impact	2
Probability of impact	4
Risk = (Extent + Duration + Magnitude) x Probability	Low -44
Recommendation	Implement and manage the mitigation measures

Whereas a robust labour regulatory framework exists, there have been gaps in implementation in the general labour sphere. There is therefore the risk that the Contractor may not operate in conformance with the provisions and in line with international best practice. Forced labour, child labour and discrimination is unlikely to occur if relevant standards on Labour and Working Conditions are adhered to. Employees who are ignorant of the legal provisions and of their labour rights can however be susceptible to manipulation in any work environment.

Labour and working conditions, including occupational health and safety, will need to be factored to avoid occupational incidents and/or injuries (Table 7-5). Issues that need to be considered include: fair treatment of workers, transparency in recruitment, non-discrimination, equal opportunities, as well as the provision of a safe and healthy working environment. This section focuses on both construction and operational phases of the Project due to the applicability of the labour conditions throughout the Project cycle.

Receptors to this impact may include those contracted or subcontracted to work on the Project. Receptors with heightened sensitivity may include employees who are ignorant of the requirements of OHS standards or limited choices regarding employment options.

8.4.1.2 Possibility of Increased transmission of HIV/AIDS and Other STIs

The road project is expected to create a demand for labour from various skill groups which may cause some influx into the project area for positions which may not be filled locally. Owing to the income from construction activities, project workers may be appealing to locals and if proper caution is not taken, it is possible for workers to engage with local community in high-risk sexual behaviour which can lead to transmission of venereal disease.

In the event of existence of opportunistic infections associated with venereal diseases such as tuberculosis among the workers, areas visited by infected workers and people who interact with

them will also become susceptible to these communicable diseases. The low number of health care facilities in the project area may also contribute to increased transmission of diseases as infected persons will have a challenge accessing health care in a timely manner leading to adverse health outcomes.

Extent of impact: It is anticipated that the potential impacts of increased social disturbance factors will have impacts at the local level i.e., communities along the road.

Magnitude of impact: Communities have limited access to health care as such, an increase in prevalence of disease transmission will result in a decline in quality of life.

Duration of impact: The impacts identified are expected to be largely linked to the construction period and therefore short-term.

Likelihood of impact: The incidence of communicable disease is likely to recur in the absence of mitigation and monitoring measures.

Unmitigated impacts of HIV/AID and other STIs Transmission

Extent of impact	4
Magnitude of impact	4
Duration of impact	3
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (44)
Recommendation	Implement and manage the mitigation measures

Comments/mitigation

- The Contractor should develop and implement pre-employment screening measures for workers, which should include applicable diseases. Individuals found to be suffering from these diseases will need to be sensitized on prevention of transmission to others and management of the disease prior to mobilisation to site.
- The Contractor should develop and implement a HIV/AIDS and other STIs policy and an information document for all workers directly related to the Project. The information document should address factual health issues as well as behaviour change issues around the transmission and infection of HIV/AIDS and other STIs.
- The Contractor will make condoms available to employees and communities neighbouring the site office during construction
- All project personnel should be inducted on a Code of Conduct that gives guidelines on worker-worker interactions, worker-community interactions and development of personal relationships with members of the local communities.
- As part of the Code of Conduct, the Proponent should explicitly forbid all Project personnel as well as the Contractor staff from engaging in illicit activities including procuring of commercial sex workers

which could affect the reputation of the Agency and or its relationship with communities. Anyone caught engaging in illegal activities should be subject to disciplinary action. ➢ If workers are found to be in contravention of the Code of Conduct, which they will be required to sign at the commencement of their contract, they will face disciplinary action including dismissal from duty.	
Mitigated impacts of HIV/AID and other STIs Transmission Construction Phase	
Extent of impact	2
Magnitude of impact	3
Duration of impact	2
Probability of impact	4
Risk = (Extent + Duration + Magnitude) x Probability	Low -28
Recommendation	Implement and manage the mitigation measures

8.4.1.3 Impacts on Employment, Procurement and the Economy

The predominant economic activities in the two counties were found to be agriculture, mainly crop farming (horticulture farming), livestock keeping and cash crop farming. Most of the communities in these areas practice farming for subsistence production, surplus is however ferried to nearby markets in Nairobi, Thika and Kiambu. A number of small-scale retail outlets dealing in household commodities have been set up in the market centres.

Receptors in the project area that may be able to make the most of the direct and indirect employment opportunities in the project are those who have some level of experience in formal employment, as well as those who have gained a basic education.

Educational attainment and experience in formal employment in the project areas is moderate. The locals in this area are however capable of carrying out manual work and under some level of apprenticeship and supervision; they can take one the more challenging semi-skilled roles in the project. It is therefore assumed that the majority of local labour sourced from the Project area will be unskilled or semi-skilled. Furthermore, based on the material and the type and quality of equipment required for the construction of the road, it is unlikely that local communities will have the capacity to supply all the goods and equipment. In the event that all material and equipment needed cannot be sourced from the community, some of the raw materials such as marram stones and hardcore should be sourced within the two counties, before considering the wider region or the National level.

Given the typical role of women in African societies, particularly in the rural communities, there may be restrictions on the roles they can take up in the project. Roles that are traditionally a preserve for men and likely to be left as such. Women should however be encouraged and

incentivised by deliberately setting aside roles such as housekeeping of the site camp, and supplying food to project workers.

The number of personnel to be employed by the Project has not been confirmed, however, the construction of the road projects will create direct employment opportunities across different skills levels, from unskilled to highly skilled labour.

Anticipated benefits of the Project include:

- Direct employment opportunities mainly during construction of the roads
- Indirect employment generated by the procurement of goods and services for the Project.
- Induced employment related to jobs ensuing from the expenditure of incomes associated with direct and indirect Project related jobs.
- Direct and indirect business opportunities to the local population. Individual and small businesses are expected to benefit from selling goods and services to workers.

The number of people who will be hired from the project area is not known. However, the Project will hire where possible from the local population which will lead to benefits to local households. Based on the analysis provided above, the creation of direct and indirect employment opportunities will have a positive impact during construction phase pre-mitigation.

Unmitigated impacts of Employment, Procurement and the Economy

Extent of impact	1
Magnitude of impact	1
Duration of impact	2
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (16)
Recommendation	Implement and manage the mitigation measures
Comments/mitigation ➢ The Project should prioritise the employment of labour from the local villages in the first instance especially for unskilled and semi-skilled positions. In the event the position cannot be filled from the project area, labour should be sourced in order of preference from neighbouring communities within the Counties. ➢ The Proponent should adopt a fair and transparent employment and procurement strategy to avert any potential favoritism. The strategy should be well understood by local communities. ➢ Employment should be fairly distributed among the local ethnic representations to avoid any conflict over the project. ➢ KeNHA should notify identified representatives of the County Government and Public Administration (i.e. the County Commissioner's office) of the specific jobs and the skills required for the Project, prior to the commencement of construction. This will give the local population time, prior to the	

commencement of construction, to identify persons with the relevant skillset to be employable in the Project. ➢ The Project should prioritise the procurement of raw materials from Nyeri and Nyandarua Counties. In the event that goods and services cannot be procured from within the Counties, then preference should be given to regional companies. The Contractor should however aim at procuring locally available materials where feasible and use local suppliers where appropriate. ➢ Job advertisements on employment and procurement opportunities during construction phase should be placed at the Public Administration notice board and applications to be done through this office. In the event that the position cannot be filled from within these villages and towns it should be advertised further afield (County-wide in Nyeri and Nyandarua then nationally).	
Mitigated impacts of Employment, Procurement and the Economy	
Extent of impact	2
Magnitude of impact	3
Duration of impact	2
Probability of impact	4
Risk = (Extent + Duration + Magnitude) x Probability	Low -28
Recommendation	Implement and manage the mitigation measures

8.4.1.4 Loss of Property and Livelihood Sources

Receptors in the proposed project area that will be affected include farmers, land owners, households and businesses that had encroached into the existing road reserve. Some of the affected groups will experience a significant impact from the loss of livelihood depending on the economic, or the livelihood source that has been lost. The affected group may face a challenge in obtaining suitable alternative sites; they may lose clients, and, upon relocation, may incur additional costs to re- establish themselves.

Unmitigated impacts of loss of Property and Livelihood Sources

Extent of impact	2
Magnitude of impact	3
Duration of impact	2
Likelihood of impact	4
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (28)

Comments/mitigation

- An inventory of affected properties including cost of purchase of land, land acreage under crop production and expected amount of crop harvest should be prepared to determine the level of loss and enable costing/valuation.
- Further the process should identify persons who have been affected in this regard, with an aim of generating their socio-economic profile to determine which alternative intervention can be suitable to help them cope with their loss.
- Consider implementing suitable alternative livelihood options as supported by local conditions and as proposed by the affected communities would entail: job opportunities in the project, setting up tree nurseries, tea farming, bamboo plantation, bee keeping for honey production, dairy farming, establishing medicinal herb garden etc.
- The local leaders including special interest groups such as village elders, women, youth and political leaders should be involved and consulted in identification of interventions and restoration of community livelihoods
- Positive interventions geared towards capacity building and restoration of livelihoods may attract those who were not affected and these may in turn lead to competition for limited slots in the various opportunities. For this reason, the Proponent should work closely with the local leaders to ensure a fair, transparent and inclusive process.
- Establish a community grievance redress mechanism to address concerns arising from the community and to avoid conflict.

Mitigated impacts of loss of Property and Livelihood Sources

Extent of impact	2
Magnitude of impact	1
Duration of impact	2
Probability of impact	4
Risk = (Extent + Duration + Magnitude) x Probability	Low -20

9 CUMULATIVE ENVIRONMENTAL IMPACT

9.1 Introduction

Cumulative environmental impact (CEI) is a change brought on environment due to combine impact of past, present and future human activities and natural processes. Minor direct impacts from multiple activities can be significant when combine with others. They may, however, be insignificant by themselves but the accumulate over time from one or more sources and can result in the degradation of environment (EPA, 1999, Ray, 1994). The multiple activities may have an additive, synergistic or antagonistic effect on each other. Predicting cumulative impact may be a daunting task due to lack of knowledge of other activities and inadequate baseline data from existing projects (Ray, 1994). Superimposition of effects of these activities on natural processes can cause unpredictable cascading effect on ecosystem.

9.2 Identification of other activities and reasonably foreseeable Developments

9.2.1 Nyeri Cluster Roads

The proposed road cluster lies within a landscape that has undergone changes in land cover (forest trees) over a long period due to agricultural actitvities. Most trees have been lost only few indigenous species that remain tells the story of the ancient status. This project will therefore add impacts to already existing impact of agricultural activities on biodiversity. The construction of the cluster roads in Nyeri will attract other associated activities such as expansion of market centers that will have addiotional impact over the proposed road project. Thus, the following ecological cumulative impact are foreseen from the project:

- Loss of micro-habitat and connectivity
- Solid organic waste generation
- Attraction of vermins

9.2.2 Nyandarua Cluster Roads

Nyandarua cluster roads lies in an area that is generally grassland and wetland that were converted into farmlands. Most areas have drainage problem which floods during rainy seasons making cultivation difficult. Upgrading of the road will cause increased restricted flow of water due to raised road levels. This is a situation where impact of road construction activities will add to the natural flooding on the landscape. The upgrading of the road will create an expansion on existing market centers like Ndunyu Njeru. Increased influx of population and goods to this markets will cause increase in generation of solid wastes (especially organic). Envisaged cumulative environmental impacts in Nyandarua are;

- Increased flooding
- Solid organic waste generation
- Attraction of vermins

9.2.3 Ihithe – Kiandogoro – Mutubio – Kahuruko Road

This road section lies within the protected areas of forest reserve and national park in the Aberdare which hold diverse habitats and species of flora and fauna. The Aberdare ranges plays important role in regulating the local and regional climate besides being a biodiversity hotspot in the region. Currently, montane areas are at a high risk to climate change which compromises rainfall amount and pattern of distribution in the adjacent areas. Changes in the montane climate will potential cause upshift of lower elevation species to move into the section.

Vehicles using the current road are potential source of noise pollution which repel animals sensitive to high noise levels. The African elephant are sensitive to noise from vehicles and they avoid such as areas until night when there are no vehicles. Increase in traffic after ugrading the road will only accumulate this impact hence very few populations will utilize resources near the road. Cumulative impacts envisaged for this road section include:

- Change in micro-climate
- Elevational shift in species distribution
- Noise pollution

9.3 Cumulative Impacts Assessment

9.3.1 Nyeri Cluster Roads

Agricultural intensification in the area has directly caused loss of species and population. Indirectly, agricultural expansion has destroyed habitats for the wildlife by clearing vegetation, burning to create space for the activity. Construction of the road will see hedges along the road destroyed to accommodate dimension of road upgrade. Farm hedges currently provide habitat (especially foraging) and connection for birds and herpetofauna species across the landscape. Destruction of the hedges will deprive birds and herpetofauna species foraging areas and cover from predators which will make them vulnerable to destruction. Increase of traffic in the clusters will increase incidences of road kills on small birds and herpetofauna.

The operation of the road is predicted to potentially cause littering in the area solid wastes from the vehicles. In addition to this, there is an envisaged expansion of market centers which will have high influx of population potential of generating soilid organic wastes from the markets and the local hotels. Illegal waste dumps will appear near the market centers (Mukarara) that will attract vermins such as rats, ravens, and invertebrates (incuding insects). Vermins are species that potentially upset population of local species by competing for habitat and also preying on the local species.

9.3.2 Nyandarua Cluster Roads

Most of the area along the cluster roads experience flooding during rainy season due to drainage systems. This is a natural phenomenon that will be made worse by constructing road which will be raised in level. The raised road level will potentially increase flooding on the upstream; it will cause stagnation or delay in flow of floodwaters. Farms on the upstreams will not be used for longer period unless drainage system is properly managed.

Potential littering of solid wastes in the area is predicted during the operation of the road from vehicles and other road users. In addition to this, there is an envisaged expansion of market centers in Ndunyu Njeru which will have high influx of population potential of generating solid organic wastes from the markets and the local hotels. Illegal waste dumps will appear near the market centers (Ndunyu Njeru) that will attract vermins such as rats, ravens, and invertebrates (incuding insects). Vermins are species that potentially upset population of local species by competing for habitat and also preying on the local species.

9.3.3 Ihithe – Kiandogoro – Mutubio – Kahuruko Road

Montane areas in East Africa are currently affected by climate change; decreased rainfall amount and pattern in distribution, and increase in temperature. Upgrading of the road in the protected area in the upper montane area will increase the Land Surface Temperature (LST). The bitumen surface will absorb a lot of heat from the sun and release the heat into the surrounding. Changes in LST in the montane area in combination with the current climate change will disrupt moisture spills on the adjacent areas that will affect human activities, and upshift of lowland plants and animals. The elevational shift of some species is a phenomenon predicted in montane areas affecting species which are range restricted. The change also attracts spread of pests and diseases to the upslope which threaten survival of range restricted species.

Currently, most of wildlife species avoid utilizing resources near the road and this is due to disruption from noise of vehicles using the road. With the increase in traffic flow bothe day and night, wildlife distribution will tend to be far away from the road than it is at the moment. This impact will superimpose on the current impact already xperienced along the road.

9.4 Cumulative impacts mitigation measures

Mitigation of cumulative impacts is important in order to take care of impacts or magnitude which were not envisaged at impact assessment. Mitigation measures are proposed for each cumulative impacts outline from the project in the table 8-1 below.

Table 9-1: Summary of Cumulative Impacts and Corresponding Mitigation Measures

Cumulative impacts	Mitigation measures
Loss of micro-habitat and connectivity	Encourage re-establishment of farm hedges with indigenous plant species.
Solid organic waste generation	Waste management plan should be developed for the market centers focusing on management of wastes from source
Attraction of vermins	• Avoid establishment of illegal waste dumps. • Adopt waste management plan
Increased flooding	Construct numerous drainage channels through the road to discharge stagnant waters

10 ENVIRONMENTAL AND SOCIAL MONITORING PLAN

10.1 Introduction

In order to effectively manage the social and environmental issues identified during the impact assessment process, an environmental and social management and monitoring plan (ESMP) will be implemented. The ESMP is comprised of a set of plans developed that outlines the mitigation and management measures that will be implemented during construction and operation of the Ihithe -Ndunyu njeru Road projects. These plans are collectively referred to as the Environmental and Social Management and Monitoring Plans.

The management system shall delegate effectively through a clear system of responsibilities, policies, procedures, monitoring and reporting processes.

10.2 Objectives

Objectives of the ESMP are to:

- Identify potential impacts that may occur during the project cycle –construction, operation and decommissioning phase;
- Develop detailed specific mitigation measures with relevant costs implication that will need to be achieved during the project cycle;
- Specify responsibilities and institutional arrangement that will be put in place to ensure that the mitigation measures are implemented
- Integrating environment fully into the various activities of the proposed project and ensuring inclusion of environmental requirements into tender documents, continuing management and evaluation of the environmental performance of the project.
- Tracking to ensure the effectiveness of the mitigation measures at meeting the anticipated standards;
- Provide targets to achieve, timeframe and monitorial indicators.

10.3 The Environmental and Social Management and Monitoring Plans

Table 8-1 summarises the ESMP for the project. It describes parameters that can be monitored, and suggests how monitoring should be done, how frequent, and who should be responsible for monitoring and action.

10.3.1 Key Components of Management Plans

The management plans for the project will be developed to align with national regulatory requirements and Good International Industry Practice (GIIP) including policies of IFC and World Bank Group Operating Standards. The management plans will incorporate the following components.

- **Activity:** a short description of the activity that is expected to result in significant impacts/risks and the phase (construction, operations) of the project plan applies to.
- **Aspect:** the main environmental or social issue that will be impacted.
- **Action/Mitigation Measure**: a description of the mitigation/management measures that will be implemented to manage each significant impact/risk.

- **Responsibility:** the party responsible for implementing the action.
- **Monitoring mean(s):** measurable indicators that show the extent to which the desired outcomes are being achieved.
- **Frequency of Monitoring:** the party responsible for the plan, the status of the plan, and the frequency of review (and revisions as needed).
- **Cost Estimate**

10.4 Management and Responsibilities

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 which will be involved in the project. The following entities should be involved in the implementation of this ESMP:

- The Contractor;
- The resident Engineer;
- The proponent
- NEMA;
- Ministry of Gender Youth and Social Welfare; and
- County Governments.

10.4.1 The Proponent

The proponent will be charged with the responsibility of supervision to ensure the project is implemented in a sustainable manner; this includes environmental, social and fiscal.

This can be achieved by putting measures encouraging sustainability and social inclusion in the tender specifications, selection of renowned socially and environmentally conscious contractors to ensure that the objectives of this ESMP are met. As an authority and instrument of the Government of Kenya the proponent is also tasked at ensuring the project is up to standard.

The responsibilities of the Project Proponent will also include:

- Appointing or designating a suitably qualified Project Manager to manage the implementation of the proposed project;
- Appointing the suitably qualified and experienced Contractor;
- Establishing and maintaining regular and proactive communications with the designated/ appointed Project Manager/Engineer Contractor(s) and Environmental Compliance Officer (ECO); and
- Ensuring that the ESMP is reviewed and updated as necessary.

10.4.2 National Environment Management Authority

The responsibility of NEMA as an Authority is to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government of Kenya in the implementation of all policies relating to the environment.

10.4.3 The Contractor

The Project Proponent will appoint a Contractor(s) to construct the road. The Contractor(s) will be contractually required to undertake their activities in an environmentally responsible manner, as described in the ESMP.

The role of the Contractor shall be to:

- Ensure that the environmental specifications of this document (including any revisions, additions or amendments) are effectively implemented. This includes the on-site implementation of steps to mitigate environmental impacts;
- Preserve the natural environment by limiting any destructive actions on site;
- Ensure that suitable records are kept and that the appropriate documentation is available for review;
- Take into consideration the legal rights of the individual landowners, communities and Project Proponent's staff;
- Ensure quality in all work done, technical and environmental;
- Underwrite the Project Proponent's Environmental Policy at all times, and
- Ensure that all sub-contractors and other workers appointed by the Contractor are complying with and implementing the ESMP during the duration of their specific contracts.

The responsibilities of the Contractor will be to:

- Discuss implementation of and compliance with this document with staff at routine site meetings;
- Designate, appoint and/or assign tasks to personnel who will be responsible for managing all or parts of the ESMP. The Contractor must appoint or designate a Safety, Health, and Environment Officer (SHEO) to monitor daily implementation of the ESMP on the Contractor's behalf as a minimum;
- Monitor environmental performance and conformance with the specifications contained in this document during site inspections;
- Report progress towards implementation of and non-conformances with this document at site meetings with the Proponent;
- Advise the Proponent of any incidents or emergencies on site, together with a record of action taken;
- Report and record all accidents and incidents resulting in injury or death;
- Resolve problems and claims arising from damage immediately to ensure a smooth flow of operations; and
- The Contractor will be required to provide for the appropriate Environmental Training and awareness as described in this ESMP in his costs and programming.

Reporting Structure:

The Contractor will report to the Proponent, as and when required.

10.4.4 Sub-contractors

The Contractor may from time to time appoint Sub-contractors. The role of the Subcontractors shall be to:

- Perform certain services and/or provide certain products on behalf of the Contractor. The Sub-contractors will be contractually required to undertake their activities in an environmentally responsible manner, as described in the ESMP; and
- Ensure environmental awareness among employees so that they are fully aware of and understand the Environmental Specifications and the need for them.

The responsibilities of the Sub-contractor will be to:

- Be familiar with the contents of the ESMP, and his/her roles and responsibilities as defined therein;
- Comply with the Environmental Specifications in the ESMP and associated instructions issued by the Contractor to ensure compliance;
- Notify the Contractor verbally and in writing, immediately in the event of any accidental infringements of the Environmental Specifications and ensure appropriate remedial action is taken; and
- Notify the Contractor, verbally and in writing at least 10 working days in advance of any activity he/she has reason to believe may have significant adverse environmental impacts, so that mitigation measures may be implemented timely.

Reporting Structure:

Sub-contractors will report to and receive instructions from the Main Contractor.

10.4.5 Consultants

The sourced consultant will have to ensure that the proposed ESMP is up to date and is being used by the contractor. Periodic audits of the ESMP will have to be done to ensure that its performance is as expected.

10.4.6 County Governments

The relevant departmental officers in the County Government of Nyeri and Nyandarua should be called upon where necessary during project implementation to provide the necessary permits and advisory services to the project implementers.

10.5 Communication with Stakeholders and Grievance Redress Mechanism

10.5.1 Grievance Redress Mechanism

Grievance Redress Mechanisms are essential tools as avenues for airing concerns in as far as the ongoing project construction is concerned. Most important, the GRM will facilitate the project stakeholders including the PAPs, local, regional authorities, residents of nearby residential areas, Proponent's employees, contractor and subcontractors' staff and other interested parties to voice their concerns about the project as they arise and, if necessary, for corrective action to be taken promptly. The objective of a grievance procedure is to ensure that all comments and complaints from any project stakeholders, including local, regional authorities, residents of nearby residential areas, Proponent's employees, contractor and subcontractors' staff and other interested parties are considered and addressed in an appropriate and timely manner. The grievance mechanism will be made public through the on-going consultation meetings, Proponent's website, posters and community leaflets which will be distributed in all project affected settlements during construction phase and will be maintained during the operation. The grievance mechanism will also be available for the project labour, including non-employees engaged though sub-contractors.

10.5.2 Auditing and Monitoring

Pursuant to EMCA, second schedule of the Environmental Management and Coordination Act (1999), environmental audits will be carried out after the first year of operation. Areas to be audited will include material sites and the workmen's camps.

10.6 Environmental and Social Management Plan

10.6.1 Construction Phase

Table 10-1: Environmental and Social Management Plan- Construction Phase

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Environmental Impact Assessment					
Reduced vegetation cover and above-ground biomass	High	• Cleared trees should be kept within the forest and should be used in order to prolong period of carbon emission • Sites should be identified for offsetting the loss of forest cover and biomass. This will require an adoption of compensation plan	Balancing biomass and carbon sequestration on a landscape	KENHA, Road Contractor, KWS/KFS	2,000,000
Potential Human-Wildlife conflict	Medium High	-Construction of the road should be conducted faster to minimize potential diversion of animal movements -Excavation of deep long channels should be avoided	Minize incidences of damages to properties, injuries and deaths	Road Contractor, KWS	2,000,000
Wildlife Poaching	Medium High	-Routine entrance and exit by constructors into road and adjacent areas -KWS should screen contractor personnel working in the project. -Contractor should work within the construction space of the road and designated construction camp. -KWS should screen contractor's construction plant, equipment, containers, etc. -Security in the region should enhance surveillance on vehicles	Prevent trade on wildlife	Road Contractor, KWS	1,000,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	Medium High	-Construction of road should be conducted faster during dry season to allow for natural dispersal tendency of wildlife during wet seasons -Crossing ramps should be put in place where temporary trenches are constructed -Avoid deep trenches as much as possible -Provide drinking water troughs and mud puddles away from the roads	Enhance movement of wildlife for access to resources across the landscape	Road Contractor, KWS	500,000
Impact on aesthetic Value	High	-Plant grasses, lianas and climbers on cut slopes -Level of road fillings on valleys should be synchronized with the gradient of the topography in the valleys -Trees should be planted near the road reserve to moderate on visual intrusions -Structures should be painted green colour -Control the spread of solid wastes in the protected areas -Control introductions and spread of AIPS	To manage visual expectation, satisfaction derived from landscape. Also, control visual intrusions	KENHA/ Contractor, KWS/KFS	800,000
Solid waste pollution	Medium High	Dumping used foods, food covers and water bottles Construction waste -Contractor to provide solid waste storage bins and skips; -Contractor to ensure that the solid waste collected is disposed of in an approved dumpsite.	Enhance environmental sanitation and manage visual expectation	KENHA/ Contractor, KWS/KFS	2,000,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Accidental oil spill	Medium High	Stalling and servicing of vehicles -Contractor should have well maintained engines and equipment to avoid accidental oil leakages -Construction camp should not be established within the Protected Areas (National Park and Forest Reserve) -Construction should be confined during dry seasons only to avoid rains washing oily equipment and machines -All Earthmovers, vehicles and equipment should be removed from the water tower before the onsets of rainy seasons -Clear spills immediately they occur	Prenvention of pollution of streams and wetland	KENHA/ Contractor, KWS/KFS	1,500,000
Pollution of streams, rivers and reservoirs	Medium High	Piling of soil along the road -Avoid generating piles of soils along the road -Cover piles of soils with waterproof materials to prevent erosion -Excess generated loose soils should disposed safely	Prenvention of pollution of streams and wetland	KENHA/ Contractor, KWS/KFS	800,000
Draining of wetland and poor resilience to Climate Change	Medium High	Excavating road crossing points for constructing bridges. -The contractor Construct barrier before the road crossing to prevent water from wetland drained when channel is excavated for bridge construction	Sustain wetland habitat and enhancing their capacity to support more wildlife	KENHA/ Contractor, KWS/KFS	1,500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Impact on conservation of the grey-crowned Crane	Medium High	Clearing, leveling/grading, laying -Active feeding of the Grey-crowned Crane is mostly in the early morning and in the evening. -Construction on site should begin from 8am and ends at 4pm to allow the birds including other wetland birds to forage	Protect population of the Grey-crowned Crane from declining	KENHA/ Contractor, KWS	500,000
Potential road kill of the Aberdare Cisticola	Medium High	• Introduction of speed bumps specifically towards the mooreland valleys • Avoid clearing of tall vegetation on valleys to allow these birds to scale flight height higher than the height of cars. • Plant the indigenous shrubs and trees near the valleys to control the flight speed of the bird and allow this bird to scale its flight higher once the trees grow taller	Protect population of the Aberdare Cisticola from declining	KENHA/ Contractor, KWS	
Introduction of Alien Invasive Plant Species	Medium high	-Equipment to be used should be decontaminated -Always avoid the top surface of the soil from borrow pit when excavating gravels for road reinforcements in order to avoid transporting AIPS propagules to new areas. -Since AIPS appears later after soil disturbance, aftermath proliferation of AIPS should be controlled by regularly reducing their population and recruitment	Control introduction and spread of AIPS in protected areas and grazing areas	KENHA/ Contractor, KWS/KFS	500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Pitfalls resulting from excavation of trenches	Medium high	Trenching -Provide a temporary crossing over the trench to enable the small mammals, reptiles and amphibians cross easily before backfilling of soil is done. -Construction personnel should provide a ramp to enable trapped animals to get out and monitor trenches for animal rescue	Prevention of deaths, traumatization of animals. Also, enhance movement of the animals	Road Contractor	600,000
Potential collection of live specimens of chameleon	Medium high	-Contractor personnel should be educated on CITES in order to understand how to protect species from collection of live specimens -Environmentalist expert should be incorporated in the personnel team to monitor on incidences of collection of live specimens	Control trade on specie and specimens	KENHA/ Contractor, KWS/KFS	600,000
Accidental killings of reptiles and rodents crossing the roads	Medium high	Excavation of top soil and movement of vehicles. -The contractor to employ proper methods of bush clearing and excavation to minimize this impact.	Conservation of animal diversity in the project area.	KENHA/ Contractor, KWS	2,000,000
Impact on climate change		To mitigate this the workers should be trained on management of air pollution from vehicles and machinery. All construction machinery shall be maintained and serviced in accordance with the legal requirements and the contractor's specifications.	Minimise climate change impact in the project area.	KENHA/ Cotractor	600,000
Social Impact Assessment					

Exposure of Workforce to Poor Labour and Working Conditions (Pre- Mitigation	Low	The Project should develop and implement an Occupational Health and Safety Management System in line with good industry practice. These systems should include consideration of hazard identification, risk assessment and control, use of Personal Protection Equipment (PPE), incident investigation and reporting, reporting and tracking of near misses, incidents etc. The management system should also include emergency response plans. Roles and responsibilities should be clearly defined. In contract documents for the Contractor, KeNHA should make explicit reference to the need to abide by Kenyan law, international best practice and the ratified ILO conventions and KeNHA policies in relation to health and safety, labour and welfare standards. In selection of a Contractor, KeNHA should refer to past performance in similar assignments as an indicator of future performance with respect to worker management, worker rights, health and safety as outlined in Kenyan law and international standards. Regular checks by KeNHA should be undertaken to ensure the relevant labour laws and occupational health and safety plans are adhered to at all times. All project workers should, as part of their induction, receive training on health and safety KeNHA will put in place mechanism to ensure no employee or job applicant is discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation.		Contractor/ KeNHA	2,500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
		-All workers will have contracts which clearly state the terms and conditions of their employment and their legal rights. Contracts will be verbally explained to all workers where this is necessary to ensure that workers understand the provisions. Contracts must be in place prior to workers reporting to duty for the first time. The contract document will be enhanced by the Code of Conduct that will be provided by the Proponent. -The Proponent and the Contractor will put in place a worker grievance redress mechanism accessible to all workers, whether permanent or casual, directly or indirectly employed. The Proponent worker grievance mechanism shall be open to the Contractor workforce in the event that their grievance is not adequately resolved by their direct employer. The Proponent will then have the authority to act to resolve this grievance. -All project workers should have access to training on communicable diseases and STDs and community interactions in general. This training will be developed in collaboration with local health institutions. -Contractor should ensure that all the laborer's are over 18 years of age			

Increased transmission of HIV/AIDS and Other STIs	Low	-The Contractor should develop and implement pre-employment screening measures for workers, which should include applicable diseases. Individuals found to be suffering from these diseases will need to be sensitized on prevention of transmission to others and management of the disease prior to mobilisation to site. -The Contractor should develop and implement a HIV/AIDS and other STIs policy and an information document for all workers directly related to the Project. The information document should address factual health issues as well as behaviour change issues around the transmission and infection of HIV/AIDS and other STIs. -The Contractor will make condoms available to employees and communities neighbouring the site office during construction -All project personnel should be inducted on a Code of Conduct that gives guidelines on worker-worker interactions, worker-community interactions and development of personal relationships with members of the local communities. -As part of the Code of Conduct, the Proponent should explicitly forbid all Project personnel as well as the Contractor staff from engaging in illicit activities including procuring of commercial sex workers which could affect the reputation of the Agency and or its relationship with communities. Anyone caught engaging in illegal activities should be subject to disciplinary action. -If workers are found to be in contravention of the Code of Conduct, which they will be required to sign at the commencement of their contract, they will face disciplinary action including dismissal from duty	Zero transmissions of STDs and STIs	Contractor	1,500,000

Impacts on Employment, Procurement and the Economy	Low	-The Project should prioritise the employment of labour from the local villages in the first instance especially for unskilled and semi-skilled positions. In the event the position cannot be filled from the project area, labour should be sourced in order of preference from neighbouring communities within the Counties. -The Proponent should adopt a fair and transparent employment and procurement strategy to avert any potential favoritism. The strategy should be well understood by local communities. -Employment should be fairly distributed among the local ethnic representations to avoid any conflict over the project. -KeNHA should notify identified representatives of the County Government and Public Administration (i.e. the County Commissioner's office) of the specific jobs and the skills required for the Project, prior to the commencement of construction. This will give the local population time, prior to the commencement of construction, to identify persons with the relevant skillset to be employable in the Project. -The Project should prioritise the procurement of raw materials from Nyeri and Nyandarua Counties. In the event that goods and services cannot be procured from within the Counties, then preference should be given to regional companies. The Contractor should however aim at procuring locally available materials where feasible and use local suppliers where appropriate. -Job advertisements on employment and procurement opportunities during construction phase should be placed at the Public Administration	Minimal Grievances in the project area Fair and transparent employment	Contractor	2,000,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
		notice board and applications to be done through this office. In the event that the position cannot be filled from within these villages and towns it should be advertised further afield (County-wide in Nyeri and Nyandarua then nationally).			

Loss of Property and Livelihood Sources	Low	-An inventory of affected properties including cost of purchase of land, land acreage under crop production and expected amount of crop harvest should be prepared to determine the level of loss and enable costing/valuation. -Further the process should identify persons who have been affected in this regard, with an aim of generating their socio-economic profile to determine which alternative intervention can be suitable to help them cope with their loss. -Consider implementing suitable alternative livelihood options as supported by local conditions and as proposed by the affected communities would entail: job opportunities in the project, setting up tree nurseries, tea farming, bamboo plantation, bee keeping for honey production, dairy farming, establishing medicinal herb garden etc. -The local leaders including special interest groups such as village elders, women, youth and political leaders should be involved and consulted in identification of interventions and restoration of community livelihoods -Positive interventions geared towards capacity building and restoration of livelihoods may attract those who were not affected and these may in turn lead to competition for limited slots in the various opportunities. For this reason, the Proponent should work closely with the local leaders to ensure a fair, transparent and inclusive process. -Establish a community grievance redress mechanism to address concerns arising from the community and to avoid conflict.		KeNHA	1,000,000

10.6.2 Operation phase

Table 10-2: Environmental and Social Management Plan- Operation Phase

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Potential Human-Wildlife conflict	Medium-high	-Continous awareness creation at the project area on ways that communities can co-exist with wildlife.	Minize incidences of damages to properties, injuries and deaths	Road Contractor	2,000,000
Wildlife Poaching	Medium high	-Strengthening law enforcement: This includes increasing patrols, conducting sting operations, and prosecuting poachers to the fullest extent of the law. -Providing alternative livelihoods to the local communities e.g prioritizing them on employment. -Patnership with the local communities in conservation efforts.	Zero wildlife poaching	Road Contractor	1,000,000
Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	Medium high	- Provide drinking water troughs and mud puddles away from the roads - Crossing points such as underpass should be provided for the animals	Free movement of elephants and Rhinos to their foraging areas	Road Contractor	500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Potential road killing of the Aberdare Cisticola	Medium high	-Introduction of speed bumps specifically towards the mooreland valleys -Avoid clearing of tall vegetation on valleys to allow these birds to scale flight height higher than the height of cars. -Plant the indigenous shrubs and trees near the valleys to control the flight speed of the bird and allow this bird to scale its flight higher once the trees grow taller	Zero killings to aberdare cisticola	Contractor and KeNHA monitoring team	800,000
Impact on aesthetic Value	High	-Plant grasses, lianas and climbers on cut slopes -Level of road fillings on valleys should be synchronized with the gradient of the topography in the valleys -Trees should be planted near the road reserve to moderate on visual intrusions -Structures should be painted green colour -Control the spread of solid wastes in the protected areas -Control introductions and spread of AIPS	Manage visual expectation, satisfaction derived from landscape. Also, control visual intrusions	KENHA/ Contractor	800,000
Solid waste pollution	Medium high	-Construction waste during road maintenance	Clean environment	KENHA/ Contractor	2,000,000
Accidental oil spill	Medium high	-Vehicles using the road should qualify for vehicle inspection in order to ensure they are well maintained; - Oil spills should immediately be cleared from road and containers of oil removed from the road side;	Prenvention of pollution of streams and wetland	KENHA/ Contractor	1,500,000
Impact on conservation of the grey-crowned Crane	Medium high	- Conservation awareness and education should be provided to local and road users on conservation need for the species	Grey crowned crane conserved and population protected	KENHA/ Contractor	500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Introduction of Alien Invasive Plant Species	Medium high	- Physical uprooting of AIPS recruitments before the develop seeds	Control introduction and spread of AIPS in protected areas and grazing areas	KENHA/ Contractor	500,000
Potential collection of live specimens of chameleon	Medium high	- Road users should be educated on CITES in order to understand how to protect species from collection of live specimens; - The Public Service Vehicles should not allow carrying of wild animals or specimen or part of the species in the vehicle.	Conservation of animal diversity in the project area.	KENHA/ Contractor	600,000
Potential flooding Incidences on farms	Medium high	-Reduce high energy water in upstream of the road by designing several crossing channels across the road and through the farms. -Construct channels on downstream that outlet into streams or rivers -Reinforce the channel to resist potential erosion associated with runoff erosion -Drainages should be designed well in order to improve on movement of water across the road -Regular mentenance of drainage channels.	Zero flooding incidences in farms	KENHA/ Contractor	800,000
Accidental killings of reptiles and rodents crossing the roads	Medium high	-Reducing speed limits in the project area. -Increase awareness: Educating Road users about the importance of being alert for small animals on the road and taking steps to avoid hitting them can help reduce the number of animal deaths -Create habitat corridors: Creating habitat corridors that connect natural areas can help small animals move around safely without having to cross roads -Technology such as animal detection systems and warning signs can help alert road users to the presence of small animals on the road, allowing them to take evasive action	Popolation of reptiles and rodens proteccted	KENHA/ Contractor	2,000,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Potential erosions on farmlands	Medium high	-Diversion of runoffs on farm by channelization. -Avoid generating piles of soils along the road -Cover piles of soils with waterproof materials to prevent erosion -Excess generated loose soils should disposed safely	Soil erosion controlled	KENHA/ Contractor	2,000,000
Impacts on Employment, Procurement and the Economy	Medium high	The Proponent should adopt a fair and transparent employment and procurement strategy to avert any potential favoritism. The strategy should be well understood by local communities. -Employment should be fairly distributed among the local ethnic representations to avoid any conflict over the project.	Zero grievances among the communities at the project area. Economic development.	Contractor	2,000,000

10.7 Environmental and Social Monitoring Plan

Environmental and Social Monitoring Plan (ESMoP) will involve regular surveillance of the performance of specific environmental and social
functions during the construction and operation phases of proposed Mau Mau Road project. The overall objective of ESMoP is to ensure that all mitigation measures are effectively implemented. ESMoP will also enable different players to response to the dynamic processes and emerging environmental and social issues. The activities and indicators that have been recommended for monitoring are presented in the ESMoP.

ESMoP below are applicable to Nyeri, Nyandarua cluster road projects because impacts are similar for the sites, with exception of the protected areas where more mitigation measures apply due to its unique biodiversity. The aspects to be monitored will include the following:

- Construction
    - Health and Safety particularly of the construction workers and the neighbouring communities
    - Social linkages and interactions with the construction works
    - Interaction with key sensitive environmental features including hydrology, aquatic ecology,
    - Soil erosion, vegetation loss, air quality, etc.
- Operations
    - Safety aspects of the head and tail works
    - Downstream hydrology
    - Biodiversity
    - Land use trends
    - Economic features

This ESMoP is a dynamic document that will be updated as necessary as the Mau Mau Road project moves
through the different phases of the road project. The monitoring parameter, method, location frequency,
threshold for corrective action, and cost is included below.

The contractors will be responsible to conduct the monitoring of their works during the construction
period and will be required to prepare a detailed Monitoring Plan for approval by the client. The
results of monitoring must be regularly reported to the client for supervision and environmental compliance, i.e. the NEMA or county environmental
departments. Recommended example monitoring criteria to be included in the contractors' ESMoP are as
follows:

- Regular inspection to determine compliance with stated mitigation measures with respect to
excavation, spoil disposal, treatment and revegetation of land.
- Regular inspection to determine compliance with mitigation measures with respect to community
facilities, land acquisition, and livelihood restoration.
- Regular inspection to determine compliance with defined truck routes.
- Sampling and analysis of river water upstream and downstream of any construction works, quarry borrow areas or effluent discharges (see Table 8.2 below).

- Sampling and analysis of effluents and drainage discharged from construction sites and camps (see Table 8.2 below).
- Air quality monitoring at active construction sites.
- Noise monitoring at active construction sites near to settlements or noise sensitive receptors.

10.7.1 Construction phase

Table 10-3: Environmental and Social Monitoring Plan- Construction Phase

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Reduced vegetation cover and above-ground biomass	Construction	Vegetation cover Biomass	• % Cover • Amount of biomass	Ihithe to Kahuruko	Quarterly	Road Contractor
Potential Human-Wildlife conflict	Construction and operation phase of the project	Safety of local residents, constructors and animals Safety of properties	• Incidences of conflicts • Records of injuries, deaths • Records of damages to propoerties	Ihithe and Kiandogoro area	Monitoring should be conducted frequently in the first year i.e., after every 3 months in the first year; 6 months interval in the second year once a year until the 5th year.	Road Contractor
Wildlife Poaching	Construction phase	Species population (elephants, leopard, cheetah etc.)	• Incidences of poaching in the project area. • Records of evidence on specimens or live species	Ihithe to Kahuruko area	Daily monitoring during construction and operation phase of the project	Road Contractor
Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	Construction phase	Migration and local movements	• Stranded movement of elephant • Diverted movements of animals	Ihithe to Kahuruko area	Monitoring should be conducted daily on active sites of construction activities	Road Contractor

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Potential road killing of the Aberdare Cisticola	Operation phase	population	• Presence of deaths caused by collision on road	Kiandogoro to Mutubio (only in mooreland)	Monitoring should be conducted daily on active sites of construction activities	Contractor and KeNHA monitoring team
Impact on aesthetic Value	Construction and operation phase	Visual appreciation	• Complains from tourists	Ihithe to Kahuruko area	Quarterly inspection on project area for solid waste and trees and grass planted.	KENHA/ Contractor
Solid waste pollution	Construction and operation phase	Visual appreciation	• Presence of scattered solid wastes on road side	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Weekly inspection of solid waste management	KENHA/ Contractor
Accidental oil spill	Construction and operation phase	Water quality, Aquatic habitats	Site free of oil spills	Ihithe to Kahuruko area	Quarterly inspection on oil spills records and visual inspection of the site.	KENHA/ Contractor
Pollution of streams, rivers and reservoirs	Construction	Water Quality	No stock piles along the road Piles covered with a waterproof material	Ihithe to Kahuruko area	Daily visual inspection	KENHA/ Contractor
Draining of wetland and poor resilience to Climate Change	Construction	Water Quantity (Volume)	Barriers constructed	Ihithe to Kahuruko area	Daily inspections	KENHA/ Contractor
Impact on conservation of the grey-crowned Crane	Construction Phase	Foraging	Foraging activities early morning and late evening	Nyeri and Nyandarua spur roads	Quarterly	KENHA/ Contractor

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Introduction of Alien Invasive Plant Species	Construction phase Operation phase	Species displacement/destruction	Emergence of new species (i.e., AIPS)	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Monitoring should be conducted every 3 months for the first two years	KENHA/ Contractor
Pitfalls resulting from excavation of trenches	Construction	Movement of animals	Fallen amphibians and reptiles in trenches and rescuing them	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Daily monitoring of trenches on specific sites of active construction	Road Contractor
Potential collection of live specimens of chameleon	Construction phase	Occurrence of species	Incidences of specimen collections	Ihithe to Kahuruko area	Performance of random checks on personnel bags	KENHA/ Contractor
Potential flooding Incidences on farms	Operation phase	Flow of water	Increased incidences of flooding on farms	Nyandarua spur roads	Performing of checks for stagnant waters on farms along the roads during rainy seasons Reporting system at community level to report on incidences of flooding	KENHA/ Contractor
Accidental killings of reptiles and rodents crossing the roads	Construction and operation phase	Local movement for foraging and breeding	Incidences of kills	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Reporting system should be established for daily construction activities. Weekly monitoring should be undertaken.	KENHA/ Contractor

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Potential erosions on farmlands	Operation phase	Surface soil profile	• Increased incidences of erosion • Types of erosions on farms	Nyeri and Nyandarua spur roads	Spot checks on for erosion on farms should be conducted during wet seasons; at the onset and end of rainy seasons Reporting system at community level to report on incidences of erosions	KENHA/ Contractor
Exposure of Workforce to Poor Labour and Working Conditions (Pre-Mitigation	Construction phase	Workers	• No of employees engaged weekly statistics. • No of training for the workers	Nyeri and Nyandarua spur roads	• Regular checks by KeNHA should be undertaken to ensure the relevant labour laws and occupational health and safety plans are adhered to at all times. • All project workers should, as part of their induction, receive training on health and safety In selection of a Contractor, KeNHA should refer to past performance in similar assignments as an indicator of future performance with respect to worker management, worker rights, health and safety as outlined in Kenyan law and international standards	Contractor/ KeNHA

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Increased transmission of HIV/AIDS and Other STIs	Construction phase	Local residents/ Workers	No increase in transmission of HIV/AIDS among project workers	Nyeri and Nyandarua spur roads	The Contractor should develop and implement pre-employment screening measures for workers, which should include applicable diseases Individuals found to be suffering from these diseases will need to be sensitized on prevention of transmission to others and management of the disease prior to mobilisation to site The Contractor should develop and implement a HIV/AIDS and other STIs policy and an information document for all workers directly related to the Project All project personnel should be inducted on a Code of Conduct that gives guidelines on worker-worker interactions, worker-community interactions and development of personal relationships with members of the local communities	Contractor

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Impacts on Employment, Procurement and the Economy	Construction phase/Operation phase	Local community Construction workers	• Requirements for local employment included in contract established with Maintenance Contractor • Percentage of local community members employed on the Project • Percentage of locally purchased goods and services	Nyeri and Nyandarua spur roads	The Project should prioritise the procurement of goods and services from within Nyeri and Nyandarua Counties.	Contractor

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Loss of Property and Livelihood Sources	Construction	Land and assets	• An inventory of affected properties • A community grievance redress mechanism	Nyeri and Nyandarua spur roads	An inventory of affected properties including cost of purchase of land, land acreage under crop production and expected amount of crop harvest should be prepared to determine the level of loss and enable costing/valuation. (RAP) •Positive interventions geared towards capacity building and restoration of livelihoods may attract those who were not affected and these may in turn lead to competition for limited slots in the various opportunities. For this reason, the Proponent should work closely with the local leaders to ensure a fair, transparent and inclusive process. •Establish a community grievance redress mechanism to address concerns arising from the community and to avoid conflict	KeNHA

10.7.2 Operation Phase

Table 10-4: Environmental and Social Monitoring Plan- Operation Phase

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Potential Human-Wildlife conflict	Operation phase	Safety of local residents, constructors and animals Safety of properties	• Incidences of conflicts • Records of injuries, deaths • Records of damages to propoerties	Ihithe and Kiandogoro area	Monitoring should be conducted frequently in the first year i.e., after every 3 months in the first year; 6 months interval in the second year once a year until the 5th year.	Road Contractor
Wildlife Poaching	Operation phase	Species population (elephants, leopard, cheetah etc.)	• Incidences of poaching in the project area. • Records of evidence on specimens or live species	Ihithe to Kahuruko area	Daily monitoring during construction and operation phase of the project	Road Contractor
Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	Operation phase	Migration and local movements	• Stranded movement of elephant • Diverted movements of animals	Ihithe to Kahuruko area	Monitoring should be conducted daily on active sites of construction activities	Road Contractor
Potential road killing of the Aberdare Cisticola	Operation phase	population	• Presence of deaths caused by collision on road	Kiandogoro to Mutubio (only in mooreland)	Monitoring should be conducted daily on active sites of construction activities	Contractor and KeNHA monitoring team

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Impact on aesthetic Value	Operation phase	Visual appreciation	• Complains from tourists	Ihithe to Kahuruko area	Quarterly inspection on project area for solid waste and trees and grass planted.	KENHA/ Contractor
Solid waste pollution	Operation phase	Visual appreciation	• Presence of scattered solid wastes on road side	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Weekly inspection of solid waste management	KENHA/ Contractor
Accidental oil spill	Operation phase	Water quality, Aquatic habitats	Site free of oil spills	Ihithe to Kahuruko area	Quarterly inspection on oil spills records and visual inspection of the site.	KENHA/ Contractor
Introduction of Alien Invasive Plant Species	Operation phase	Species displacement/destruction	Emergence of new species (i.e., AIPS)	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Monitoring should be conducted every 3 months for the first two years	KENHA/ Contractor
Potential flooding Incidences on farms	Operation phase	Flow of water	Increased incidences of flooding on farms	Nyandarua spur roads	Performing of checks for stagnant waters on farms along the roads during rainy seasons Reporting system at community level to report on incidences of flooding	KENHA/ Contractor
Accidental killings of reptiles and rodents crossing the roads	Operation phase	Local movement for foraging and breeding	Incidences of kills	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	Reporting system should be established for daily construction activities. Weekly monitoring should be undertaken.	KENHA/ Contractor

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Potential erosions on farmlands	Operation phase	Surface soil profile	• Increased incidences of erosion • Types of erosions on farms	Nyeri and Nyandarua spur roads	Spot checks on for erosion on farms should be conducted during wet seasons; at the onset and end of rainy seasons Reporting system at community level to report on incidences of erosions	KENHA/ Contractor
Impacts on Employment, Procurement and the Economy	Operation phase	Local community Construction workers	• Requirements for local employment included in contract established with Maintenance Contractor • Percentage of local community members employed on the Project • Percentage of locally purchased goods and services	Ihithe to Kahuruko area, Nyeri and Nyandarua spur roads	The Project should prioritise the procurement of goods and services from within Nyeri and Nyandarua Counties.	Contractor

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 The Report

This ESIA highlights the social and environmental impacts associated with the proposed rehabilitation Mau Mau Ihithe- Ndinyu Njeru Roads. In line with existing national legislation and international practice, an Environmental Assessment entailing detailed analysis of social and environmental impacts of the project was undertaken leading to preparation of an Environmental and Social Management and Monitoring Plan (ESMP).

11.2 Findings of the Assessment

This ESIA for the proposed road project has identified various adverse impacts (as presented in chapter 8). The majority of adverse impacts identified are short-term in nature, of low significance and will cease once the construction phase is completed. Further, other impacts can be managed through mitigations recommended.

11.3 The Mitigation Programs

An ESMP to guide resolution of adverse impacts has been developed as part of the ESIA in which case, the burden of mitigation largely lies with the Project Contractor under supervision by the Project Manager through the Supervisor of Works. Key observations are that most adverse impacts are short-term and will disappear once civil works ends. The Contract should bear relevant clauses binding the contractor to institute environmental mitigation as recommended in this report. Thus, in this case, the core monitoring strategy for this project will be through site meetings.

It is the duty of NEMA to consider licensing the project subject to annual environmental audits once it has been commissioned. This will be in compliance with the Environmental Management and Coordination Act, EMCA of 1999 and the Environmental Impact Assessment and Audit Regulations, Legal Notice No. 101 of 2003.

When completed, the road project will be subjected to statutory environmental and quality audits.

11.4 Recommendation

The Consultant recommends that every effort be made by the Proponent to accommodate the mitigation measures recommended during the ESIA process to the extent that is practically possible, without compromising the economic viability of the Project. The implementation of the mitigation measures listed in the ESMP (Chapter 8) will provide a basis for ensuring that the potential positive and negative impacts associated with the establishment of the development are enhanced and mitigated to a level which is deemed adequate for the development to proceed.

In summary, based on the findings of this assessment, the study team finds no reason why the Project should not be authorized, contingent on the mitigations and monitoring for potential environmental and socio-economic impacts as outlined in the ESMP.

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13 APPENDICES

13.1 Appendix I: Biodiversity and Social Baseline Studies

A. Physical Characteristics

i. Climatic Conditions

Abardare forest

Aberdare forest is situated along the Equator within the four counties (Kiambu, Muranga, Nyeri and Nyandarua) of central Kenya. Its climate is generally characterized by two rainy seasons - from April to May, and October to November. Rainfall varies with altitude and exposure to the dominant wind from the Indian Ocean, but reaches a maximum of around 2,600 mm annually on the south-eastern slopes and drops to less than 900 mm a year on the northern and south-western lee slopes. The climate of each side of the forest is different from each other as shown below.

d) **Western side:** this side has reduced rainfall of about 1400mm at the forest boarder to less than 700mm in the Valley of Malewa River.
e) **Northern side**: this side has 3 to 4 dry months in a year with three different rainfall peaks in a year (March-May, July-August and November)
f) **Southern side:** This side has average annual temperature of 18˚C and average rainfall of about 989mm

The Moorland experiences mean minimum daily temperatures of -2˚C and mean maximum daily temperature to 27˚C.

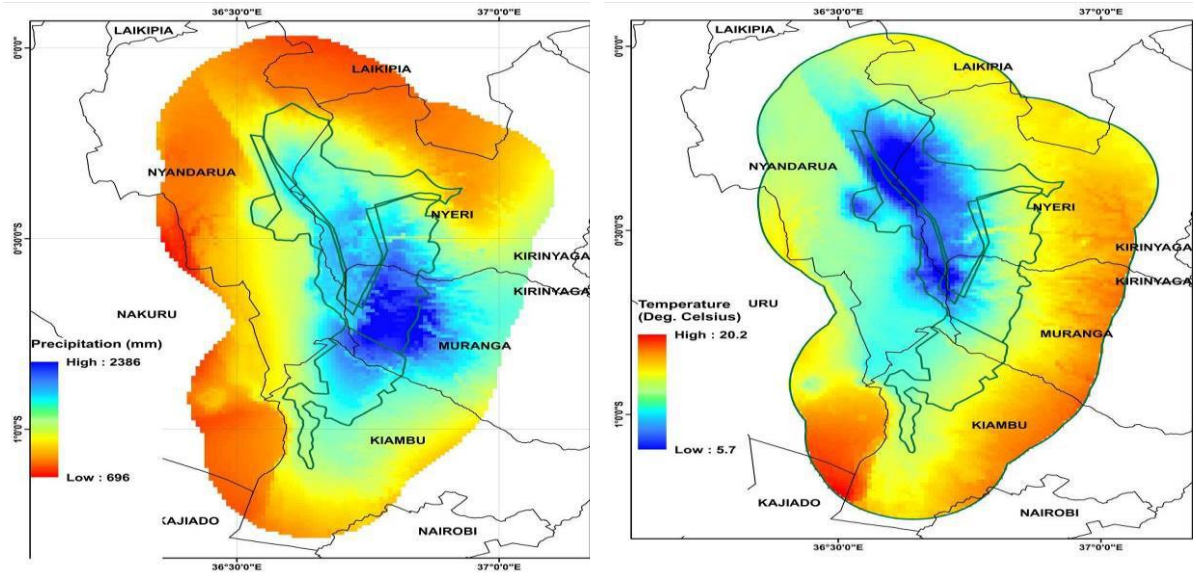
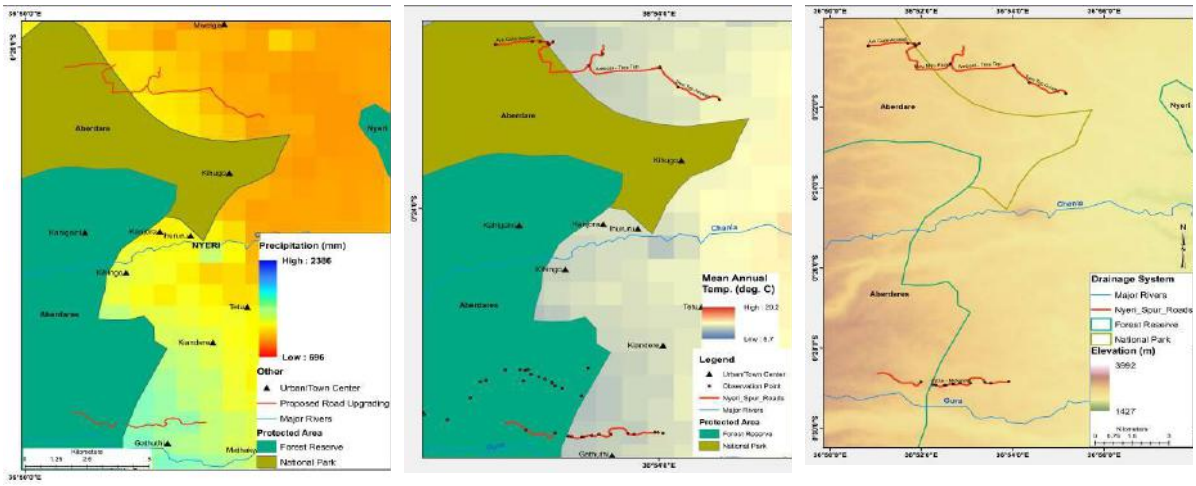


Figure 13-1: The mean annual precipitation, mean annual temperature, and major drainage system of aberdares

Nyeri County

The climate of the study area is generally characterized by two rainy seasons - from April to May, and October to November. The Nyeri Spur Roads occur on the eastern side of Aberdare Forest which is characterized by variation of climate with the altitude, this side falls within the tropical moderately cool regime with Mean temperature range between 10.3°C- 25.8°C, lowest to highest respectively. July and August have the lowest temperature. Rainfall distribution is influenced by the Inter-tropical convergent zones (ITCZ) of air masses of southern and Northern Hemisphere. It has equatorial type of climate (wet and humid) with rainfall of 1400-2200mm and extended wet season. The topography of the project area has an average elevation of 2000m occurring on the eastern side. Rivers on the wider landscape on which the proposed Nyeri Spur Roads are located derive their waters from the Aberdare Forest. Most of these rivers/streams drain into the Tana River; they include Chania, Gura, Magura, Gikururu, Karuru, Thika, Karimu, North Mathioya, South Mathioya, Maragua and Amboni (Honi).



Mean Annual Precipitation | Mean Annual Temperature | Major drainage system

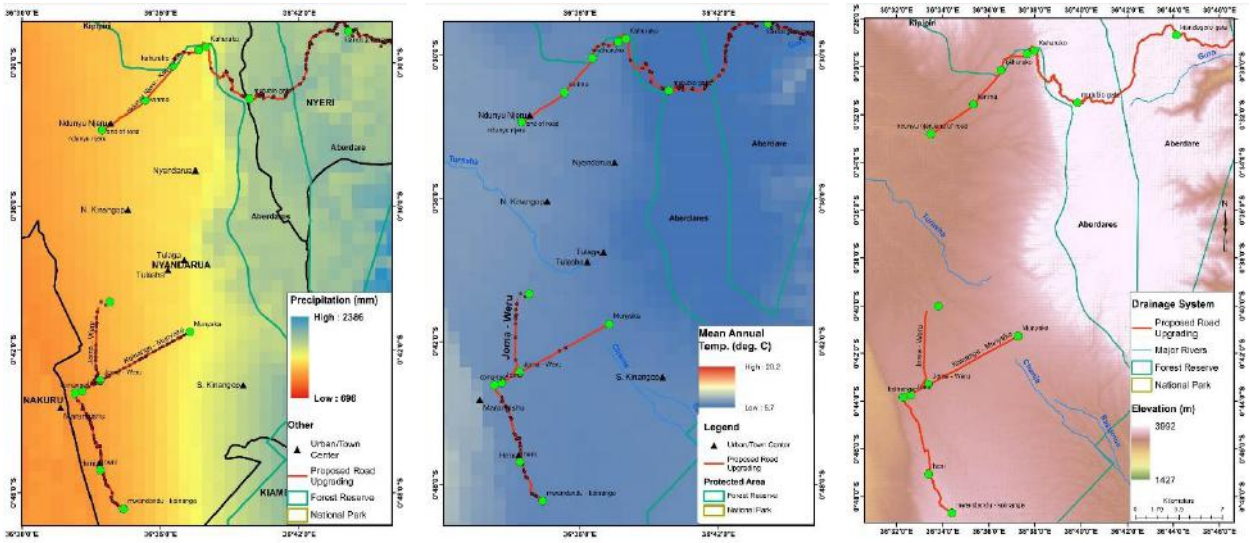
Figure 13-2 Physical factors: The mean annual precipitation, mean annual temperature, and major drainage system in Nyeri County (eastern side of the Aberdare Forest.

Nyandarua Spur Roads

The areas within which the Nyandarua road clusters are situated are characterized by two rainy seasons - from April to May, and October to November. The mean annual rainfall reaches 900 mm a year on south-western lee slopes. The rainfall amount ranges from 700mm in the Valley of Malewa River to 1400mm at the forest boarder. The average elevation for the project area is 2555m with minimum range of 2497m in Weru to maximum elevation 2672m in Mwendandu.

The northern side of the project area descends gradually from the Oldonyo Lesatima peak towards Nyahururu with numerous steep valleys, high peaks and isolated hills. It is generally described as a flat ramp slightly tilted to the East. The Oldonyo Lesatima is characterised by undulating hills, deep incised river valleys and remnants of volcanic vents and sheets. The southern side descends steeply from Kinangop peak towards the Northern part of Murang'a.

The major rivers from the forest drain into Malewa River. These rivers have numerous tributaries joining them as they flow downstream from the Aberdare Forest draining into the Lake Naivasha. The rivers draining into Lake Naivasha Basin include; Malewa, Wanjohi, Kitiri, Turasha, Kaheho, Sugurui and Pesi.



Mean annual precipitation | Mean annual temperature | Major drainage system and elevation

Figure 13-3 Physical factors: The mean annual precipitation, mean annual temperature, and major drainage system in Nyandarua County (western side of the Aberdare Forest

ii. Topography (elevation and slope)

The Aberdare Forest is located within the Aberdare Ranges which stretches over 125 kilometers from Nyahururu in the North to Limuru in the South. It is the third highest mountain in Kenya with altitude of 2000m on the eastern side and 4001m on the northern side. It has two main peaks Oldonyo Lesatima (4001m) on the north and Kinangop (3906m) on the south.

The northern side descends gradually from the Oldonyo Lesatima peak towards Nyahururu with numerous steep valleys, high peaks and isolated hills. It is generally described as a flat ramp slightly tilted to the East. The Oldonyo Lesatima is characterised by undulating hills, deep incised river valleys and remnants of volcanic vents and sheets. The southern side descends steeply from Kinangop peak towards the Northern part of Murang'a. The moorlands of the area comprise of undulating hills, bogs, clear mountain streams and numerous waterfalls. Several rivers originate from the slightly sloping ground in the water bogs.

In general, the topography is diverse; from the highest point's canyon like V-shaped valleys to gentler river valleys separated by steep hills and rocky outcrops. The forest zone slopes further down gently to the undulating plains of the northern side and parts of the lower salient.

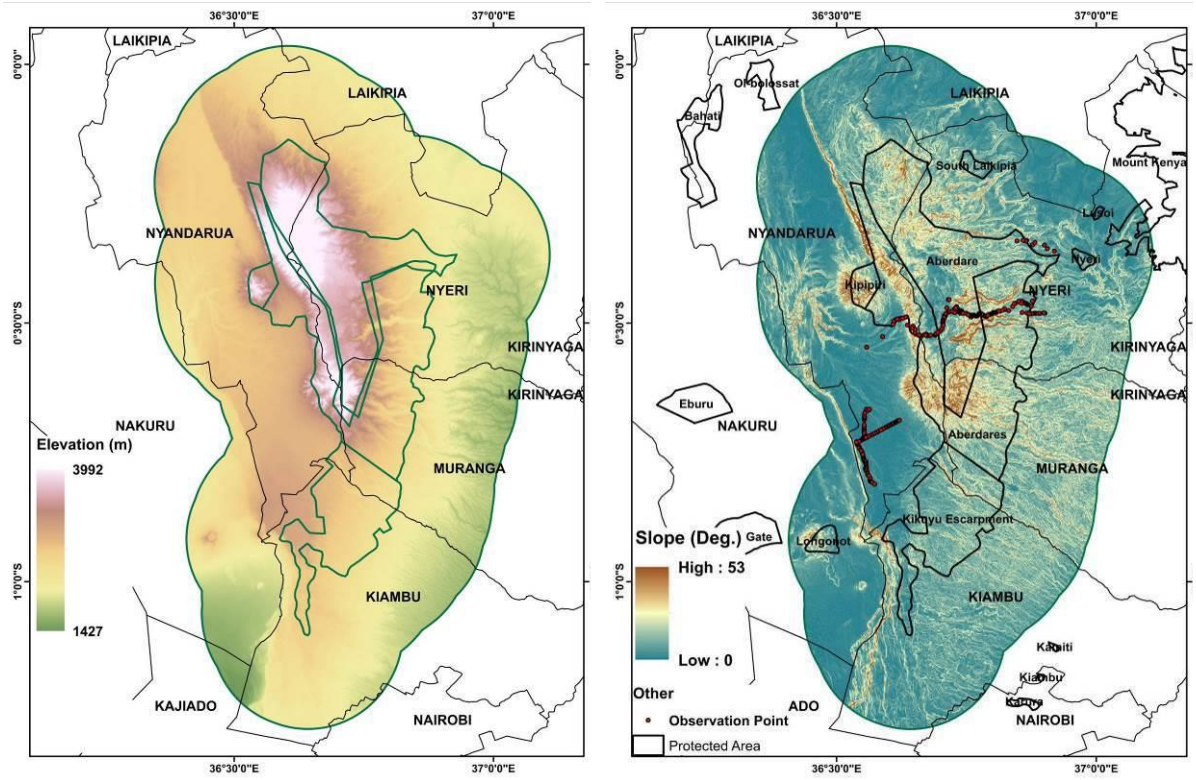


Figure 13-4 Topographical representation of the project area

iii. Drainage features

The Aberdare is an important water catchment zones in Kenya. Its water feed four out of six Kenya's drainage basin. The major rivers from the forest are; Tana, Athi, Ewaso Nyiro and Malewa River. These rivers have numerous tributaries joining them as they flow downstream within the Aberdare Forest to form four River basins (Tana, Athi, Ewaso Nyiro and Lake Naivasha). Rivers flowing to Ewaso North Basin include; Engare ongibit and Ewaso Narok. The rivers draining into Lake Naivasha Basin include; Malewa, Wanjohi, Kitiri, Turasha, Kaheho, Sugurui and Pesi. The rivers draining into Tana basin include; Chania, Gura, Magura, Gikururu, Karuru, Thika, Karimu, North Mathioya, South Mathioya, Maragua and Amboni (Honi). The rivers draining to Athi river basin include; Thika, Chania and Ruiru River.

The moorlands and afro-alpine zones have numerous water bogs marking the source of streams and rivers down the slopes. Aberdare range supplies water to Nairobi through Sasumua and Ndakaini dam. Together with Mt Kenya, they contribute 70% of the country's hydro-power produced by Tana River. The forest has numerous constructed water intakes that supplies water to the adjacent communities for both domestic use and agricultural purposes.

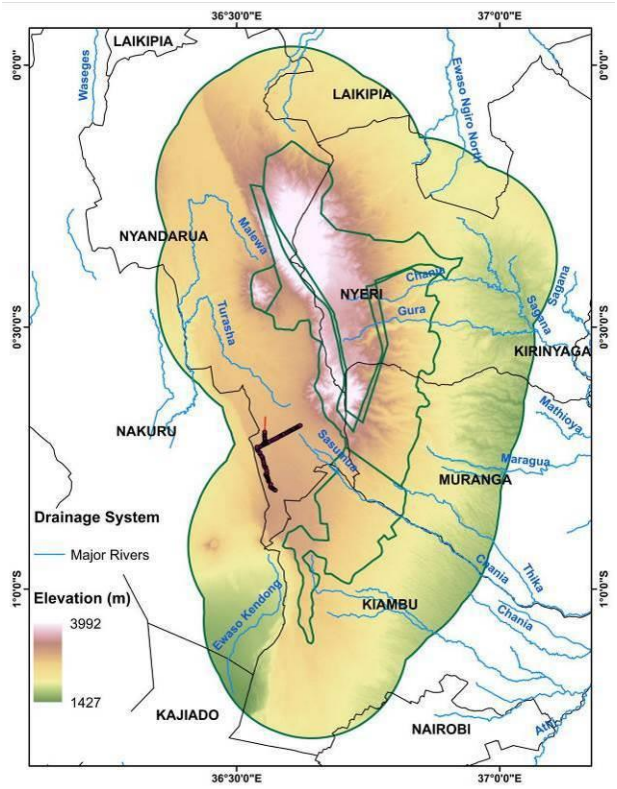


Figure 13-5 Drainage system representation of the project area

B. Social Economic Status

This section provides a socio-economic profile of project affected area with the objective of understanding the demographic trends and economic performance of the area.

i. Demography

Nyeri County

Nyeri County is one of the 47 counties in Kenya and is located in the central region of the country. It covers an area of 3,337.2 km2 and is situated between longitudes 36o,38" east and 37o20" east and between the equator and latitude 0o 38o South. The County lies between Mount Kenya and the Aberdare ranges with agriculture as the main economic activity.

It borders Laikipia County to the North, Kirinyaga County to the East, Murang'a County to the South, Nyandarua County to the West and Meru County to the North East.

The county has a population of 845,863 (male - 49% and female - 51%), according 2019 census. Majority of the people living in Nyeri County are from the Kikuyu Community most of whom are predominantly farmers growing tea and coffee as cash crops alongside food crops such as maize, beans, assorted vegetables and sweet potatoes. Nyeri County plays host to all Kenyan communities who are mostly engaged in own businesses or employed by the government. The County is also renowned for horticultural farming.

Nyandarua County

Nyandarua County is one of the 47 counties in Kenya and is located in the North-Western part of former Central Province of Kenya. It covers an area of 3,245.2 Square Km and lies in the central part of Kenya between latitude 0°8' North and 0°50' South and between Longitude 35° 13' East and 36°42' West.

Nyandarua borders Nyeri to the East, Laikipia to the North, Nakuru to the West, Murang'a to the South East and Kiambu to the South.Nyandarua County is divided into five Sub-Counties

namely: Ol'Kalou, Kinangop, Kipipiri, Ndaragwa and Ol'Joro Orok and further into twenty-five Wards. Kinangop is the biggest Sub-County with eight Wards. Kipipiri, Ol'Kalou and Ol'Joro Orok have four Wards each, whereas Ndaragwa has five Wards. The major urban centres in the County are Ol'Kalou, Njabini, Engineer and Mairo Inya. Other vibrant centres include Ndunyu Njeru and Miharati. The county has a population of 638,289 (male - 49% and female - 51%), according 2019 census.

Ol'Kalou, the County headquarters, is situated about 150 kilometres North West of Nairobi. Ol'Kalou town has strong economic ties with other regional towns such as Nyahururu, Gilgil, Naivasha, Kiambu, Embu, Nakuru and Nyeri. The major economic activities in the County include farming, quarrying and trade. Agriculture is the backbone of Nyandarua's economy due to the fertile soils and favourable climate. It is considered the food basket of Kenya because of its high production of potatoes, cabbages, carrots, peas and milk that are sold in Nairobi and most other towns in the country

ii. Administrative units

Nyeri County

The county is divided into eight administrative sub counties namely; Kieni East, Kieni West, Mathira East, Mathira West, Nyeri Central, Mukurweini, Tetu and Nyeri South.

Table 14 below shows the area of the county by sub-counties. The county is further subdivided into 21 divisions, 69 locations and 256 sub-locations

The proposed road project traverses through the Tetu and Kieni East sub-counties.

Table 13-1 Area of the County by Administrative Sub-Counties

Sub-County	Area (KM^2)	Divisions	Locations	Sub-Locations
Mathira East	131	4	13	44
Mathira West	165.6	3	8	31
Kieni West	623.3	2	6	26
Kieni East	817.1	2	12	33
Tetu	217.5	2	8	35
Mukurwe-ini	178.6	4	7	32
Nyeri Central	167.8	1	4	26
Othaya	174.5	3	11	29
TOTAL	***2,475.5**	**21**	**69**	**256**

Source: Nyeri County CIDP 2017-2022

Nyandarua County

The county is divided into five administrative sub counties namely; Kinangop, Kipipiri, Ol' Kalou, Ol' Joro Orok and Ndaragwa. This is according to the Nyandarua County Integrated Development Plan; 2018-2022. Table 1 below shows the area of the county by sub-counties. The proposed road project traverses through the South Kinangop and Ol' Joro Orai sub-counties.

Table 13-2 Area of the County by Administrative Sub-Counties. Source: Nyeri County CIDP 2017-2022

Sub-County	Area (KM2)	No. of Wards	Sub-Locations
Kinangop	822.0	8	23
Kipipiri	543.7	4	13
Ol-Kalou	586.7	5	11
Ol' Joro Orok	389.1	4	14
Ndaragwa	653.6	4	19

Sub-County	Area (KM2)	No. of Wards	Sub-Locations
Aberdare Forest	250.1		
Total	**3245.2**	**25**	**80**

iii. Political units

Nyeri County

The political units are represented by elected persons at the national and county level. Table 4.3 shows political units in the county divided into constituencies and electoral wards. It further shows the distribution of electoral wards by constituency.

Similar to the sub-counties, the proposed project falls under the Tetu and Kieni constituencies

Table 13-3 County Electoral Wards by Constituency

Constituency	Electoral Wards	Administrative Sub-County	Ward Name
Mathira	6	Mathira West	Ruguru, Kirimukuyu
		Mathira East	Iriani, Karatina, Magutu, Konyu
Kieni	8	Kieni East	Gakawa, Naromoru,/Kiamathaga. Thegu River
		Kieni West	Gatarakwa, Mugunda, Endarasha/Mwiyogo, Mweiga
Tetu	3	Tetu	Aguthi/Gaaki, Dedan Kimathi, Wamagana
Mukurwe-ini	4	Mukurwe-ini	Rugi, Gikondi, Mukurwe-ini Central, Mukurwe-ini West
Nyeri Town	5	Nyeri Town	Kamakwa/Mukaro, Kiganjo/Mathari, Rware, Ruringu, Gatitu/Muruguru
Othaya	4	Othaya	Chinga, Mahiga, Iriaini, Karima
TOTAL	**30**		

Source: Independent Electoral and Boundaries Commission, 2017

Kieni with 8 wards has the highest number while Tetu with three has the lowest. This is majorly attributed to the fact that Kieni is vast compared to other constituencies.

Nyandarua County

The County has 5 constituencies, namely Ol Kalou, Ol'Joro Orok, Ndaragwa, Kipipiri and Kinangop and 25 County Wards. Similar to the sub-counties, the proposed project falls under the Kinangop and Ol'Joro Orok constituencies. Table 2 shows political units in the county divided into constituencies and electoral wards. Kinangop with 8 wards has the highest number followed by Ol' Kalou which has 5 wards.

Table 13-4 County Electoral Wards by Constituency. Source: Independent Electoral and Boundaries Commission, 2017

Constituency	Wards	Area (KM^2)
Kinangop	Engineer	118.8
	Gathara	109.9
	North Kinangop	134.7
	Murungaru	164.8

Constituency	Wards	Area (KM^2)
	Njabini/Kiburu	98.9
	Nyakio	146.1
	Githabai	107.7
	Magumu	53.8
Kipipiri	Wanjohi	199.2
	Kipipiri	127.6
	Geta	64.4
	Githioro	152.6
Ol'Kalou	Karau	105.2
	Kanjuiri Ridge	122.8
	Mirangine	69.6
	Kaimbage	111.7
	Rurii	127.2
Ol'Joro Orok	Gathanji	108.3
	Gatimu	72.3
	Weru	133.9
	Charagita	124.7
Ndaragwa	Leshau/Pondo	119.6
	Kiriita	73.3
	Central	287.6
	Shamata	173

iv. Population size and composition

Nyeri County

The population growth rate in the County is estimated at 2.2% against the national average of 2.6%. According to the 2019 population and housing census, the county has a population of759,164 persons comprising of 374,288 males (49%) and 384,845 females (51%).

Over 60% of the population is below 30 years, portraying a youthful population which is more productive and thus the need to consider them in development activities.

Table 16 below shows the population densities and distribution of the areas that will potentially be affected by the proposed hydro power project. (Kenya National Bureau of Statistics, 2019).

Table 13-5 Population Distribution of Project Affected Administrative Areas

Area	Total	Male	Female	Households Total	Land Area (sq. km)	Density (Persons per sq.km)
Nyeri County	759,164	374,288	384,845	248,050	3,325	228

Area	Total	Male	Female	Households Total	Land Area (sq. km)	Density (Persons per sq.km)
Tetu Sub-County	80,453	39,293	41,155	24,139	217	372
Kieni West Sub-County	88,525	43,843	44,677	27,619	518	171
Aberdare Forest	106	74	32	79	722	-

Majority of the population is found in the high potential areas of Mathira, Othaya, Nyeri Town, and parts of Mukurwe-ini. The low land areas of Kieni with low rainfall have lower population densities.

According to the Kenya Population and Housing Census of 2019, Nyeri Central sub-county has the highest population with a total of 140,338 people.

Nyandarua County

The population growth rate in the County is estimated at 2.2% against the national average of 2.6%. According to the 2019 population and housing census, the county has a population of 759,164 persons comprising of 315,022 males (49%) and 323,247 females (51%) (Table 3).

The County has a total number of 179,686 households. Kinangop Sub-County has the highest number of households with a population of 111,410 persons. Kinangop Sub-County was formerly divided into Kinangop North and Kinangop South divisions.

The table below shows the population densities and distribution of the areas that will potentially be affected by the proposed hydro power project. (Kenya Population and Housing Census (KPHC- 2019).

***NB**: Most secondary sources of information indicate that the sub-counties are as mentioned under the "Administrative Units". However, the KPHC documents, indicate that there are 7 sub-counties in Nyandarua County, namely: Kinangop, Kipipiri, Mirangine, Nyandarua North, Nyandarua South and Nyandarua West subcounties. The Oljoro orai area in this case falls under Nyandarua West Sub-County.*

Table 13-6: Population Distribution of Project Affected Administrative Areas

Area	Total	Male	Female	Households Total	Land Area (sq. km)	Density (Persons per sq.km)
Nyandarua County	638,289	315,022	323,247	179,686	3,285.8	194
Kinangop Sub-County	111,410	54,727	56,679	30,970	293.6	379
Nyandarua West Sub-County	97,965	48,752	49,209	29,008	384.9	255

The level of urbanisation in Nyandarua is low compared to other counties in the region. The level of services provided in the designated urban centres is also low compared to the package of facilities for an urban centre as spelt out in the Urban Areas and Cities Act, 2011. As per that criteria, the County has four urban centres: Mairo-Inya, Engineer, Njambini, and Ol'Kalou.

The County urban population is 4.2% of the total population. The population density of the County has been steadily increasing over the years.

v. Education and Literacy Levels

Nyeri County

The county has a total of 765 schools; 571 public and private primary schools and 194 private and public secondary schools.

The gross enrolment rate in public Early Childhood Development Education centers for the county stands at 59.2 per cent, indicating that there is a large number of children who are not in school despite having a total of 758 centers.

For Primary Education, the County has a total enrolment of 141,243 comprising of 72,227 boys and 69,016 girls. Although the net enrolment rate is high at 99%, the county will require additional investment for infrastructural improvement. The completion rate stands at 89.4 % while retention and transition stand at 91 and 85 % respectively.

The County has a secondary school gross enrolment of 31,242 boys and 31,959 girls. The net enrolment rate stands at 95 per cent and it is noted that there is a negligible variance between boys and girls' enrolment. The completion rate stands at 86.2 per cent while retention rate is 89%.

There are 49 youth polytechnics with a total population of 3882 trainees. Additionally, there are two public universities, one private university campus, three public university campuses, one national polytechnic, one science and technology institute, nine other public colleges, one private accredited college and six private non-accredited colleges.

The Technical, Vocational Education and Training (TVET) in Nyeri County consists of public and private institutions. The public TVET institutions are; one national polytechnic i.e., the Nyeri polytechnic and two technical training institutes namely Mathenge and Mukurweini. The county hosts a number of private/faith-based TVET institutions such as the Consolata Training Institute and Little Flowers Training Institute among others.

Plans are being put in place towards revitalizing and staffing of the polytechnics across the county and this is expected to enhance enrolment and offer quality courses in the institutions

Nyandarua County

The county has a total of 603 schools; 453 public and private primary schools and 150 private and public secondary schools.

The gross enrolment rate in public Early Childhood Development Education centers for the county stands at 49.9 %, indicating that there is a large number of children who are not in school despite having a total of 929 Early Childhood centers.

For Primary Education, the County has a total enrolment of 151,165, where 128298 are in public primary schools and 22427 are in private schools. In this enrolment, 76,165 are boys while 75,000 are girls. The enrolment is 92.5% of the County population aged 6 and 13 years.

The County has a secondary school enrolment which stands at 60,021, comprising of 53,974 in public schools and 6,047 in private schools. In this enrolment, 28,303 are boys while 31,718 are girls. This enrolment is 60.66% of population aged 4–17 years. There are 1,656 teachers in public schools in the County giving a teacher/student ratio of 1:33. The dropout in secondary schools stands at 5.8%. Students travelling less than one kilometers to school account for 12%, with 54% travelling 1.1 to 4.9 km and 34% travelling for five kilometres and above. The transition from primary to secondary school is 21%, meaning that 79% either join tertiary institutions or they drop out of school after primary school education.

The County has twenty-four (24) public youth polytechnics (YP) distributed as follows: 9 in Ndaragwa Sub-County, 2 in Ol'Joro Orok, 4 in Ol'Kalou, 4 in Kipipiri and 4 in Kinangop. Out

of this, 15 polytechnics are operational with total enrolment of 1540 trainees, while 4 are non-functional, 3 are under construction and two 2 needs to be renovated.

The County has four technical training institutes, namely Nyandarua Institute of Science and Technology (NIST), Leshau, Kinangop, and Kipipiri Technical Training Institutes. In addition, there is the Aberdare Teacher Training College. The County also has Animal Health Industry Training Institute (AHITI) at Ol'Joro Orok. Lack of adequate tertiary institutions has negatively affected the transition to higher learning for skills development and also upgrading from traditional to market driven courses.

The main challenges in the education sector include inadequate infrastructure, equipment; long distance travelled from home to ECDE centres, acute shortage of qualified instructors; lack of modern teaching machines, tools and equipment in polytechnics; high examination fees in polytechnics; high dropout rate in Youth Polytechnics; inadequate institutions of higher learning; lack of an institution offering agro-based courses which would be more relevant to the economy of the County; lack of land tenure documents in primary schools and insufficient special schools.

vi. Health and Health Care Services

Nyeri County

Health services in Nyeri County are organized across five (5) levels of service delivery that includes 118 public health facilities, including a beyond zero mobile clinic and a hospice for care of the terminally ill distributed as follows: one (1) county referral hospital (level V); four (4) county hospitals (level IV); 25 health centers (level III); 88 dispensaries (level II); 251community units (level I).

The county also hosts several private health facilities providing a wide range of health services and distributed as follows; four (4) private level IV hospitals; one (1) nursing home; three (3) faith-based organization hospitals; 16 Faith Based Organization health centres and dispensaries; and 228 private clinics.

Kieni west is served by one FBO hospital (Mary immaculate) located approximately 15km from Nyeri town and may not be convenient for most of the residents' sub county.

The most prevalent diseases in Nyeri County are upper repertory trachea infection, skin diseases rheumatic and joint pains, hypertension and, diarrhea. Trends further indicate an increase in non-communicable diseases such as cancer, diabetes, kidney failure and others.

There is a 28.8 per cent morbidity rate for the County of that, 27.03 % being male and 30.5 % being female. Maternal mortality rates are 318 per 100,000 and child mortality rates at 10 per 1000.

HIV and AIDS has a prevalence of 3.7% amongst the Nyeri County population where about, 21,428 people are living with the disease. Statistics indicate that a larger percentage of women (5.5) than men (1.9) are living with HIV and AIDS. Youth between the ages of 15-34 years in pre-urban areas are mostly impacted. In 2017, approximately 26 children and 398 adults died because of HIV and AIDS. This illustrates a 26.6 % increase in child deaths (below the age of 15) compared to 2015 (Kenya HIV county Profiles, 2018).

There are currently 207 health facilities of which 73 of these are public health facilities. There is a county referral hospital; J.M. Kariuki Memorial Hospital, a County hospital at Engineer and one faith-based hospital; North Kinangop Catholic Hospital. The County hospital in Engineer, Kinangop Sub- County is in the process of being upgraded to a Level 5 hospital.

The County has a total of 788 health personnel. The doctor population ratio is 1:28,000; nurse population ratio is 6: 10,000 a staff population ratio of 11: 10,000 (the WHO recommended ratio is 23: 10,000). The average distance to the nearest public health facility is 3.7 Km; recommended 5 Km (WHO). In some areas of the County, access is hindered by geographical barriers.

The average distance to the nearest health center is 3.2km. In the County, 21 % of the households travel up to one kilometer to access health service, 78 % travel between 1.1 km and 4.9 km while those who travel above five kilometers account for 1 % of the population.

Nyandarua County

Health services in Nyandarua County are organized across four (4) levels of service delivery that includes 128 Government owned facilities, one (1) county referral hospital (level V); three (3) county hospitals (level IV); 29 health centers (level III); 188 dispensaries (level II); 128 community units (level I).

The most prevalent diseases in Nyeri County are upper repertory trachea infection, skin diseases rheumatic, pneumonia, diarrhea and arthritis. The average morbidity rate for the County is 21.2 % with the male morbidity rate at 19.2 % and female morbidity rate at 23.4 %. Most of these diseases are bacterial infections that can be prevented through proper clothing, appropriate beddings, water treatment and hand washing.

HIV prevalence in the County stands at 3%. HIV prevalence among women in the County is higher (4.4%) than that of men (1.6%). The County contributes 0.8% of the total number of people living with HIV in Kenya and is ranked 29th nationally. There are estimated 12,754 people living with HIV in the County with 10% being young people aged 15-24 years and 4% being children under the age of 15 years. Antiretroviral treatment coverage in the County is 92% but viral suppression is poor at 44%. Mother to Child transmission rates is 6.4% in the County against global target of 5%. (Kenya HIV profile 2016).

vii. Land Use

Nyeri County

Nyeri county has a total area of 987.5 Km2 and 758.5 Km2 of arable and non-arable land respectively. The larger part of the arable land is used for food crop while the rest is used for cash crop farming, livestock rearing and farm forestry. The mean holding size is one hectare for majority of the small holders.

Over 85% of farmers have title deeds as adjudication started early after independence. The main reason for lack of the title deeds by some farmers is domestic wrangles while other landowners in settlement schemes have never been issued with title deeds. There are many colonial villages where the government will continue to plan and issue titles deeds.

The settlement pattern in Nyeri county takes two types of settlements; clustered and scattered. Clustered settlement patterns are mainly found around towns and horticulture producing areas. Scattered settlement patterns are mainly found in Kieni which is semi-arid and were formally colonial settlement area. Apart from the major towns the county has witnessed ribbon type of development along the major highways which possess a challenge in service delivery especially in waste management as the centres are poorly planned. Such urban centres include Kiawara, Chaka, and Nairutia among many others.

Nyandarua County

Land is a very important resource in the County, being the mainstay of the County economy. Land ownership in Nyandarua is largely private with most owners being small-scale farmers with a few large farms spread across the County. The average holding size per household is 3.5 ha. With the projected population growth and the predominant cultural practices on inheritance, the average acreage per household will continue to decrease due to subdivisions. Over 90% of the households owning land have their title deeds.

According to common belief in the County, every man must own land. This belief has led to fragmentation of land into small uneconomical pieces where they grow maize and other staple crops. This has been observed particularly in South Kinangop where the original farm sizes have been getting smaller at an alarming rate.

There are three major settlement patterns identified in the County;

1. Clustered Settlements; This type of settlement is found within the main urban centres. It is characterized by highly built-up areas with compact housing. The region has a high population density and the inter-house distance is usually small. Such areas include Ol'Kalou, Engineer, Njabini, Mairo-Inya as well as parts of Ol'Joro Orok and Ndaragwa. These towns are either economic centres or administrative areas with settlement density reducing towards the periphery.
2. Dispersed Settlements: Mostly found in the rural hinterland of the County which is largely characterized by farming villages spread across the County. The built-up area is less compact, and the region has a low population density. Most of the rural settlements are influenced by availability of land, soil fertility, pastures, topography, climate and provision of basic services such as water, electricity and roads. Areas with this type of settlement include Shamata, Central, Charagita, Gathanji, Kanjuiri and Gathara Wards.

The County can be categorized into two broad agricultural potential zones based on agro-ecological conditions: high potential zones (65%) and low potential zones (35 %). The high potential zones include Kinangop, most of Ol'Kalou and Ol'Joro Orok Sub-Counties. The low potential zones include most parts of Ndaragwa and lower parts of Kipipiri Sub-Counties.

There is pressure to subdivide land including land in agricultural areas with high potential as a result of increased population growth in urban areas. A total of 55,500 ha has already been affected, thus reducing average farm holding. The average land holding has come down to 4 ha and 0.8 ha in low and high potential zones respectively. Available data indicates that the optimum land holdings are 8.9 ha and 2.0 ha, respectively in both zones. While 57% of the land in the County is arable, only about 25% is cultivated. In addition to size and fertility, other main challenges include urban sprawl which threatens agricultural land, inadequate service provision in urban settlements and unplanned growth of settlements.

The county is predominantly rural with small urban area and many trading centres of varying sizes. Ol'Kalou town is the biggest town and the capital of the County; others are Njabini, Engineer, and Maili Nne. Towns and trading centres are growing and need to be planned and equipped with necessary infrastructure such as solid waste and waste water management facilities. Even Ol' Kalou the biggest town does not have a sewage system

Forests and conservation areas are other forms of land use. The eastern boarder of the County boarders the Aberdare National Park and forest. Other forests include Geta, Kinangop, Lake Old, bollosat is famous for its bird's varieties and hippopotamus but its

potential is underutilized. These forests are important in conservation and recharge of water resources in the county and county.

Squatters have been settled in various parts of Nyandarua County since the colonial era. Squatters are mainly located within the townships and trading centres which happen to be the colonial labour camps. Following the post-election violence of 2007, some internally displaced persons who moved into Nyandarua are yet to be resettled.

viii. Livelihoods and Economic Profile

Nyeri County

The predominant economic activity in Nyeri is Agriculture. The local population is involved in growing tea and coffee as cash crops alongside food crops such as maize, beans, assorted vegetables and sweet potatoes. The County is also renowned for horticultural farming.

Other agricultural activities which act as a source of income include dairy farming and fish keeping. There are also a number of light industries, tea and coffee factories providing a market and employment to the residents.

The communities are also engaged in own businesses or employed by the government.

80,943 hectares of land in the county is dedicated towards farming food crops such as maize, beans, Irish potatoes and vegetables. These food crops are predominantly produced on small scale due to smallholding size as a result of population pressure. The average size of small-scale farms are 0.7 hectares. The main food storage facilities include National Cereal and Produce Board, on farm storage granaries and, in farmer's houses.

18,521 hectares of land is used for farming cash crops such as coffee, tea and, horticulture. Tea is grown in the upper zone of the County by the Aberdare Ranges and Mt. Kenya, while coffee is grown in the lower region.

Additionally, there is livestock breeding and fishing activities in the County. Dairy cattle, poultry, pigs, goats, donkeys and, sheep are bred at a carrying capacity of five livestock per hectare. The main fishing activities include fish pond farming, dam and river line fisheries. There was a total of 2,343 households involved in the fishing activities with 2,488 fish ponds by the end of year 2016, spread across the County. The main species of fish found in the region are tilapia, catfish and, trout.

Bee keeping and other small stock farming such as rabbits and quails are on the rise.

Nyeri county has one Industrial Park at Karatina and eight (8) Constituency Industrial Development Centers six (6) of which are complete and two (2) Jua kali shed (Mihuti and Mweiga) which have not been completed.

There are 28 manufacturing industries primarily engaged in coffee, tea, dairy, grain, water bottling, ceramics, bio-diesel, beverage, general-engineering, poultry farming and processing. The trade and industry sector in Nyeri County is energetic and organized into Jua Kali Associations, wholesale, traders, retailers and hoteliers.

The major industries in the county are flour milling, soft drink processing and milk processing. These includes; Maisha Flour Mills, Coca-Cola, Highland, KCC, and Anchor Millers.

Nyandarua County

The major economic activities in the County include farming, quarrying and trade. Agriculture is the backbone of Nyandarua's economy due to the fertile soils and favorable climate. It is considered the food basket of Kenya because of its high production of potatoes, cabbages, carrots, peas and milk that are sold in Nairobi and most other towns in the country. The County

is an aspiring member of the Mt Kenya and Aberdare Regional Economic Bloc being considered.

The agricultural sector is dominated by subsistence production of crops among others; maize, Irish potatoes, cabbages, carrots and peas. Milk production is an important activity in the sector with few factories established in the County. Value addition through agro-processing is a potential activity that will make the sector more beneficial to producers. Horticultural products are an upcoming sub-sector and there is more potential for growth.

The County, apart from being predominantly agricultural, has other resources which include: forestry, water, tourism and natural stone for quarrying. There is potential for secondary utilization of these resources. Potential for agro-industrial processing exists in the dairy and livestock sector, horticulture and food crop production. Other economic activities include: saw-milling, commerce and small-scale Jua Kali industrial enterprises.

There are about 313 trading market centres. The majority of them have scheduled market days where buyers and sellers congregate for trading on retail basis. Major goods traded in these markets include potatoes, cabbages and tomatoes among other agricultural produce, second-hand clothes and household items. There are 537 registered wholesale traders and 12,900 retailers in the County. This implies that the bulk of the trade is in retail.

No established industrial parks exist in the County; however industrial areas have been set aside in the zoning plans. There are four already established Constituency Industrial Development Centres in Kipipiri, Kinangop, Ol'Kalou and Ndaragwa but operating under capacity due to lack of equipment.

In the absence of a strong formal industrial base, the Jua Kali sector remains the most important economic activity. The main activities include tailoring, carpentry and joinery, blacksmith, welding/ fabrication and motor vehicle repairs. This sector provides the bulk of farm implements.

There are no large-scale industrial activities related to manufacturing and processing. There are however numerous small-scale industrial activities such as saw-milling, furniture and metal fabrication, among others concentrated mainly in the urban and market centres.

ix. Employment

Nyeri County

According to the 2019 Population and Housing Census, there is a labour force (ages 15-60) of 390, 809 persons in the County comprising 49% males and 51% females of the total population while there are 38,250 and 44,448 people in the labour force in Tetu and Kieni West sub-counties, respectively. This is the productive population of the county

In the county, 92,205 persons are wage earners thus contributing 24% of the household income. They are mainly employed by the national and county governments, learning institutions and the business community.

Rural self-employed persons in the county are 15,368 contributing 4 % of household income while urban self-employed persons are 4,444 and contribute 13% of the household income. The county will need to provide affordable credit for the establishment of micro enterprises to create more self-employment opportunities.

According to the 2019 Population Census, the population aged between 15 and 64 years in the county is 473,982 comprising of 239,451 females and 234,531 males. This represents 62.4 % of the county population.

The bulk of the labour force is either unskilled or semi – skilled and is mainly engaged in agricultural activities and there is need to equip and employ instructors for the youth polytechnics and other training institutes to impart the youth with necessary and marketable skills.

Nyandarua County

In 2018, the unemployment level in the county was 17.5% since out of the potential labor force of 421,298 persons, only 347,502 are employed then. The dependency rate in the county therefore stan According to the 2019 Population and Housing Census, there is a labour force (ages 18-50^{+}) of 268,190 persons in the County comprising 64% males and 36% females of the total population while there are 47,665 and 35,157 people in the labour force in Kinangop and Nyandarua West* sub-counties, respectively. This is the productive population of the county

Most of Nyandarua's population, about 46.2%, is self-employed, 13.0% is in full time employment, 9.4% are casual labourers, 20.1% are students and 11.4% are unemployed. About 24.5% of the households earn between 5,000 and 10,000 Kenya shillings a month, about 22.5% earn from 10,000 to 20,000 shillings monthly and a minority of about 3.3% earn above 50,000 per month.

Food crops, livestock and to a large extent horticulture production comprise the major economic activities in the agricultural sector. Cottage and small-scale industries are minor economic activities carried out in the market centres. The role of the sawmill as a major source of employment has declined with the fall in available trees for lumber in the County. Commercial tree production is now the only source of timber for the few saw mills that are still operational. The Jua Kali sector remains the most important economic activity in the urban and trading centres. These sectors are the major sources of employment opportunities in the County.

Agriculture employs about 50% of the population with most people employed in the family agricultural holding (Exploring Kenya's Inequality, 2013). Arable/Crop farming is the main agricultural activity in Nyandarua with a total arable land of 184,900 ha; in 2016, nearly 46% of this land was under crop farming. About 76.9% of households practice crop farming. Livestock farming is the second major employment sector under agriculture with approximately 65.1% of households rearing livestock: cattle, sheep, goats, poultry, pigs and rabbits. Cattle and sheep account for the largest percentage. Fishing is picking up as a source of employment and income for a number of households.

Unemployment rates are highest among the youth in Nyandarua due to a lack of manufacturing and service industries which the youth prefer to work in. In addition to the limited job opportunities, poor skill development is another major contributor for youth unemployment. Although, majority of the youth in the county have basic education (primary school education), additional training is required for both formal and informal employment. As a result, a high number of them are involved in drug and alcohol abuse.

x. Poverty Levels and Inequalities

Nyeri County

According to the County poverty index, 28.8 per cent of the population is living in extreme poverty conditions. The majority of these peoples are located in the slums of Nyeri Town, these include areas such as Majengo, Kiawara, colonial villages in Mathira, Kieni and Tetu. Residents of Nyeri County that are landless and reside in villages nearby forested areas fall under this bracket as well.

As a result of under employment and unemployment of the youth over the past 20 years, a larger portion of the Nyeri County population has been living on very low incomes. Other contributing factors include poor market information and, inadequate use of proper technology.

Furthermore, farmers do not have the capacity to add value to their agricultural products and as a result are not able to demand high process in the market and rely on middle men.

Nyandarua County

The Kenya National Bureau of Statistics (KNBS) indicates that the poverty level in the County is at 46%. In urban areas, high unemployment especially among the youthful population expose majority of them into anti-social behaviours especially excessive consumption of illicit brew. Low profitability in the agricultural sector, heavy reliance on rain fed agriculture coupled by shocks in the weather patterns, and the increase in sub-division of land into small and uneconomical sizes are thought to be the main contributors of rural poverty. Female headed households who comprise of 36% of total households in the county are expected to be made worse off as a result of high poverty incidence. This is because of traditional practices that marginalized women economically

xi. Gender Issues

Nyeri County

Women constitute 51 per cent of the population and contribute 70 per cent of the agricultural labour force. Gender parity in primary and secondary schools is minimal.

Women in the county are discriminated in access and control of productive resources. Despite women being the main labourers in the agricultural sector, they do not own land hence cannot access credit facilities due to lack of collateral to secure loans. This minimizes opportunities for economic development that would reduce poverty.

Gender based violence is one of the most widespread and socially tolerated forms of human rights violations, cutting across nationality, race, class, ethnicity, and religion. It is a major source of inequality in Kenya today.

Gender based violence is of great concern in Nyeri County. It is mainly attributed to the consumption of illicit brew and high unemployment levels. This has led to men neglecting their duties and responsibilities. Over the years there has been an increase in cases of domestic violence, which led to the opening of a special gender-based violence unit in 2014 at the Nyeri County Referral Hospital and since then there has been a significant drop in cases of gender-based violence. The county had also become popular for the numbers of men who were coming out openly to report violence meted out on them by their partners.

Information from the Department of Gender, Youth and Social Services indicates that the Mathira Sub-County leads in cases of Gender Based Violence followed by Mukurweini sub-county.

Similar to the County scenario, alcohol abuse and neglect of domestic responsibilities is attributed to causes of gender violence at the sub-county and ward level.

Forms of gender-based violation that are likely to occur within the workplace is sexual harassment/violence where the men demand for sexual favors in exchange for a job opportunity.

The County is in the process of developing a Gender Policy that will be aligned to the National Gender Policy. Additionally, the County has taken the initiative to train community caregivers who handle

Nyandarua County

Gender inequalities within the County have been brought about by cultural beliefs that marginalized women economically. In this regard, women were never allowed to own property especially land which is very critical since agriculture is the main economic activity in the

county. Women were disadvantaged by lack of property as it constrained their access to credit financial institution. Women have also been disadvantaged in leadership due to traditional gender roles that assigned these positions to men. The inequality gap is however expected to narrow with the affirmative action that requires that one third of these positions be held by women, and the sustained campaign on educating the girl child, and change in the traditional beliefs that barred women in succession of property.

xii. Water Resources and Sanitation

Nyeri County

Access to safe water and good sanitation are crucial to the health of a population. Use of unsafe water sources coupled with poor sanitation poses one of the greatest threats to health. Hence, universal access to safe water and sanitation is a key priority of the Government.

The quantity and quality of water affects human welfare though several channels. Water availability influences the pattern of human settlement and the distribution of various development activities including agriculture and industry. Water shortages on the other hand can lead to low resource utilization, poor yields and food insecurity. Further, water scarcity accentuates poverty by limiting people's access to food and employment.

In Nyeri County, water resources comprise of groundwater and surface water sources. Surface water consists of permanent rivers such as Nanyuki, Burguret, Naromoru, Thegu, UwasoNyiro, Karemeno, Rwarai, Gikira, Thuti, Kururu, Muthira, Sagana, Nairobi, Chania, Gura, Honi and Ragati among others.

There are 49 permanent rivers, 77 water dams/ Pans, 72 boreholes and other sources including roof catchment, Shallow wells and springs. The main catchment area in Nyeri County for rivers is the Aberdare Ranges and Mount Kenya. The quality of water is good and suitable for domestic, livestock, wildlife and irrigation dedications. Majority of the population take between 5 and 29 minutes to fetch water for domestic usage.

There are five major supplies of water service providers and four small ones in the county namely; Nyeri Water and Sewerage Company, Tetu-Aberdare water and sanitation company, Mathira water and sanitation company, Othaya-Mukurwe-ini water services company, Narumoru water and sanitation company, Mutitu water and sanitation company, Mwiyogo water users association, Zaina Muhoya water users association and Kinaini water users association There are also other Communities based projects and Individual water projects under the department of water and irrigation. A total of 124,886 households have access to piped water.

These water and sewage companies also provide sanitation services. Human waste is disposed of with 97.68 of the County using covered and uncovered pit latrines, whilst 2.32 per cent use other disposal methods. The portion of the County population using other waste disposal methods originate specifically from informal settlements such as Witemere, Kiawara, Majengo and Ndurutu.

Nyandarua County

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Nyandarua County is categorized as water scarce. The situation has been aggravated by degradation of water catchments leading to reduced ground water recharge. As a result, boreholes have medium to low yields. The main source of water in the County is rainwater which ends up in dams and rivers.

A total of 22 rivers flow through Nyandarua County, of which eight are permanent, namely Malewa, Ewaso Narok, Pesi, Turasha, Chania, Kiburu, Mkungi and Kitiri.

Lake Ol'Bolosat, which is the only lake and the largest water mass in the County, is fed by streams and groundwater seepage from the Aberdare and Dundori hills. Human activities and clearance of the catchment areas for settlement have affected its natural replenishment system.

The major rivers within the County originate in the Aberdare Forest and drain to the Ewaso Ng'iro, Rift Valley, Tana and Athi catchments.

The County experiences two rainy seasons with the long rainy season from March to May, with a maximum rainfall of 1,600 mm and short rainy season from September to December, with a maximum rainfall of 700 mm.

Rainfall intensity varies according to the location. Areas near the Aberdare slopes receive sufficient rainfall, whereas rainfall in the lower parts of Ndaragwa and the plateau is scanty and erratic.

The County has one lake, about 222 small dams, 280 boreholes, 6,244 shallow wells and 96 springs. Main source of water for domestic use is small dams and shallow wells. Most of the water used is untreated which poses a health risk to the population.

There are two registered water companies in the County, namely Nyandarua Water and Sanitation Company and the Ol'kalou Water and Sanitation Company, in addition there are several community-managed water supply schemes. However, some areas in the County are not covered by these schemes and therefore remain unserved. The water supply schemes are unreliable requiring augmentation and rehabilitation to increase the number of households with access to piped water.

Sanitation encompasses maintenance of personal hygiene, safe disposal of liquid and solid waste, control of disease vectors, provision of safe drinking water and provision of hygienic shelter. The main form of disposal of human waste is pit latrines, 92 % of the households have latrines, 3% have flush toilets and there is no sewerage system in the County. On the other hand, 32.8% of Nyandarua's households dispose of their solid waste at garbage pits while 28% of households burn their waste and 25% dispose it in their gardens. The County Government collects garbage for only 2% of the households.

xiii. Housing

Nyeri County

There are three main types of housing in Nyeri County; individual, National government owned and County government owned. Walls in roughly 60.2% of these houses are made out of wood whilst 0.2% use tin. 56.5% of the houses use the earth as floor compared to 0.5% that use tiles. Main roofing materials are iron-sheets (92.1 %), tiles, concrete or tin (0.1 %).

The cost of construction of houses is restrictive resulting in the presence of informal settlements specifically amongst low-income earners. These informal settlements are predominantly located in the urban areas of Nyeri and Karatina.

The Department of Land, Housing and Physical Planning aim to support cheap community development using appropriate technologies.

Nyandarua County

Housing typologies in Nyandarua County vary from one settlement to another. They vary from detached, semi-detached, bungalows, maisonettes, row housing and apartments/flats. Flats and row/ terrace houses are located mainly in major urban centres such as Ol'Kalou, Njabini and Ol'Joro Orok, while maisonettes, row houses and detached huts are found in the rural areas.

In the County, 29% of residents have homes with cement floors, while 68% have earth floors. Less than 1% of homes have tiled floors and 2% have wooden floors. Ol'Joro Orok Constituency has the highest share of cement floors at 33%, which is 4 percentage points above the County average. Gatimu Ward has the highest share of cement floors at 56%.

In Nyandarua County, less than 1% of residents h ave homes with concrete roofs, while 95% have corrugated iron sheet roofs. Grass and makuti roofs constitute 1% of homes. Kinangop and Ol'Joro Orok constituencies have the highest share of corrugated iron sheet roofs at 96% each; 4 percentage points above Ndaragwa Constituency, which has the lowest share. Githabai Ward has the highest share of corrugated iron sheet roofs at 99%.

In Nyandarua County, 16% of homes have either brick or stone walls. 36% of homes have mud/wood or mud/ cement walls. A further 43% have wooden walls while 3% have corrugated iron sheet walls and 2% have tin or other walls. Ol'Kalou Constituency has the highest share of brick/stone walls at 21%, which is 5 percentage points above the County average. Kiambaga Ward has the highest share of brick/stone walls at 36%. Ndaragwa and Ol'Joro Orok Constituency have the highest share of wooden walls at 61%. Gathanji Ward has the highest share of wooden walls at 80%; 37 percentage points above the County average.

xiv. Transport and Roads Network

Nyeri County

The county is easily accessible by road from Nairobi and other neighbouring towns. It also has three airstrips namely Mweiga on the Nyeri-Nyahururu highway, Nyaribo on the Nanyuki-Nairobi highway about 15km from Nyeri town and the Nanyuki near Nanyuki Town. The County headquarters is located in Nyeri Town which is easily accessible from all the eight sub counties.

The County has 3,092.73 km of classified roads of which, 478.25 km are bitumen, 2,492.85 km are gravel and, 121.63 km are earth surface. During the rainy season the earth surface roads are not usable. In addition to the road network, Nyeri County also has three airstrips mainly utilized by tourists i.e. Mweiga, Nyaribo and Nanyuki. There are three railway stations which are not functional at Karatina, Kiganjo and Narumoro.

Nyandarua County

Road transport is the primary/dominant mode of transportation in Nyandarua County, with a total road length of approximately 3,400kms. Earth roads account for 78% of the total road network (2,651 Km), while the bitumen roads constitute only about 7% (224 kms) and gravel roads account for 15% (525 kms) which indicates that there are challenges of mobility within the County (Table 4).

The current road network comprises of hierarchical road classifies as B, C, D, E, F and G classes. The major roads traversing the County are Nyahururu-Nyeri (B21), Ol'Kalou-Miharati-Engineer Road (formerly C now B20) and Ol' Kalou-Nyahururu road (formerly C77, now A4). The existing road network is largely shaped by human settlement pattern, as well as

internal and external growth nodes. There are also numerous Class D and E roads within the County. The table below shows.

Table 13-7: Classified types of roads with their total distance

Class of Road	Total
Classified Major Roads and length (Km)	
International Trunk Roads A	4.3
National Trunk Roads B	27.8
Primary Roads C	246.6
Secondary Roads D	285.8
Sub-Total	564.5
Classes of Minor Roads and Length (Km)	
Minor Roads E	182.5
Government Access Roads G	10.9
Settlement Roads L	357.8
Rural Access Roads R	129.8
Sub-Total	680.8

Connectivity of Nyandarua County is moderately sufficient. The County is linked to the major town centers in the region (Nakuru, Nyeri and Nyahururu) by road. The Ol'Kalou-Miharati-Engineer Road, class (B20), traverses the entire county of Nyandarua, from Dundori to Njabini. It connects to the Nairobi-Nakuru Highway (A8) to Nakuru (via Dundori) as well as the capital city, Nairobi. The County is linked to Nyahururu and Giligil (in Nakuru County) by the (A4) road which then connects to the Nyahururu-Nyeri Road; class B21. The road connects to Ol'Joro Orok to Dundori through Charagita center. Road D1323 links Engineer and Naivasha facilitating movement from Nyandarua to Nakuru County. The airstrip in Ol'Joro Orok Sub-County links the County to surrounding air transport facilities.

Poor road condition is one of the major development challenges in the County. The earth roads in the county are impassable during the rainy season while in many cases the gravel roads are cut off. This is frequent phenomenon noting that the county has three heavy seasons in any given year and the poor alignment soils (black cotton soils).

There is a 60kms long meter gauge railway connecting Gilgil to Nyahururu that passes through the Nyandarua County with stations in Ol' Kalou and Ol'Joro Orok. Currently, the railway line which was constructed in 1927, is in disuse and some of its infrastructure has been vandalized.

The County has a paved airstrip at Gatimu owned by the Government which operates for strategic purposes only and currently has no commercial importance. The airstrip is inadequately serviced and has minimal operations.

xv. Energy

Nyeri County

The County is poorly supplied with electricity having only 34 per cent of households (86, 000 households) connected. In addition to these houses, 112 trading centers and 170 secondary schools are connected to the grid.

The main sources of energy are: firewood, paraffin, gas, charcoal, biomass residue, biogas, hydroelectric power and others. 72.2 per cent of households use firewood as its main cooking fuel.

Nyandarua County

Just 1% of residents in Nyandarua County use liquefied petroleum gas (LPG), while 1% use paraffin, 78% use firewood and 19% use charcoal. The most common cooking fuel, therefore, is firewood. Kipipiri Constituency has the highest level of use of firewood at 86%. This is 12 percentage points above Kinangop Constituency, which has the lowest share at 74% and 8 percentage points below the County average. Geta Ward has the highest level of use of firewood in Nyandarua County at 85%.

Ol'Joro Orok and Kinangop constituencies have the highest level of charcoal use in Nyandarua County at 23% each. This is 11 percentage points above Kipipiri Constituency, which has the lowest share at 12%. Gatimu Ward has the highest level of charcoal use in Nyandarua County at 50%.

A total of 11% of Nyandarua residents use electricity as their main source of lighting. A further 56% use lanterns and 26% use tin lamps. Less than 1% use fuel wood. The most common lighting source among male headed households is lanterns at 56% and the same holds for female headed households at 55%.

Hydro power is potentially the biggest source of electricity in Nyandarua County. However, the County has no hydro generating plant, but is connected to the National grid. There are four power sub-stations in the County, namely: Ol'Kalou, Matundura, Magumu and Wanjohi. There is an energy center in Mirangine area which has enhanced energy throughout the County.

The Kenya Power and Lighting Company is the main electricity supplier. A total of 65,399 households are connected, accounting for approximately 40% of the total households. Majority of the residents within the urban centres are within the gridline and have been connected with the greater percentage of the unconnected households being in the rural areas.

Ol'Joro Orok and Ol'Kalou constituencies have the highest level of electricity use at 14% each. Gatimu Ward has the highest level of electricity use at 32%, which is 21 percentage points above.

xvi. Information and Communications and Technology

Nyeri County

The county is fairly developed as a result of the advent of mobile telephony and internet hubs in the urban centers. The mobile phone coverage stands at 91 per cent and there are 384 cyber cafes. This has greatly revolutionized the way people communicate and improved efficiency in service delivery. There exist six Post Offices, 19 sub-post offices and 25 licensed stamp vendors. However, Post office faces stiff competition from 30 private courier services mainly G4S, Wells Fargo, 2NK Sacco, 4NTE etc.

Both Private institutions and Government departments have embraced the use of modern methods of communication through E-Government services by use of E-Mail and mobile phone technology. The county is expected to grow fast after connection of a fiber optic cable, which will greatly revolutionize communication and information sharing.

Nyandarua County

The County is well served by a postal system network with Post Offices located in the various townships. However, with advancement in technology, other means of communication including private courier and transport service providers who offer delivery services for mail

and parcels, mobile telephone, and data communication which offer electronic mail and information transfer platforms, the use of post offices has diminished.

Nyandarua County has embraced ICT in public service delivery, and in learning institutions. The County has poor signal network apart from the centres with Base Transmission Stations (BTS). ICT infrastructure in the County remains weak as demonstrated by weak Grams per Square Metre (GSM) signal in certain areas, and lack of 4G network. The main mobile phone and telephone service providers are Safaricom, Airtel and Orange.

The County is also not fully connected to the National Optical Fibre forcing residents to rely on a weak Local Area Network (LAN). However, the County Government, in partnership with the National Government is in the process of connecting the County with fibre optic. Ol' Kalou fibre optic cable has been laid from Gilgil to Nyahururu. Ol'Kalou town is the only area connected with the fibre optic. The town has two networks, one from Nyahururu to Ol'Kalou and the other from Gilgil to Ol'Kalou.

Automation within departmental offices is reasonable though inadequate. The County relies on the IFMIS for transaction management, but total revenue collection automation is yet to be realised. ICT uptake in the Government offices is evident with 85% of the offices having access to internet, and 80% of revenue collection automated. The County has recently acquired two servers to enable back-up of digital data while all offices have LAN, a unified communication system and Bulk SMS platform. The County Government has a fully functional website. The number of specialized IT experts is also low, and much can be achieved through training and employment of more experts. To facilitate uptake of ICT in learning institutions, the County will establish adequate infrastructure such as labs and adequate qualified staff.

The County Government has various ICT development projects including 2 ICT Hubs funded by the Government which have already been budgeted for but not yet implemented; 4 ICT Hubs in each Sub-County funded by the National Government through the CDF; and the County is developing a call center at the County headquarters to cater for emergencies.

C. Biodiversity Characteristics of the project area

i. Mammal Diversity

Aberdare Forest

Field assessment of mammal species along the proposed road-upgrading alignment in the protected area recorded an estimated 21 species out of 72 species known to occur in the Aberdares. The protected area which constitutes of the Forest Reserve and National Park are unique in the assembly of mammal species. Both sections are dominated by the Elephant and Buffalo populations, including Bushbucks and Waterbucks. The National Park has unique moorland habitat that has grassland and unique herbs and short shrubs. The habitat attracts an assembly of many herbivore species such as the Eland, Warthogs,

The rapid sampling that was conducted revealed very few mammal species. These include the White-tailed Mongoose observed crossing the road, Four-striped Grass Mouse observed on grass patches in the adjacent farms, and the East African Mole Rat which was noticed by its burrowing activities in the paddocks and fallow areas along the road. None of the species recorded physically, from online database, and local accounts are listed under IUCN red list of threatened species.

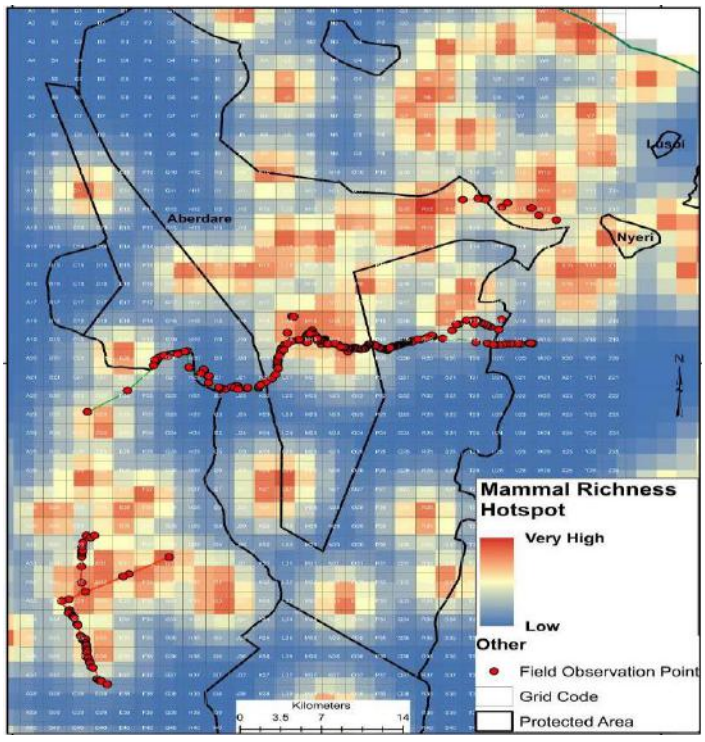


Figure 13-6 Mammalian Diversity

Nyeri Spur roads

Occurrence of about 19 mammal species is revealed around the Nyeri Spur Road project area through local accounts and physical observations (Table 4-8). These are aggregated into 6 taxa order and 8 taxa families. Due to the nature of the survey, only few species of mammal species were observed physically. These include the Common slender mongoose and the White-tailed

Mongoose observed crossing the road. The occurrence of Bat species was accounted for by the local residents who revealed a record of 7 species within the proposed spur roads in Nyeri. According to both secondary and primary mammal species data (especially small mammals), areas with potentially highest mammal hotspot occur between Amboni -Tree Top – Njegu stretch (Fig. 4-7). The stretch of the proposed road upgrading between Mukarara – Ihithe has relatively low hotspot for mammals (Fig. 4-7). None of these species recorded are listed under IUCN red list of threatened species.

Nyandarua Spur roads

The assessment of mammal species in the Nyandarua Spur Roads revealed a total of 11 mammal families and 11 species. The diversity of mammal species within the project area is well accounted for by the local residents. Most of mammal species accounted for were historical observations that were made before the landscape were fragmented by fences that created barrier to movement of the wild animals. The rapid sampling that was conducted revealed very few mammal species. These include the White-tailed Mongoose observed crossing the road, Four-striped Grass Mouse observed on grass patches in the adjacent farms, and the East African Mole Rat which was noticed by its burrowing activities in the paddocks and fallow areas along the road. According to both secondary and primary mammal species data (especially small mammals), areas with potentially highest mammal hotspot occur near Koinange area and Munyaka area (Fig. 4-7). Kahuruko to Ndunyu Njeru however, has relatively low hotspot for small mammals. None of the species recorded physically, from online database, and local accounts are listed under IUCN red list of threatened species.

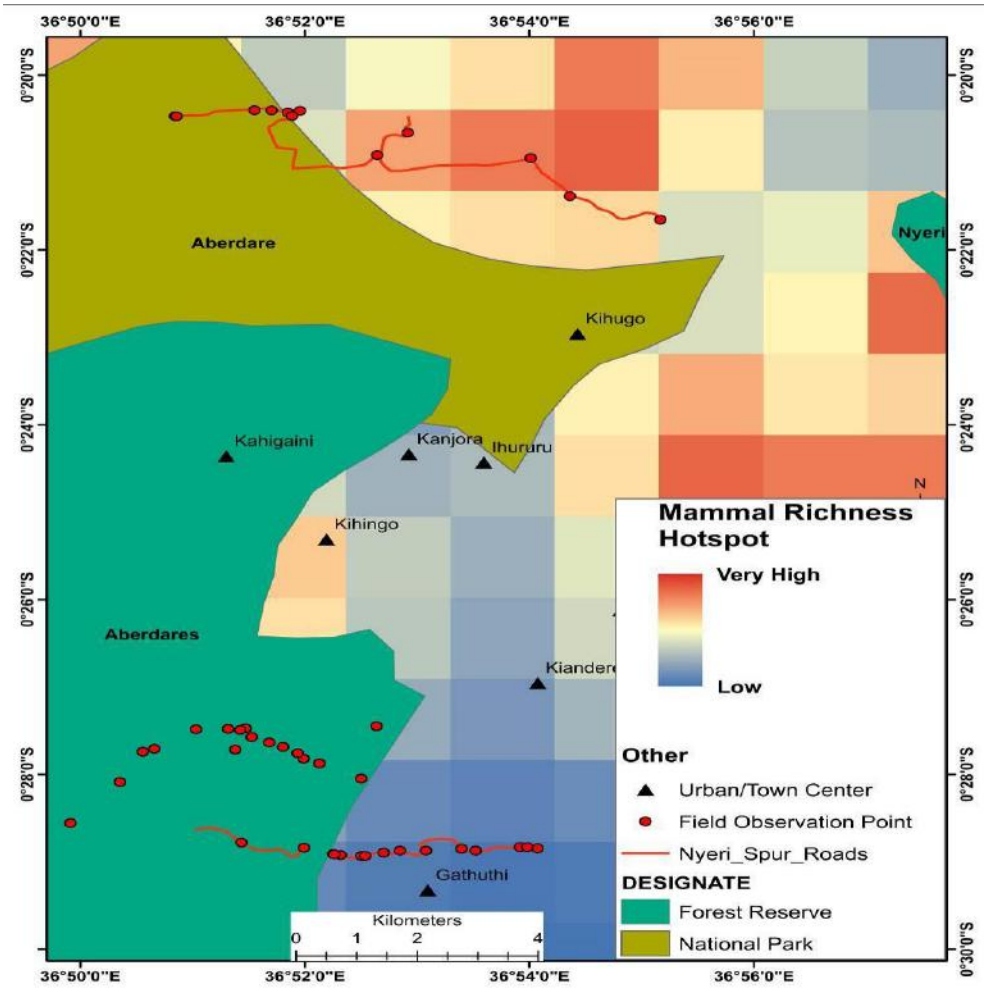


Figure 13-7 Mammal richness hotspot map

Table 13-8 Checklist of mammal species in Nyandarua county spur road areas

Family	Species	Common Name	IUCN Status
Order: Carnivora			
Herpestidae	Galerella sanguinea	Common slender mongoose	
Herpestidae	Ichneumia albicauda	White-tailed Mongoose	LC
Hyaenidae	Crocuta crocuta	Spotted Hyaena	LC
Viverridae	Genetta tigrina	Cape Genet	LC
Order: Chiroptera			
Hipposideridae	Hipposideros caffer	Cape Leaf-nosed bat	LC
Nycteridae	Nycteris thebaica	Cape Long-eared Bat	LC
Pteropodidae	Epomophorus wahlbergi	Wahlberg's Epauletted Fruit Bat	LC
Rhinolophidae	Rhinolophus eloquens	Eloquent Horseshoe Bat	LC
Rhinolophidae	Rhinolophus fumigatus	Rüppell's horseshoe bat	LC
Rhinolophidae	Rhinolophus landeri		LC
Vespertilionidae	Pipistrellus kuhlii	Kuhl's Pipistrelle	LC
Order: Lagomorpha			
Leporidae	Lepus capensis	Cape hare	LC
Order: Primates			
Cercopithecidae	Colobus guereza	Mantled guereza	LC
Order: Rodentia			
Cricetidae	Lophiomys imhausi	Crested Rat	LC
Muridae	Lemniscomys striatus		LC

Muridae	Otomys tropicalis		LC
Muridae	Thamnomys cometes		LC
Order: Soricomorpha			
Soricidae	Crocidura fumosa	Smoky White-toothed Shrew	LC
Soricidae	Crocidura olivieri	Olivier's Shrew	LC

ii. Birds Diversity

Aberdare forest

Within the forest there are important bird areas (IBA), several species of birds have been sighted. It has 52 of Kenya's 67 Afrotropical Highlands species of birds and 6 of 8 restricted range species in the Kenyan Mountains. The forest has 46 forest dependent bird species which are "true" forest birds which are mostly found in the undisturbed forests, but may persist in secondary forest and forest patches if their particular ecological requirements are met. Aberdare forest is important for the survival of five species of birds; these birds are of special concern, they include *Francolinus jacksoni, Francolinus psilolaemus, Cinnyricinclus femoralis, Cisticola Aberdare* and *Cinnyricinculus sharpie*. The forest hosts globally threatened species such as Sharpe's Long claw, Aberdare Cisticola, Abbott's Starling, and Jackson's Widowbird. In addition, it also holds birds with restricted range such as; Jackson's Francolin and Hunters Cisticola (endangered). Regionally threatened bird species that have been spotted within the forest are African green Ibis (*Bostrychia olivacea*), Barred long-tailed cuckoo (*Cercococcyx mountanus patulus*), Red chested owlet (*Glaucidium tephronotum elgonense*), Orange ground thrush (*Zoothera gurneyi*), Ayre's Hawk Eagle, African Crowned Eagle, Stripped, Flufftail, Bailon's Crake, African Grass owl, Cape Eagle Owl and Long-tailed Widowbird.

A total of 418 bird species have been recorded from the Aberdare Forest and its environs. This estimation combines information from the literature reviews, existing database and field observations. Field validation consisted of physical observation, listening to calls and accounts by the local rangers/warden. Out of these bird species, two species and listed as Endangered (EN) under the IUCN red list of threatened species, two are Vulnerable (VU), and four species are Near Threatened (NT). The distribution hotspot for bird's species occurs in the Eastern side of the National Park, and extend outside in the inhabited area where project is located. Bird richness hotspot occurs in the road section of Njegu - Tree Top – Amboni (12 km), and Ark Gate Access 2 km (grid codes T11, U12, V12, W12, X13). A section between Ihithe – Kiandogoro (gridcode U19) is also a hotspot area for high bird richness. In the Park, hotspot areas for bird richness occur within gridcode L19/20 AND M20. Richness hotspot in road sections Joma – Weru (gridcode ..), and Munyaka – Koinange (gridcode …) is contributed largely by wetland birds observed around small ponds. Mwendandu – Koinange. Low bird richness occurs between Kahuruko – Ndunyu Njeru (9 km).

Table 13-9 Birds Diversity

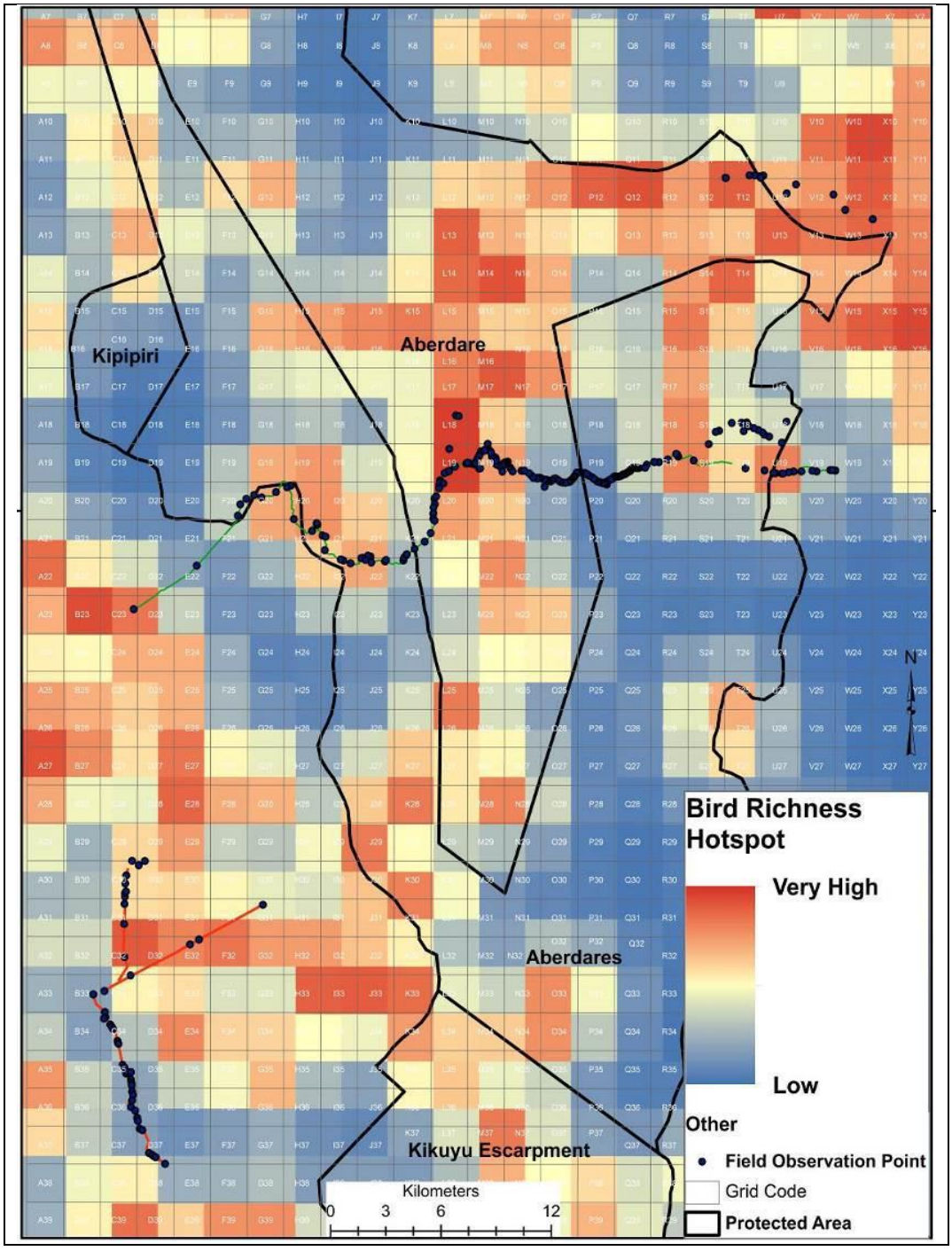
Accipitriformes	Accipitridae	Aquila nipalensis	EN
Accipitriformes	Accipitridae	Aquila rapax	VU
Accipitriformes	Accipitridae	Circus macrourus	NT
Charadriiformes	Glareolidae	Glareola nordmanni	NT
Gruiformes	Gruidae	Balearica regulorum	EN
Passeriformes	Acrocephalidae	Calamonastides gracilirostris	VU
Passeriformes	Malaconotidae	Laniarius mufumbiri	NT
Passeriformes	Parulidae	Setophaga striata	NT

Sacred Ibis (left) and Egyptian Geese

Grey Heron

Black

Long-crested Eagle



Nyeri Spur roads

A total of 106 bird species were recorded along the Mau Mau Lot 4 Nyeri Spur Roads. These is constituted by 19 taxa order and 50 taxa families. The order Passeriformes Order constitutes the highest number of species (43%) of all birds recorded in the area. This is only followed by the Order Pelacaniformes that its species forms 14% of the recorded species. Passeriformes is the largest clade of birds and among the most diverse clades of terrestrial vertebrates, representing 60% of birds globally. These birds were observed on hedges along the roads foraging and flying across the roads in Amboni – Ark Gate, Amboni – Njegu stretch. The stretch of Amboni – Tree Top and Njegu – Tree Top has more bird species compared to other spur road stretches (Fig. 4-10). The Pelecaniformes are an order of medium-sized and large waterbirds found worldwide .The occurrence of Pelecaniformes within Nyeri Spur Road area

is explained by occurrence of small wetlands adjacent to the roads. The occurrences of many small wetland habitats support growth of invertebrate species that provide forage wetland and terrestrial birds. Only one bird species, observed, is listed as Endangered; the Grey crowned Crane (*Balearica regulorum*) observed around small naturalized and artificial wetlands adjacent to roads. The Grey crowned Crane however, has a potential diverse habitat ranging from forest, savanna, grassland, wetlands (inland), artificial/terrestrial, artificial/aquatic & marine habitats. It is however, threatened by the loss and degradation of wetland breeding areas induced by changes in land-use and major project developments. It is also threatened by live-trapping for trade, egg-collecting and hunting in wetlands.

Table 13-10 Some of the bird species observed within the proposed Nyeri spur road project area

Sacred Ibis and Egyptian Goose

Red Billed Coot

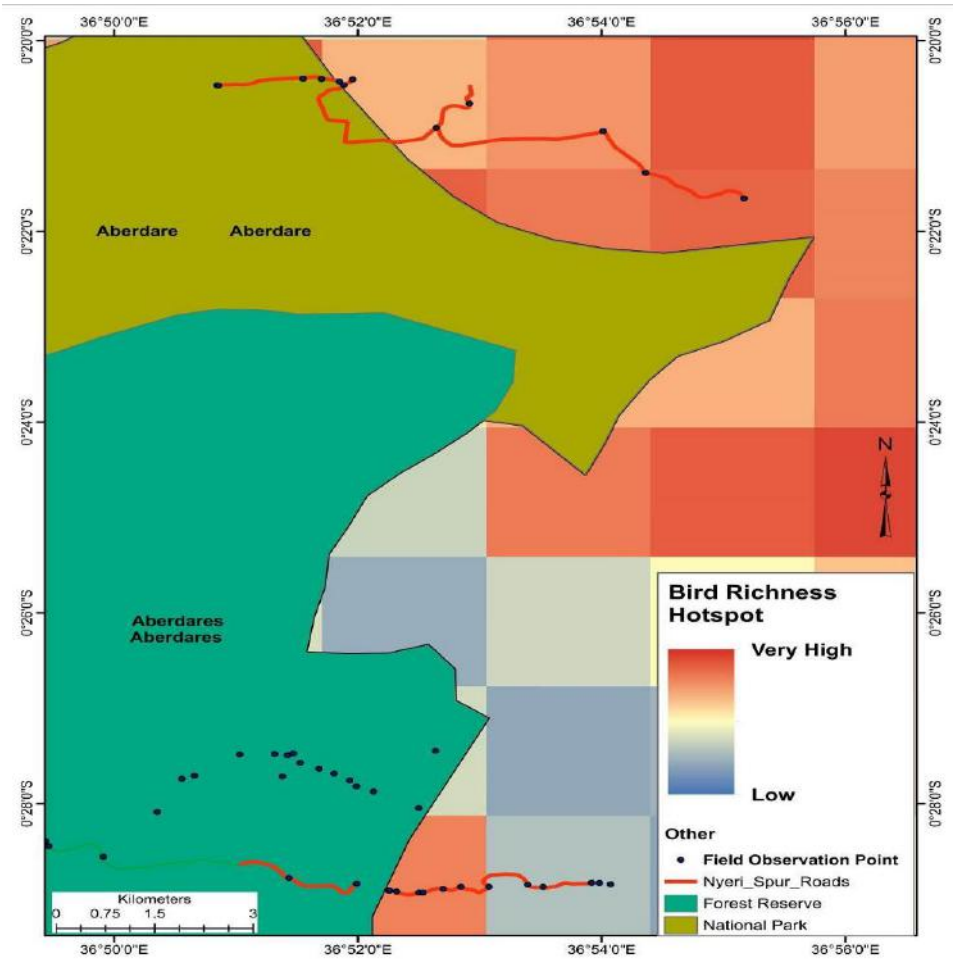


Figure 4 - Bird species richness hotspot in Nyeri county spur roads

Nyandarua Spur roads

A total of 85 bird species were recorded along the Mau Mau Lot 4 Nyandarua Spur Roads (Appendix I). Passeriformes Order constitutes the highest number of species (62%) of all birds recorded in the area. This is only followed by the Order Pelacaniformes that its species forms 11% of the recorded species. Passeriformes is the largest clade of birds and among the most diverse clades of terrestrial vertebrates, representing 60% of birds. These birds were observed on hedges and grasslands (paddocks) along the roads foraging and flying across the roads. The Pelecaniformes are an order of medium-sized and large waterbirds found worldwide. The occurrence of Pelecaniformes in Nyandarua Spur Road area is explained by several small water points (ponds, pools, waterpans and natural wetlands along streams) observed in most farms adjacent to the road. The occurrences of many small wetland habitats support growth of invertebrate species that provide forage wetland and terrestrial birds. There are many flying insects support birds from the family Hirundinidae because they highly adapted to aerial feeding. Only one bird species is listed as Endangered; the Grey crowned Crane (*Balearica regulorum*) observed around small natural and artificial wetlands on farms. This species however, has a potential diverse habitat ranging from forest, savanna, grassland, wetlands (inland), artificial/terrestrial, artificial/aquatic & marine habitats. It is however, threatened by the loss and degradation of wetland breeding areas induced by changes in land-use and major project developments. It is also threatened by live-trapping for trade, egg-collecting and hunting in wetlands. Areas with high birds' richness hotspot are in the forest area, Koinange – Munyaka, and Weru Njoma sections.

Figure 13-8 Some of the bird species observed within the proposed Nyandarua spur road project area

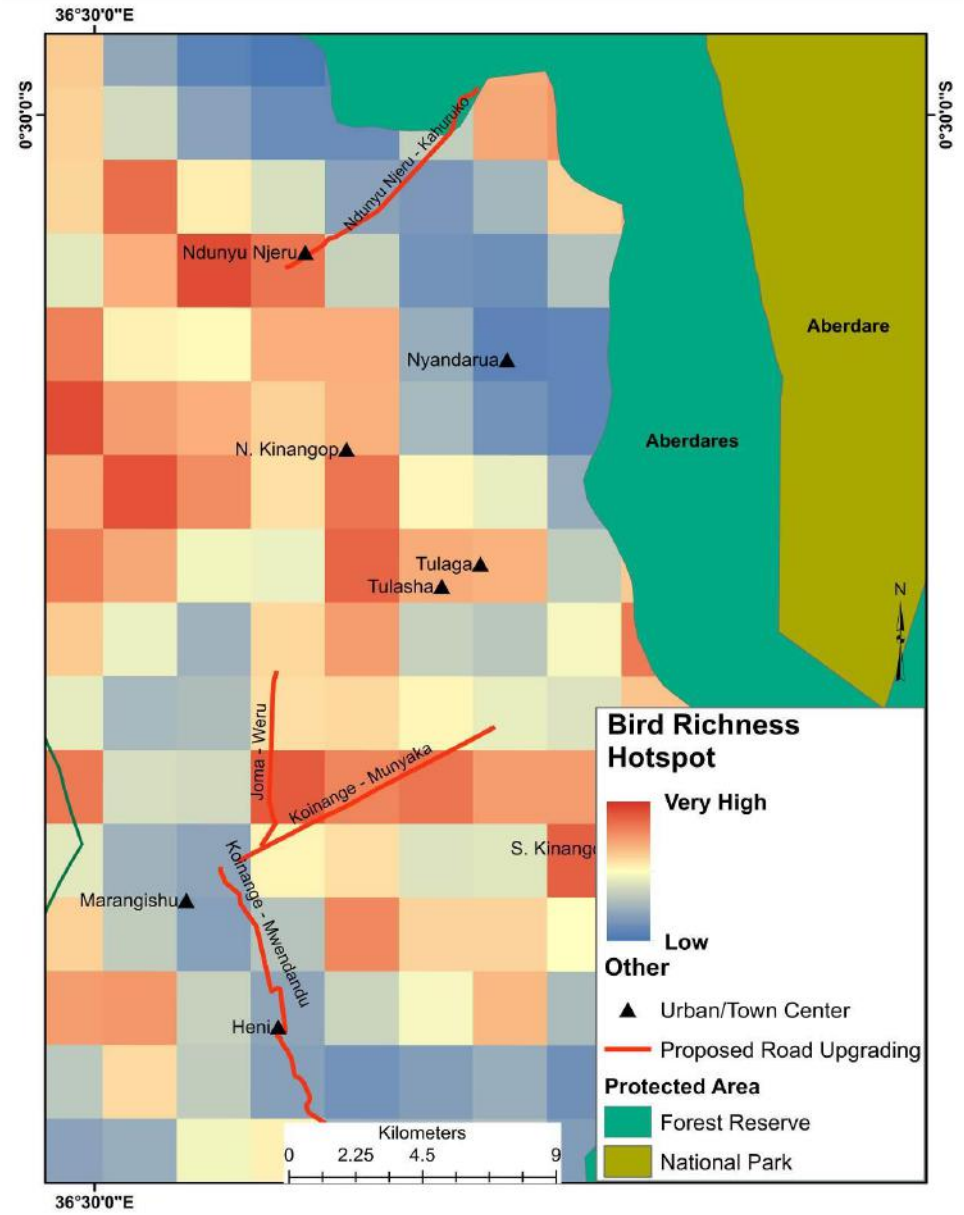


Figure 13-9 - Bird species richness hotspot in Nyandarua county spur roads

iii. Invertebrate Diversity

Aberdare forest

An estimate of 130 species of invertebrate species were recorded from the terrestrial and aquatic habitats. There are about 14 aquatic species recorded at larva from streams and flying adults. While 57 species of terrestrial invertebrates were recorded during the survey. Odonata species (dragonflies) forms majority group among the aquatic invertebrate species. Most of the terrestrial invertebrate species are constituted by the species from Diptera (flies)and Lepidotera (butterflies & moths) orders. All these invertebrate species are listed as Least Concern under the IUCN Red List of Threatened Species. The distribution of invertebrate species along the road is relatively low along the alignment of the proposed road project.

Validation of conservation status of the invertebrate species in the IUCN Red List of Threatened Species shows only 20% of the invertebrate species recorded in the field have been assessed. All these species are listed as Least Concern (LC) are listed as Least Concern under the IUCN Red List of Threatened Species. However, literature review has shown presence of

the Montane Dancing Jewel (*Platycypha amboniensis*) which is Critically Endangered has a limited extent of occurrence and area of occupancy along the montane forest streams of the Aberdares.

Richness of the invertebrate species in the area tend to be higher in Amboni – Tree Top, Tree Top – Njegu, Amboni – Ark Gate areas near the protected areas. However, the distribution of the species is relatively low on the Mukarara – Ihithe landscape.

Orthtrum guineense

Belenois aurata

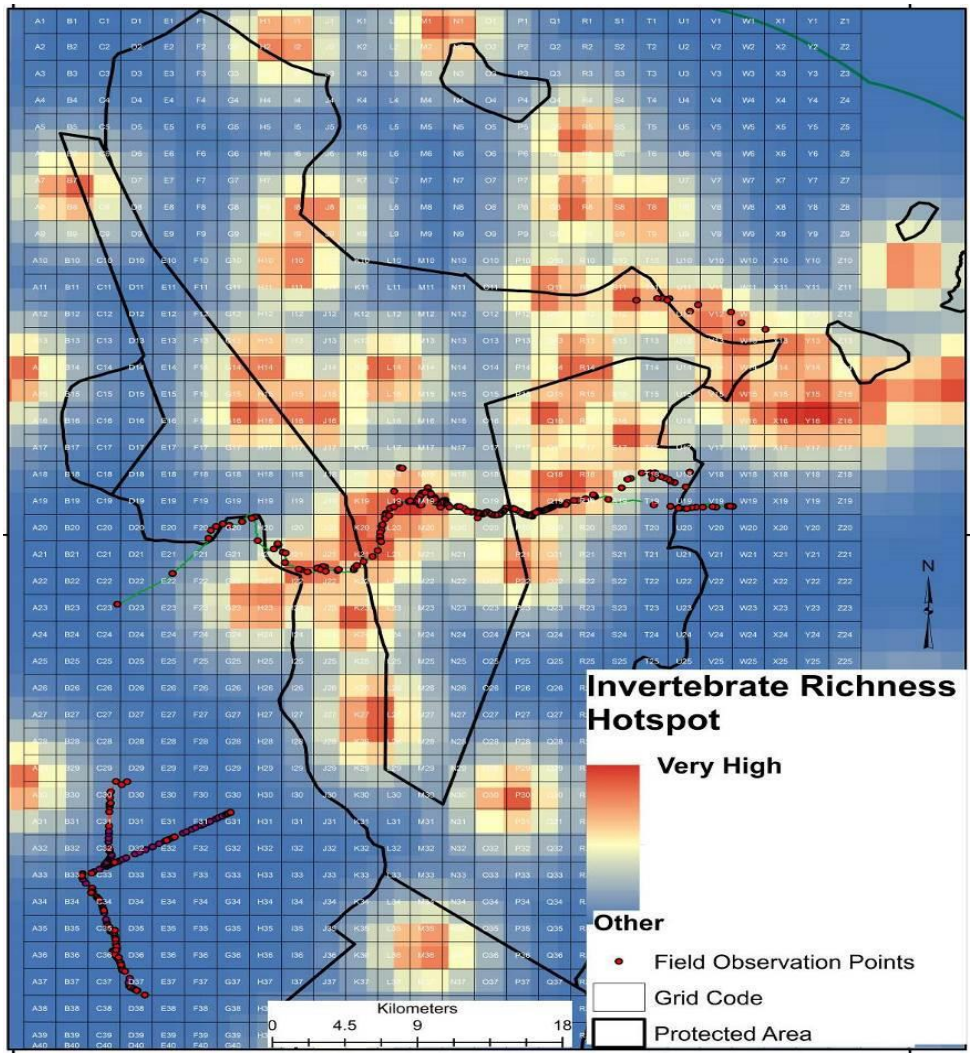


Figure 13-10Invertebrate Richness Hotsports

Nyeri Spur Roads

An estimated number 101 invertebrate species were recorded during the rapid biodiversity survey within the proposed Mau Mau Lot 4 Nyeri Spur Roads (Appendix II). Most of these are terrestrial species dominated by the butterfly species (Lepidoptera and Moths) followed by Flies (Diptera) and Hymenoptera order. The recorded number of species is; however, a representative of an estimate from the rapid biodiversity survey. These species are favoured by the network of live fences (hedges) and nearness to the forest.

Validation of conservation status of the invertebrate species in the IUCN Red List of Threatened Species shows only 15% of the invertebrate species recorded in the field have been assessed. All these species are listed as Least Concern (LC) are listed as Least Concern under the IUCN Red List of Threatened Species. Richness of the invertebrate species in the area tend to be higher in Amboni – Tree Top, Tree Top – Njegu, Amboni – Ark Gate areas near the

protected areas. However, the distribution of the species is relatively low on the Mukarara – Ihithe landscape.

Figure 13-11 Some of the observed invertebrate species within proposed Nyeri spur road

Orthetrum guineense

Belenois aurata

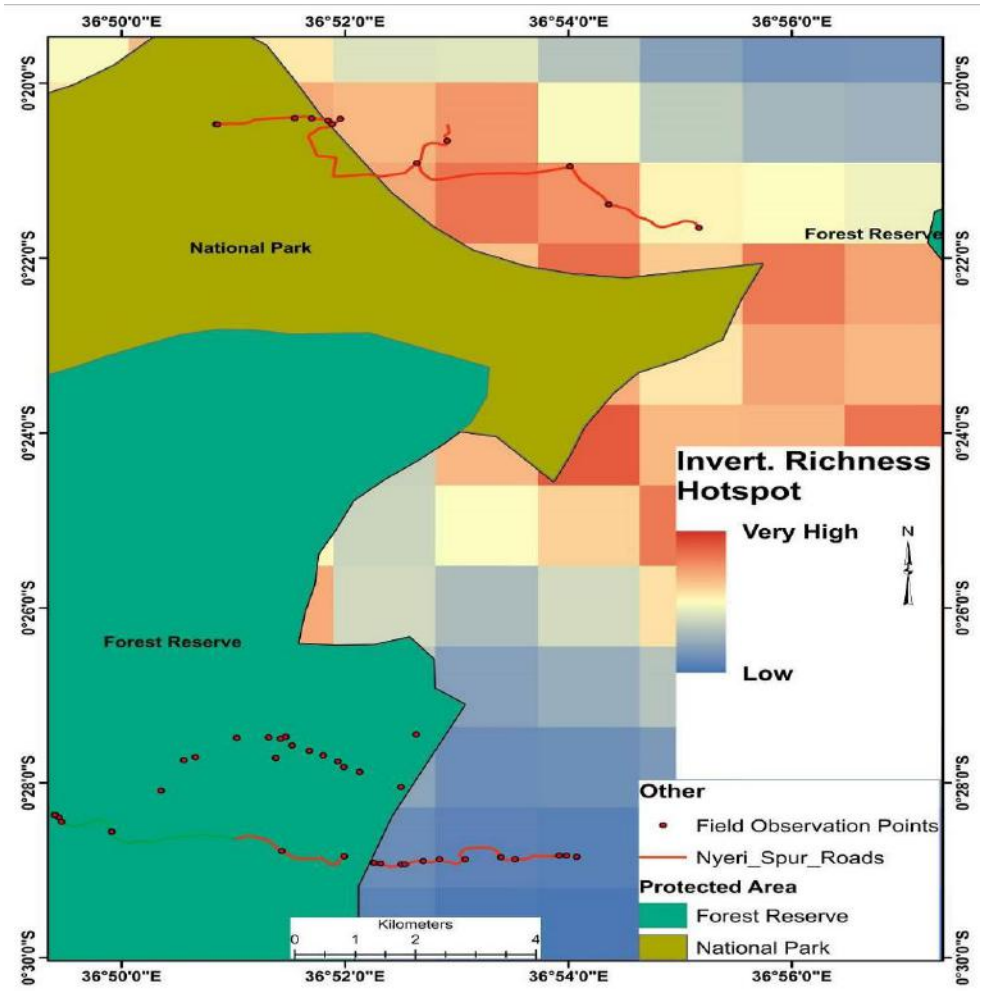


Figure 13-12 Invertebrate species richness hotspot in Nyeri county spur roads

Nyandarua Spur Roads

An estimate of 77 species of invertebrate species was recorded from terrestrial and aquatic habitats. Some of the aquatic macroinvertebrate species spend their adult lifestage in terrestrial environment. There are about 48 aquatic species recorded at larva from streams and flying adults. While 29 species of terrestrial invertebrates were recorded during the survey (Appendix II. Odonata species (dragonflies) forms majority group among the aquatic invertebrate species. Majority of terrestrial invertebrate species are formed by the species from Diptera (flies) and Lepidotera (butterflies & moths) orders. The total number of invertebrate species in the area is however not limited to the number of species recorded during the Rapid Biodiversity Survey. All these invertebrate species are listed as Least Concern under the IUCN Red List of Threatened Species. The distribution of invertebrate species is relatively low on the landscape the proposed road project is located; thus, it is low in invertebrate richness hotspot.

Figure 13-13 Some of the observed invertebrate species within proposed Nyandarua spur road

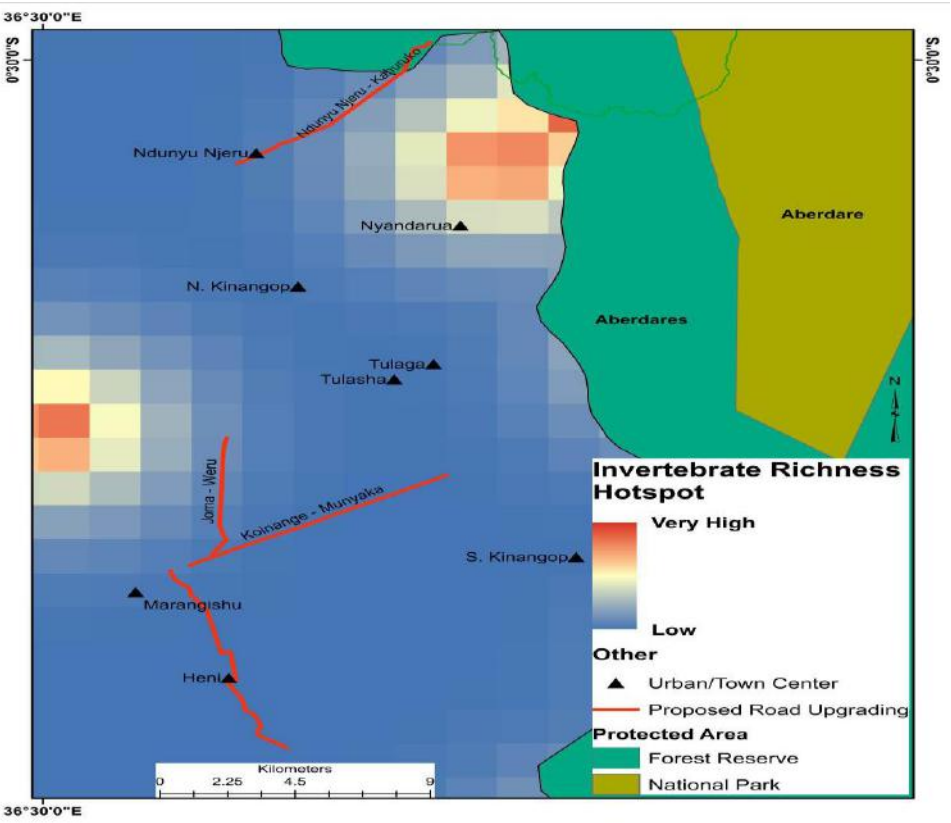


Figure 13-14 - Invertebrate species richness hotspot in Nyandarua county spur roads

iv. Plant Diversity

Aberdare forest

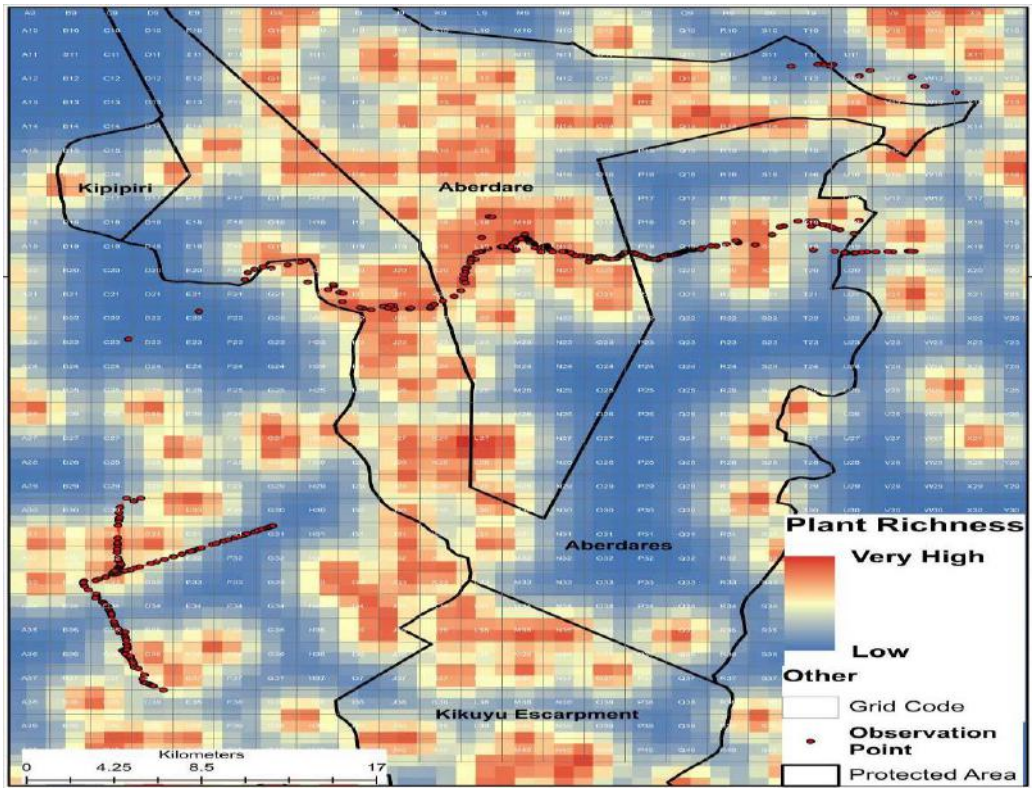
The Aberdare Forest has a rich biodiversity of vegetation types that result mainly from wide range of altitude and rainfall (Table 4-11). There is an estimated total of 1260 vascular plants taxa representing 136 families, 613 genera, 67 subspecies and 63 varieties in the Aberdare area. The ferns comprised 84 species, lycophytes 7, gymnosperms 6 and angiosperms were 1163 tax. The forest has total of 18 taxa which are endemic and 14 taxa which are threatened globally.

Endemic plant species of Aberdare Forest include; *Lobelia deckenii sattimae, Helichrysum gloriadei and Alchemilla hageniae, Lobelia bambuseti, Senecio keniensis, Senecio johnstonii battiscombei and Senecio keniodendron.* Common hardwood tree species include Camphor (*Ocotea usambarensis*), Cedar (*Juniperus procera*), Podo (*Podocarpus latifolius*) and Hagenia (*Hagenia abyssinica*) among other. The forest has varieties of medicinal plants which are used by the local communities, examples of such plants include; *Warbugia ugandensis, Lactuca inermis Carissa spinarum, Prunus africana*. The highly exploited tree species for logging and charcoal burning within the forest are; *Pinus radiate, Prunus africana* and *Croton alienus*. In addition, *Ficus sur, Ficus thonningii* and *Indigofera erecta* are considered sacred by the local community living around the Aberdare Forest.

Table 13-11 Range of altitude and rainfall in aberdares

Vegetation zone	Altitude /Location	Characteristic tree (and shrub) species
Montaneforest zone - Moist forest - Dry forest	1900 - 2500 / East 2100 - 2500 / South-East 1800 - 2400 / South-West 2400 - 3300 / West 2300 - 3200 / North, North-East	- *Cassipourea malosana, Ekebergia capensis, Teclea nobilis, Calodendrum capense, Podocarpus latifolius, Nuxia congesta* - *Ocotea usambarensis, Macaranga kilimandscharica, Neoboutonia macrocalyx, Tabernaemontana stapfiana, Prunus Africana* - *Juniperus procera, Calodendrum capense, Teclea simplicifolia* - *Juniperus procera, Olea europaea (africana), Podocarpus falcatus, Nuxia congesta*
Bamboo zone	2400 - 3000 / East, South-East 2700 - 3300 / West	- Arundinaria alpina with scattered trees, including Podocarpus latifolius and Nuxia congesta
Hagenia-Hypericum zone	2950 - 3500 (discontinuous	Hagenia abyssinica, Hypericum revolutum, Rapanae melanophloeos
Ericaceous zone	2900 - 3560 (discontinuous)	Erica excelsa, Erica trimera, Erica arborea, Cliffortia nitidula, Helichrysum nandense, Stroebe kilimandscharica

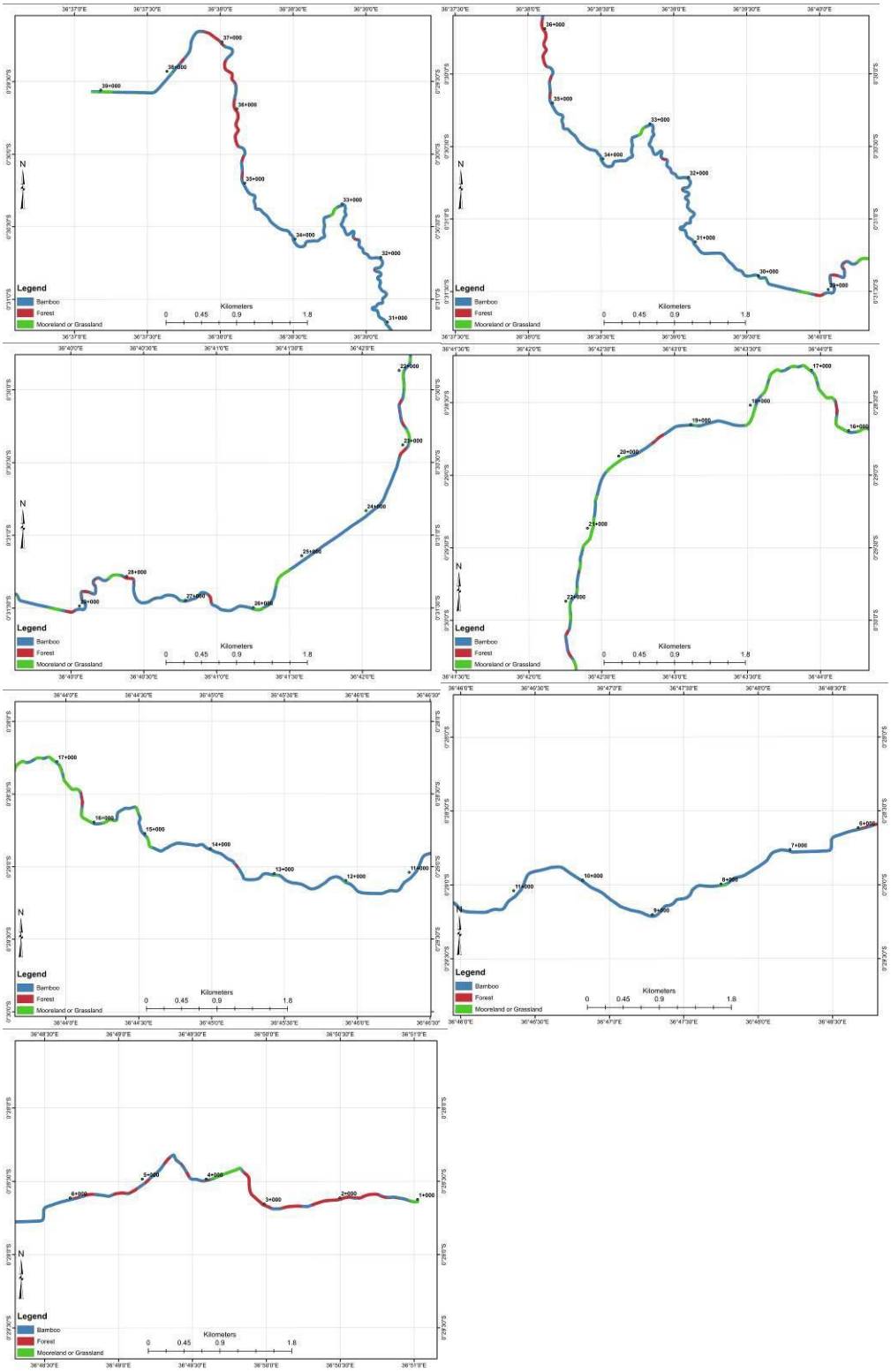
A total of 199 species of plants were identified along the proposed road project. This is out of 1260 vascular plants recorded in the Aberdare Ranges and its environs. Most of the species are in the protected areas which include the Forest Reserve and the National Park. Some of the plants are aquatic; adapted to wetland conditions, growing along the streams and on wetlands (natural and artificial).



v. Vegetation cover and the above-ground carbon

An approximated area of 156 hectares along the existing road is under the project footprint; while an area for the current existing road is estimated at 52 hectares. Around 104 hectares of vegetation is lying on areas that will potentially be cleared. Out of this, 75 hectares of bamboo will be destroyed, 14 hectares of forest, and another 14 hectares of mooreland will potentially be destroyed. In terms of distance stretch along the proposed road, total stretch of 28 km of the proposed road in the protected areas is aligned to bamboo vegetation zone. The total length of the proposed road aligned to the forest areas (indigenous and exotics) is 5km and another 5 km of the road aligns in the moorelands.

The three main land cover land use has an enormous amount of the above-ground carbon/biomass. The forest area has an estimated biomass ranging from 85 – 169 Mg ha^{-1}. The Bamboo area has an estimated mean biomass of 86 Mg ha^{-1} with the lowest range of 65 to 114 Mg ha^{-1}. Mooreland has an estimated mean biomass of 19 Mg ha-1; biomass in the land use ranges between 7 to 32 Mg ha^{-1}. Thus, the proposed road alignment passes through an area with an estimated total biomass of 5,662 Mg ha^{-1}; mooreland 177 Mg ha-1, bamboo 4,300, and Forest has 1185 Mg ha-1.



Nyeri Spur Roads

Plant species occurrence in along the proposed Nyeri Spur Roads is estimated to about 95 species. Most of the plant species recorded are from the order Poales which constitute grass families Poaceae, which constitute 35% of plant species recorded. This is followed by the Order Asparagales (11%) and Fabales 8% of the species recorded. The landscape has low plant richness of woody species but relatively moderate with herbaceous plants in few areas (Fig. 4-15 and 4-16). Woody plants in the area are mostly exotic planted as hedges running along the

proposed road. *Cirsium vulgare* is an invasive weed that already occur on the road reserve of Amboni – Ark Gate; its spread is easily facilitated by wind dispersal. Other invasive species recorded were *Parthenium hysterophorus*, *Opuntia monacantha*, *Acacia mearnsii*, *Caesalpinia decapetala*, *Lantana camara*, and *Datura stramonium.*

Conservation status of the plant species recorded only highlights about 33% of the species that already are assessed. Most of these species are listed under Least Concern (LC); while only one species, *Jacaranda mimosifolia*, was found to be Vulnerable (VU) in the IUCN Red list of Threatened Species. This species was sited along Amboni – Ark Gate; however, situated off the fence running along the road reserve.

Cyperus exaltatus

Ludwigia adscendens

***Caesalpinia decapetala* (In**

Datura stramonium

Figure 13-15 Some of the observed plant species within proposed Nyeri spur road

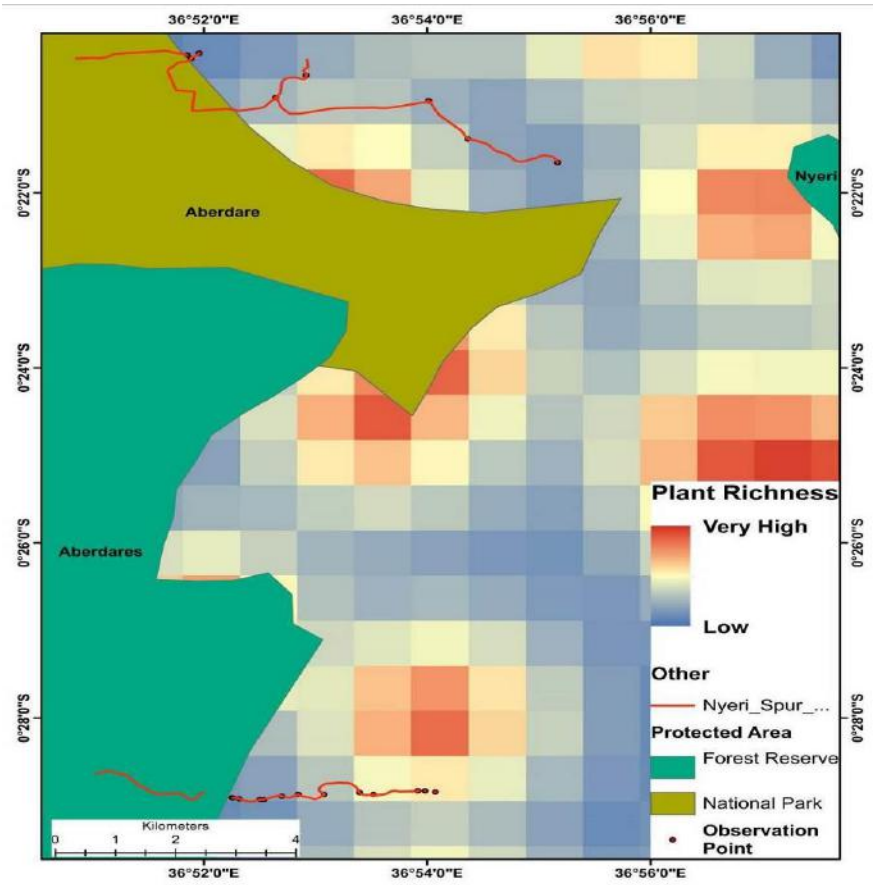


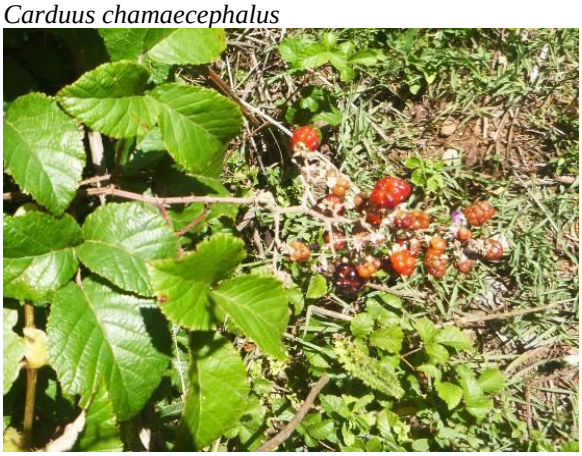
Figure 13-16 Plant species richness hotspot in Nyeri county spur roads

Nyandarua Spur Roads

The recorded number of plant species along the Nyandarua Spur Roads is about 166 species. Most of the plant species recorded are in herbs, grass and shrub cluster families; constituted by the aquatic plants and terrestrial plants. Aquatic macrophytes occur along the streams, wetlands/swamps, clogged trenches along the existing roads, in waterpans and ponds in the adjacent farms. This group include the *Azolla*, *Potamogenton*, *Kyllinga*, *Cyperus*, *Typha* sp. The *Azolla* sp. can be spread in the region by attaching on wetland birds that deposit them in different wetland habitats. Dominant terrestrial plant species (25%) are mainly from the Order Poales; this is a group of plants consisting of grasses. This is followed by the Order Polypodiales (mainly fern species) and Malpighiales (constituting some flowering shrubs & lianas). Woody plants in the area are mostly exotic planted as a hedge or woodlot on farms. *Carduus chamaecephalus* is an invasive weed that affects paddocks and farm productivity; its propagules are spread easily by wind. Most of the species are from grass, herbs and shrubs (lianas) which none of them is listed under the IUCN red list of threatened species. Plant richness hotspot including cover occurs along Joma – Weru road, Koinange and near Heni; very low richness hotspot occur along Kahuruko – Ndunyu Njeru proposed road (Fig. 4-17).

Carduus chamaecephalus

Azolla



Rubus keniensis

Solanum anguivi

- Figure 13-17 Some of the observed plant species within proposed Nyandarua spur road

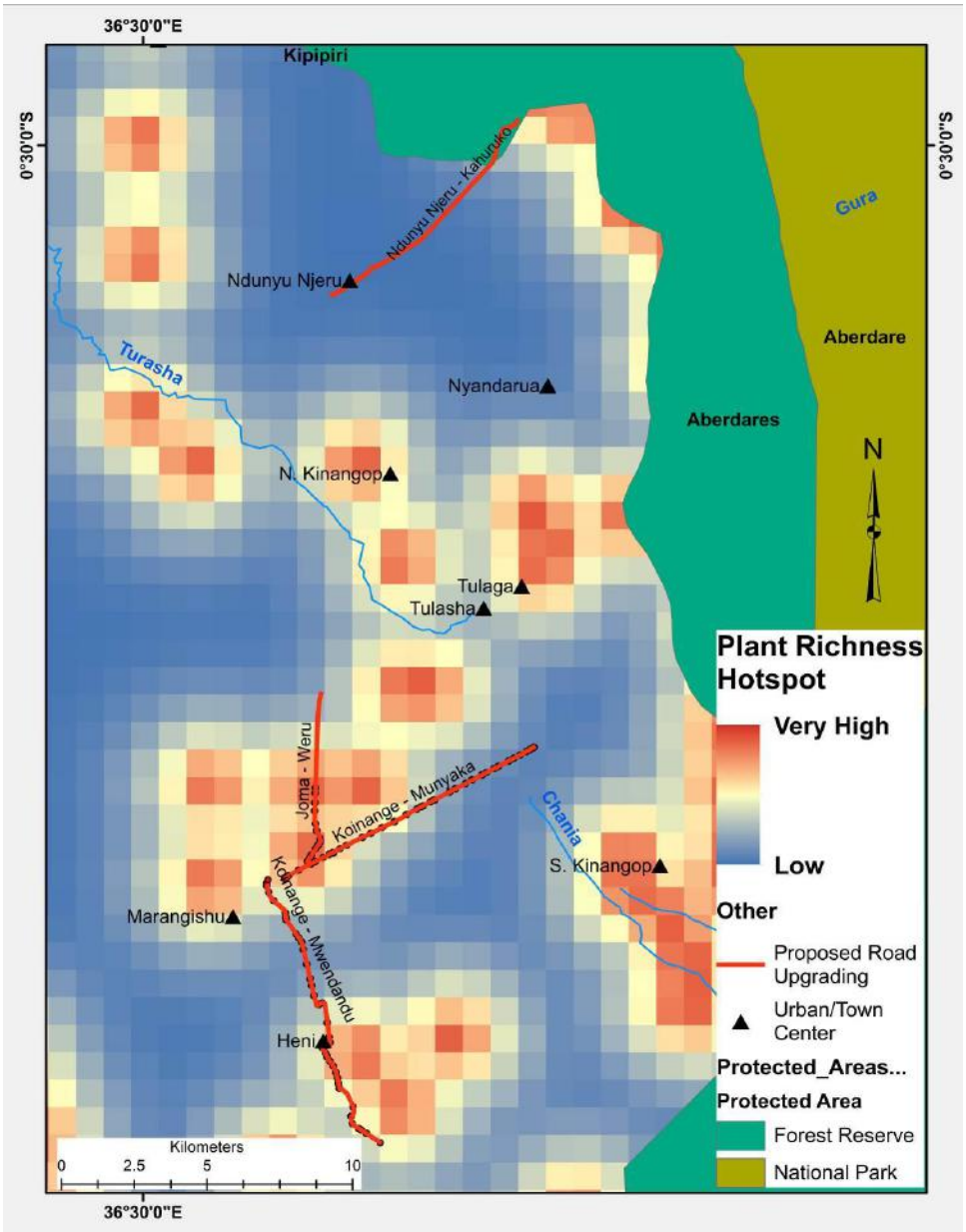


Figure 13-18 - Plant species richness hotspot in Nyeri county spur roads

vi. Herpetofauna Diversity

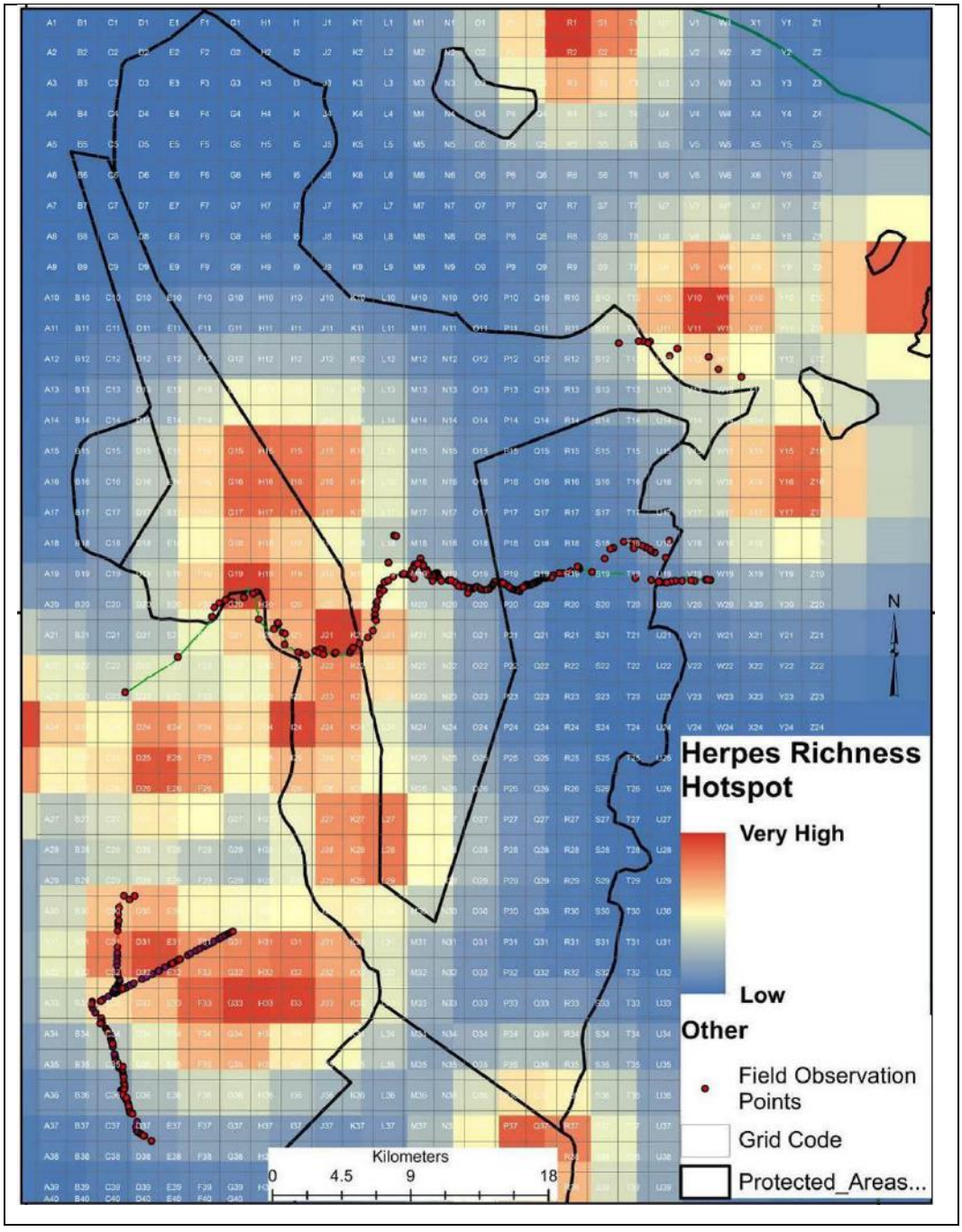
Aberdare forest

Aberdare forest in an important site for the conservation of the Kenya's herpetofauna, the forest holds several species of snakes, lizards and frogs some of which are endemic to Kenya. Some of the already sighted herpetofauna in the forest include: Montane Viper (*Montatheris hindii*) this is a small terrestrial venomous viper species endemic to the high-altitude moorlands of the Aberdare Mountain range. Currently this species is threatened by frequent fire incidents in the moorlands. This snake has the smallest range of all the poisonous snakes in Africa. Kenya horned viper (*Bitis worthingtoni*) this is endemic to Kenya and only found in the Aberdare Forest. Kenyan side stripped chameleon (*Chameleon schubotzi*), Von Hohnels chameleon (*Chamaeleo hoehneli*), Mt. Kenya Hornless chameleon (*Bradypodion excubitor*), Montane tree frog (*Hyperolius montanus*), Kinangop puddle frog (*Phrynobatrachus kinangopensis*) only known from the Aberdare moorlands. De wittes sharp nosed montane frog (*Rana wittei*),

Richard tree frog (Hyperolius cystocandicans), Alpine meadow skink (*Mabuya irregularis*) and Alpine Meadow Lizard (*Adolfus alleni*).

The wider Aberdare landscape has an estimated 28 species of herpetofauna. Reptile species constitute 57% of the herpetofauna species; while, amphibians forms about 43%. Reptiles were mostly observed on areas with rocks and stones, and on the stems of plants (mostly large trees). Amphibians occur mostly in moist places; along the streams in inhabited areas and inside the forest, and wetlands along the proposed road project. About five herpes species are currently listed in the IUCN Red List of threatened species. Two species are vulnerable (VU) and three are Near Threatened (NT). Areas with high herpetofauna diversity (richness) occur majorly in the Forest Reserve which occurs in western side of the Aberdare. Besides observations in the forest reserve, there are areas in the inhabited landscape with a considerably higher richness of herpetofauna. Hotspot areas for herpes richness in project alignment are conspicuous between Kiondogoro – Mutubio Gate within Grid Code J21/2, K21/2 occuring in the Protected Area, Mutubio Gate – Kahuruko within Grid Code G20 & H20 within Forest Reserve. While in the inhabited areas herpetofauna hotspots occur between Munyaka – Koinange within Grid Codes D32 & E32, and Joma – Weru within Grid Codes C31/2 (see map below).

Figure 13-19: Herpetofauna in aberdares



Nyeri Spur roads

Herpetofauna consist of amphibian and reptile species. Most of the herpetofauna species in Nyeri Spur Roads are formed by the amphibians than reptiles. A total of 21 species were recorded; 52% is formed by the reptile species and the remaining are amphibian species. There are few streams passing through the proposed project area which provide habitat for amphibian species. Reptile species mostly observed along the live fences running along the road reserve (Fig 4-20). Their habitats also include large trees on the fences, bottom of stones. All herpetofauna species recorded are listed under the IUCN Red List of Threatened Species as Least Concern (LC). Road sections with considerably high herpetofauna richness are Amboni – Tree Top – Njegu and Amboni – Ark Gate section (see map below); the section of Mukarara - Ihithe has very low richness of herpetofauna (Fig. 4-21).

Trioceros jacksonii Tadpoles sampled from water pool

- Figure 13-20 Some of the observed herpetofauna species within proposed Nyeri spur road

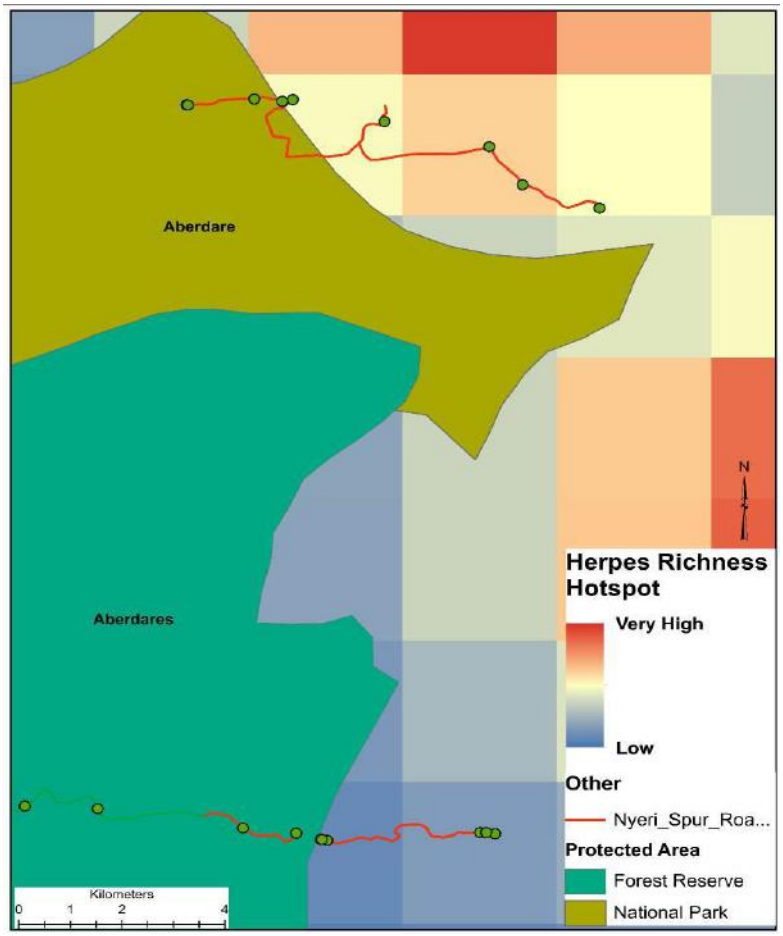


Figure 13-21 Herpetofauna species richness hotspot in Nyeri county spur roads

Nyandarua Spur Roads

Most of the herpetofauna species in Nyandarua Spur Roads are formed by the amphibians than reptiles. A total of 21 species were recorded and out of this 76% are amphibian species; the remaining are reptile species (Fig 4-22). The dominant habitat in the project area is wetland habitat that favours breeding and growth of amphibians. However, there are very few natural habits for reptiles such as rocks and stones along the proposed road alignment. There are areas with a considerably higher richness of herpetofauna. Hotspot areas for herpes richness in

project alignment are occur between Munyaka – Koinange, and Joma – Weru (see map below) (Fig. 4-23).

Flap-necked Chameleon (*Chamaeleo dileps*) *Ptychadena mascareniensis*

- Figure 13-22 Some of the observed herpetofauna species within proposed Nyeri spur road

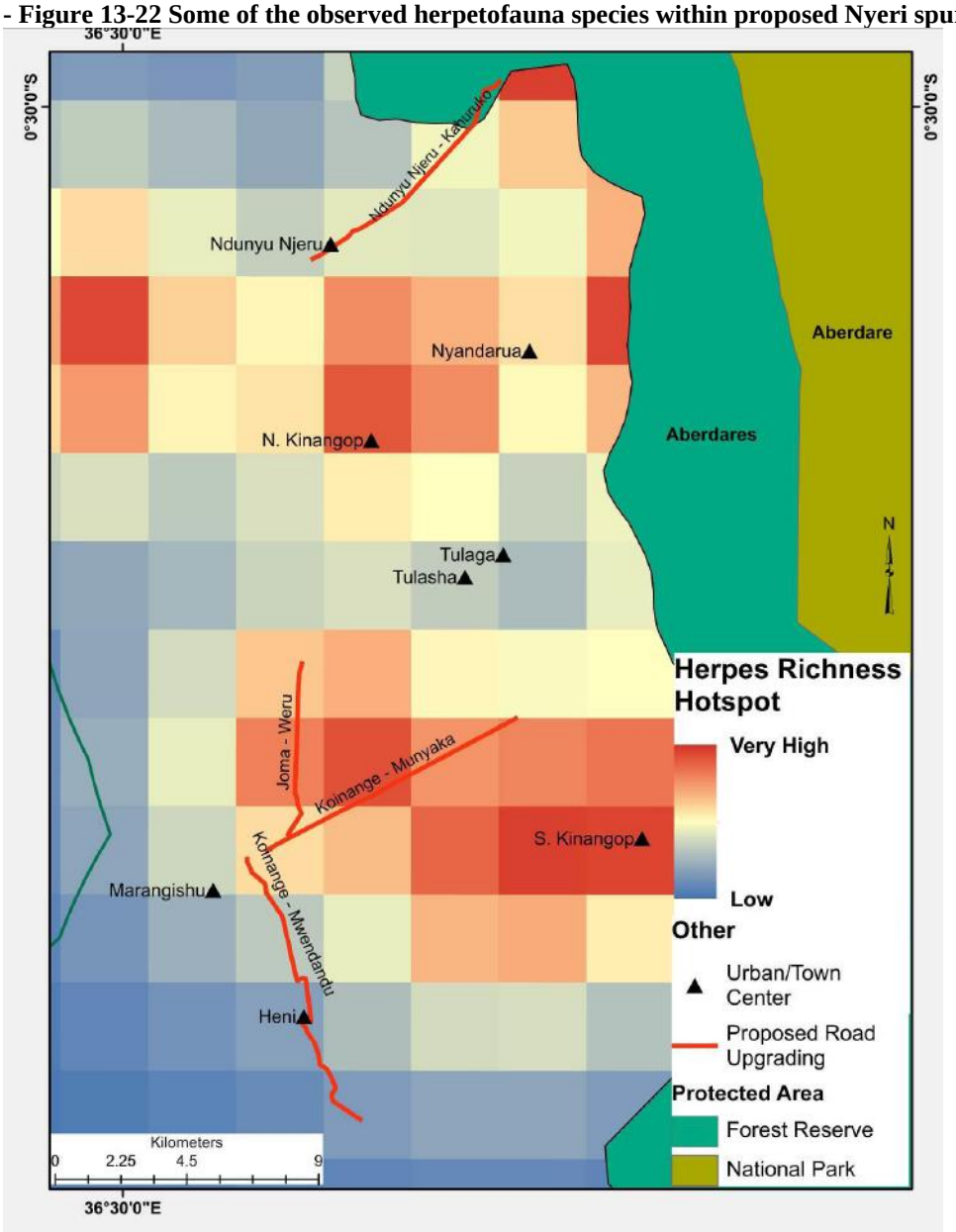


Figure 13-23 - Herpetofauna species richness hotspot in Nyandarua county spur roads

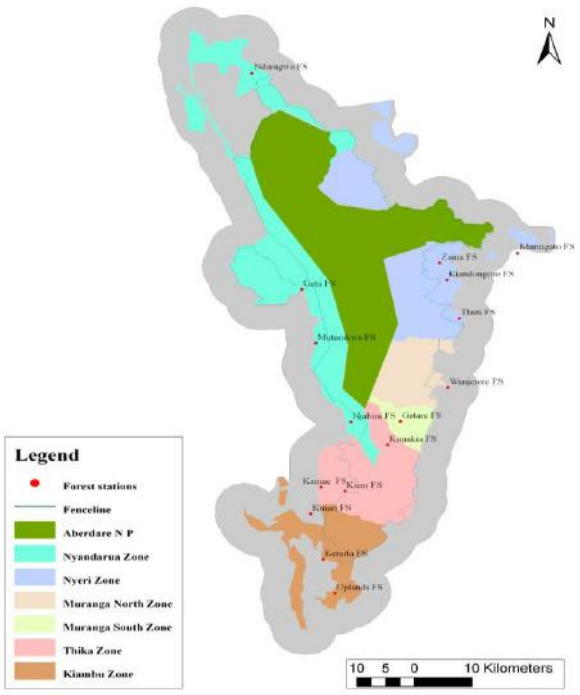
D. Aberdare Ecosystem (AE) Management Plan

The mountain ecosystem range covers a protected area of about 2,162 km^2. This consist of Aberdare (9,926.5 km^2), Kikuyu Escarpment (3,633.5 km^2), Kipipiri Forest Reserves (3,900 km^2), and Aberdare National Park (7,670.7 km^2). Also included in this ecosystem is Lake Ol bollosat and the surrounding riparian system. The calculated area of the ecosystem covers ragged terrains with deep valleys, gorges and hills with wide altitudinal range (1800m-4001m).

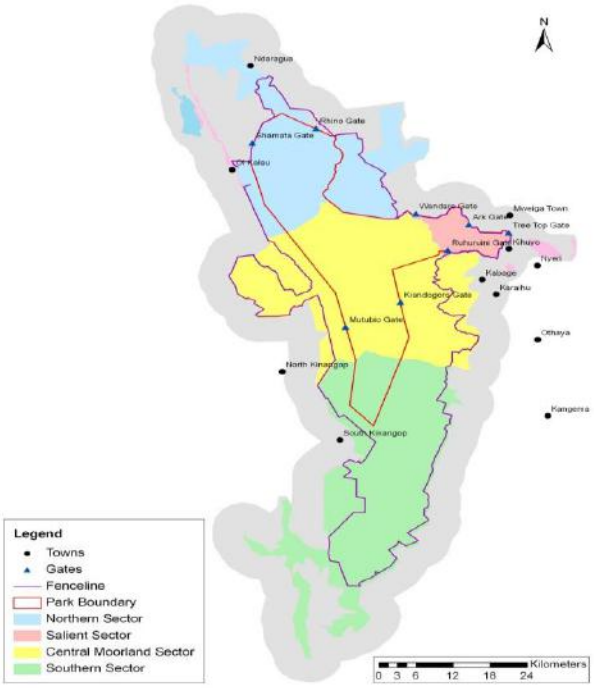
i. Management zoning

The AE is zoned in accordance with management and administration needs of both Kenya Wildlife (KWS) and Kenya Forest Service (KFS), and land use potential of the area. The ecosystem's management and use zoning are discussed in the following sections. The KFS divides the ecosystem into six management zones which are aligned with administrative district boundaries. KWS on its part has divided the ecosystem into four management zones (or sectors) that are largely based on ecological as well as tourism development considerations (see maps below).

KFS Management Zones



KWS Management Sectors



ii. The AE use zoning

The AE use zoning is intended to apply different management prescriptions to different parts of the ecosystem in order to achieve the AE's purpose and management objectives. The primary goal of ecosystem zoning is to protect the water catchment value of the area while at the same time exploiting the ecosystem's resources sustainably. Zoning is primarily geared towards ensuring environmental sustainability and responsible tourism for the next 10 years, and include low impact and environmentally sensitive development, avoidance of development in critical water catchment areas, and conservation of wilderness. The AE use zoning is an integrated approach dividing the ecosystem into five distinct zones (i.e. High Use Zone, Low Use Zone, Wilderness Activity Zone, Multiple Use Zone and Influence Zone) which support the desired and legally acceptable land uses in the ecosystem. These land uses include tourism, biodiversity protection, forestry and its associated uses, such as livestock grazing and plantation establishment.

iii. Ecosystem Management Programmes

a) Ecological Management Programme: The purpose of the Ecological Management Programme is to ensure that AE threatened species and ecological processes are conserved, and ecosystem functioning restored and understood. AE threats include illegal logging, charcoal burning, illegal livestock grazing, poaching and wildfires. The key management areas creating elephant corridors, critical species habitat protection, monitoring Black rhino populations, Bongo surveillance, bush meat trade control, carnivore-prey relationships, and to minimize siltation of Lake Ol Bolossat and downstream.

b) Natural Forest Management Programme: The purpose of this programme is to ensure that natural forests are sustainably managed for provision of wood and non-wood forest products, and environmental, socio-economic services. Several management actions have been developed relating to development of management plans for forest stations; carrying out natural resource assessments; regulating utilization of non-wood forest products; establishing livestock carrying capacity; controlling charcoal burning and illegal logging; developing and implementing a forest restoration action plan; carrying out enrichment planting and lobbying for harmonization of conflicting policies e.g. the forest act which allows grazing while water act advocates for protection of the water catchment.

c) Plantation Forest Establishment and Management Programme: The Plantation Establishment Livelihood Improvement Scheme (PELIS) is designed to establish industrial forest plantations and increase efficiency in wood utilization for wealth and employment creation. The PELIS model ensures that the participating community is held responsible for the success or failure of the scheme. The key management actions focus on: increasing output from KFS tree nurseries to meet the demand for plantation backlog; supporting establishment of tree nurseries in community adjacent areas; converting fenced-in exotic plantations to natural forest; supporting plantation establishment through PELIS; protecting PELIS sites from game damage; developing detailed operational plans for forest plantations; establishing forest plantations based on market demands; carrying out scheduled silvicultural activities in the plantations; monitoring tree pests and diseases; and demarcating forest boundaries to prevent encroachment.

d) Farm Forestry Management Programme: The purpose of the Farm Forestry management Programme is to promote farm forestry to increase tree cover for sustained timber, wood fuel, non-wood forest products and environmental conservation. KFS has established a farm forestry programme to support and facilitate farmers to raise trees and forest products in their farms and by so doing ease pressure on gazette forests. The farm forestry programme focuses mainly on provision of farm forestry extension services in the influence zone located within a 5 km distance from the forest boundary. The activities undertaken include; providing technical assistance to communities on nursery establishment, and advising farmers on suitable species for farm forestry, tree planting techniques and tree husbandly.

e) Water Resource Management Programme: The primary purpose of this programme is to ensure that water resources in the Aberdare ecosystem are protected, conserved and utilized judiciously, to meet domestic, agricultural, and industrial needs of the present and future generations. The management objectives focus on enhancing protection and conservation of AE's water catchment areas; improving allocation of water resources; and monitoring water quantity and quality in collaboration with stakeholders. Key management actions include development and implementation of sub-catchment management plans and Water Allocation Plans (WAPs) to regulate water abstraction.

f) ***Tourism Development and Management Programme***: The purpose of this programme is to ensure that AE is providing a wide range of unique, sustainable tourism experiences capitalizing on the ecosystem's special wilderness values, opportunities for solitude, and unique history. The key management actions focus on identifying and awarding tourist facility concession sites, rehabilitating Bandas, upgrading public campsites, upgrading and maintaining tourist roads, establishing and maintaining nature trails, hiking routes, horse safaris, and a visitor centre.

g) ***Community Partnership and Education Programme***: This program is designed to ensure the adjacent communities are supporting conservation efforts and community livelihoods are improving through sustainable use of natural resources. This can be achieved by 1) reducing human-wildlife conflict incidences; 2) improving community benefits from the AE; 3) improving AE Community conservation awareness, and 4) PA-community communication. Key management actions include: creating awareness on the importance of the electric fence; maintaining the electric fence; supporting establishment of viable tourism related community projects; supporting establishment of a Guides and Porters Association; providing employment opportunities to PA-adjacent communities; supporting community conservation and social projects to improve livelihoods; promoting the carbon credit programme; establishing wind farms to produce electric power; establishing a conservation education centre with hostels at Bondeni; and establishing and equipping a mobile outreach unit.

h) ***Security Management Programme***: This programme aims to ensure that the AE and surrounding community areas are secure for visitors; and natural resources are protected from illegal exploitation. Some of the major security challenges include; boundary encroachment, illegal water abstractions, marijuana cultivation, accidental forest fires, poaching of wild animals, illegal logging, and visitor insecurity. Majority of the illegal activities are carried out by members of the forest-adjacent community. The management actions on security focus on carrying out Joint patrols, developing a security database, procuring modern security equipment, carrying out a strategic re-organization of stations and sectors to cover the AE effectively, training staff in emerging conservation concepts and technologies, creating awareness among members of the judiciary and police on the importance of the ecosystem, establishing a Joint fire station, establishing an Intensive Protection Zone (IPZ) for rhinos, improving fence security, and carrying out regular de-snaring operations. In addition, modern security technology e.g., camera-based surveillance system will be adopted and intelligence systems enhanced.

i) ***Protected Area Operations Management Programme***: The purpose of this programme is to ensure that operational systems are effectively and efficiently supporting the implementation of AE's management programmes. The management systems are designed to facilitate the decentralization of management to the sectoral and station level, harmonize KWS and KFS spatial administrative zones, harmonize the gate management between KWS and KFS and establish an effective communication system are required to achieve the prorgamme purpose.

Implementation of the AE's Protected Area Operations Programme is guided by the following principles: strengthening stakeholder collaboration; enhancing staff welfare and motivation; and providing effective and efficient management infrastructure. The key management actions under this management programme include; establishing effective communication between KWS and KFS, reviewing existing KWS/KFS MoU, sharing management resources to enhance AE management, developing and implementing MoUs with Rhino Ark and other NGOs, developing and reviewing existing concessions and

agreements, establishing the Aberdare Trust, carrying out Joint training programmes, establishing a Resource Centre; constructing and rehabilitating AE buildings, constructing and maintaining the AE road network, rehabilitating and maintaining airstrips, improving the telecommunication network, rehabilitating fire towers; establishing a fire and rescue centre at Mweiga to serve other areas, and procuring and maintaining plants, vehicles and equipment.

j) Plan Monitoring

The plan monitoring framework is designed to provide guidance for the assessment of the potential impacts resulting from the implementation of each of the seven management programmes. The framework sets out the desired positive impact of each programme's objectives, as well as any potential negative impacts that may possibly occur. Also included in the framework, are easily measurable and quantifiable indicators for assessing these impacts, and potential sources of the information needed.

E. Biodiversity hotspot

Aberdare Forest

Biodiversity hotpots in the Aberdare and its environs where the Mau Mau Lot4 project is based on are areas considered to have potentially high species richness on the landscape. Species richness is a combination of richness in major taxonomic groups that are involved in this study; thus, birds, herpetofauna, mammals, invertebrates and plant richness. Very hot areas with relatively very high species richness along the proposed road alignment occur on the Njegu - Tree Top – Amboni (12 km), and Ark Gate Access 2 km (grid code U12, V12, W12/3 & X13). Biodiversity richness in this section is influenced mostly by birds, invertebrates and small mammals. In addition, the habitat is characterized preserved indigenous trees in inhabited landscape and nearness to the forest plays a great influence on the distribution of the above-mentioned taxa. The road section between Kiondogoro to Mutubio KWS Gate has a considerable area with very high species richness; these areas occur on grid codes K21, L21, L20, L19, M19 and N19. Very high hotspot area is contributed by very high richness of plants, birds, herpes, invertebrates, and mammal species. Habitats occurring within this section of the road and the nature of management protection conferred provide a suitable environment for the survival of major taxa; hence, has higher species richness.

A number of species are threatened to conservation occur in the biodiversity hotspot. These are mostly from mammals, herpetofauna, and birds (see Table 4-12). The most conspicuous along the proposed alignment is the African Elephant (VU) which was recorded mostly by its droppings that concentrates along the current existing road.

Table 13-12 Species classification

Order	**Family**	**Species: Scientific Name**	**IUCN Status**
Herpetofauna			
Anura	Bufonidae	*Mertensophryne lonnbergi*	VU
Anura	Phrynobatrachidae	*Phrynobatrachus kinangopensis*	VU
Squamata	Lacertidae	*Adolfus masavaensis*	NT
Squamata	Scincidae	*Trachylepis irregularis*	NT
Squamata	Viperidae	*Montatheris hindii*	NT
Mammals			
Artiodactyla	Bovidae	*Syncerus caffer*	NT
Artiodactyla	Bovidae	*Tragelaphus eurycerus*	NT
Carnivora	Felidae	*Panthera pardus*	VU

Carnivora	Mustelidae	*Aonyx capensis*	NT
Proboscidea	Elephantidae	*Loxodonta africana*	EN
Perissodactyla	Rhinocerotidae	*Diceros bicornis*	CR
Birds			
Accipitriformes	Accipitridae	*Aquila nipalensis*	EN
Accipitriformes	Accipitridae	*Aquila rapax*	VU
Accipitriformes	Accipitridae	*Circus macrourus*	NT
Charadriiformes	Glareolidae	*Glareola nordmanni*	NT
Gruiformes	Gruidae	*Balearica regulorum*	EN
Passeriformes	Acrocephalidae	*Calamonastides gracilirostris*	VU
Passeriformes	Malaconotidae	*Laniarius mufumbiri*	NT
Passeriformes	Parulidae	*Setophaga striata*	NT
Invertebrates			
Odonata	Chlorocyphidae	*Platycypha auripes*	EN
Odonata	Coenagrionidae	*Pseudagrion bicoerulans*	VU
Odonata	Gomphidae	*Notogomphus maathaiae*	EN
Odonata	Gomphidae	*Phyllomacromia pallidinervis*	NT

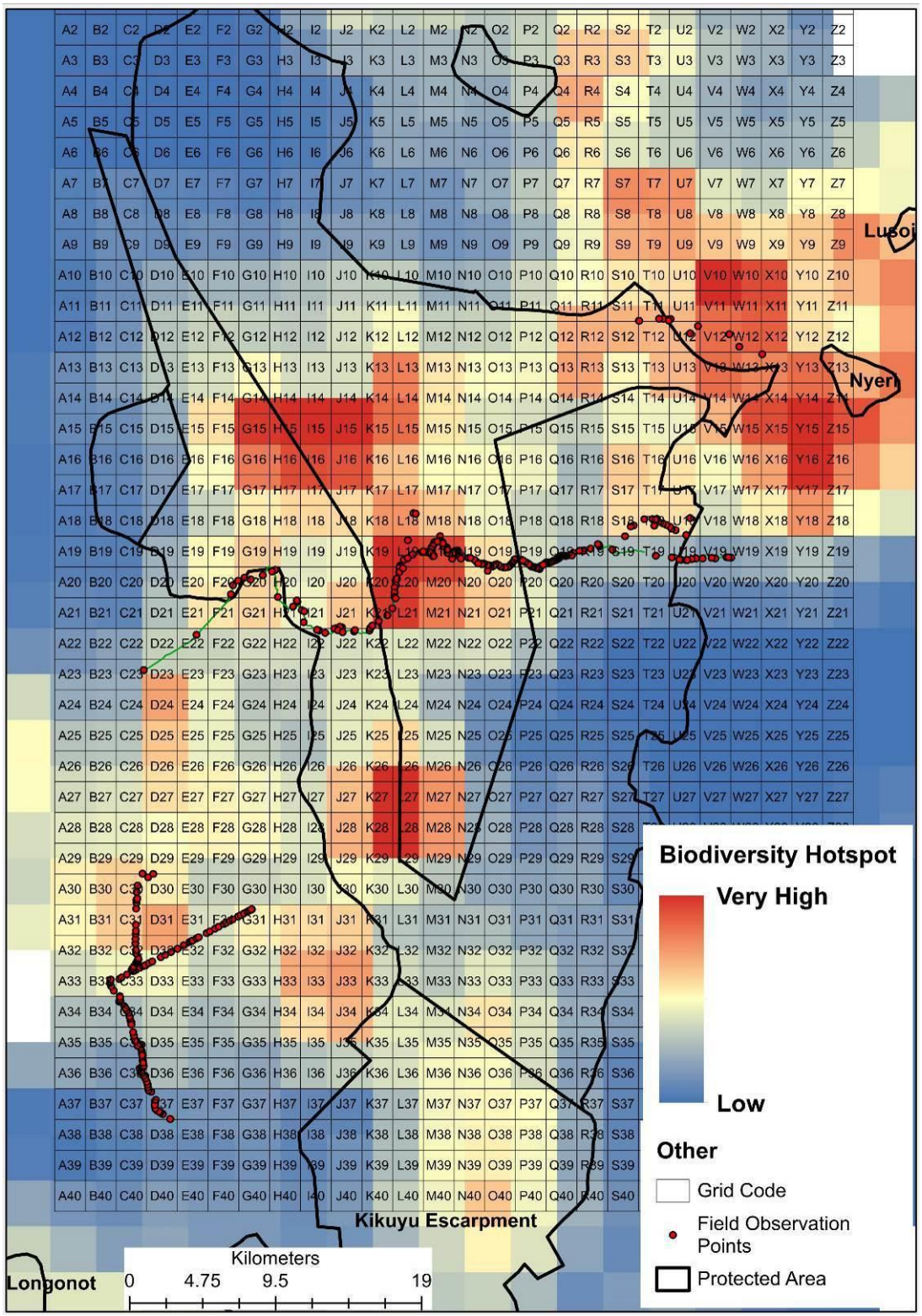


Figure 13-24 Biodiversity hotspot in Aberdare forest.

Nyeri Spur Roads

Biodiversity hotpots in Nyeri Spur Roads is high on Amboni – Tree Top – Njegu section (Fig. 4-23). This section is adjacent to the Aberdare National Park which probably influences the hotspot. That is, the section has relatively high number of flora and fauna species compared to the section of Mukarara – Ihithe. Species richness is a combination of richness in major taxonomic groups that are involved in this study; thus, birds, herpetofauna, mammals, invertebrates and plant richness. Biodiversity richness in this section is influenced mostly by

birds, plants and invertebrates. Despite existence of relatively hot species richness, only one species observed, the Grey-crowned Crane (*Balearica regulorum*), is enlisted in the IUCN red list of threatened species as Vulnerable.

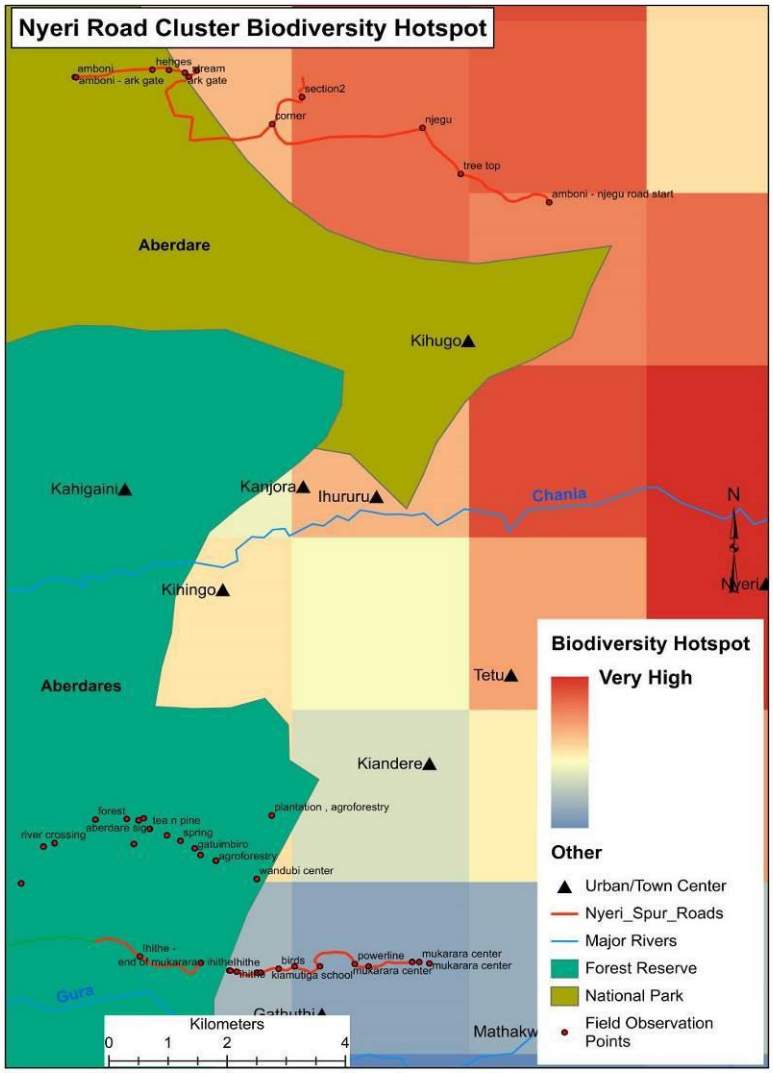


Figure 13-25 Biodiversity hotspot in Nyeri county spur roads

Nyandarua Spur roads

Biodiversity hotpots in Mau Mau Lot4 Nyandarua Spur Roads is based on areas considered to have potentially high species richness on the landscape. Species richness is a combination of richness in major taxonomic groups that are involved in this study; thus, birds, herpetofauna, mammals, invertebrates and plant richness. Areas with relatively hot species richness occur between Koinange – Munyaka (Fig. 4-26). Biodiversity richness in this section is influenced mostly by birds, plants and invertebrates. The area is characterized by wetland habitats that provide a conducive habitat for birds, and invertebrate species. Despite existence of relatively hot species richness, only one species observed, the Grey-crowned Crane (*Balearica regulorum*), is enlisted in the IUCN red list of threatened species as Vulnerable.

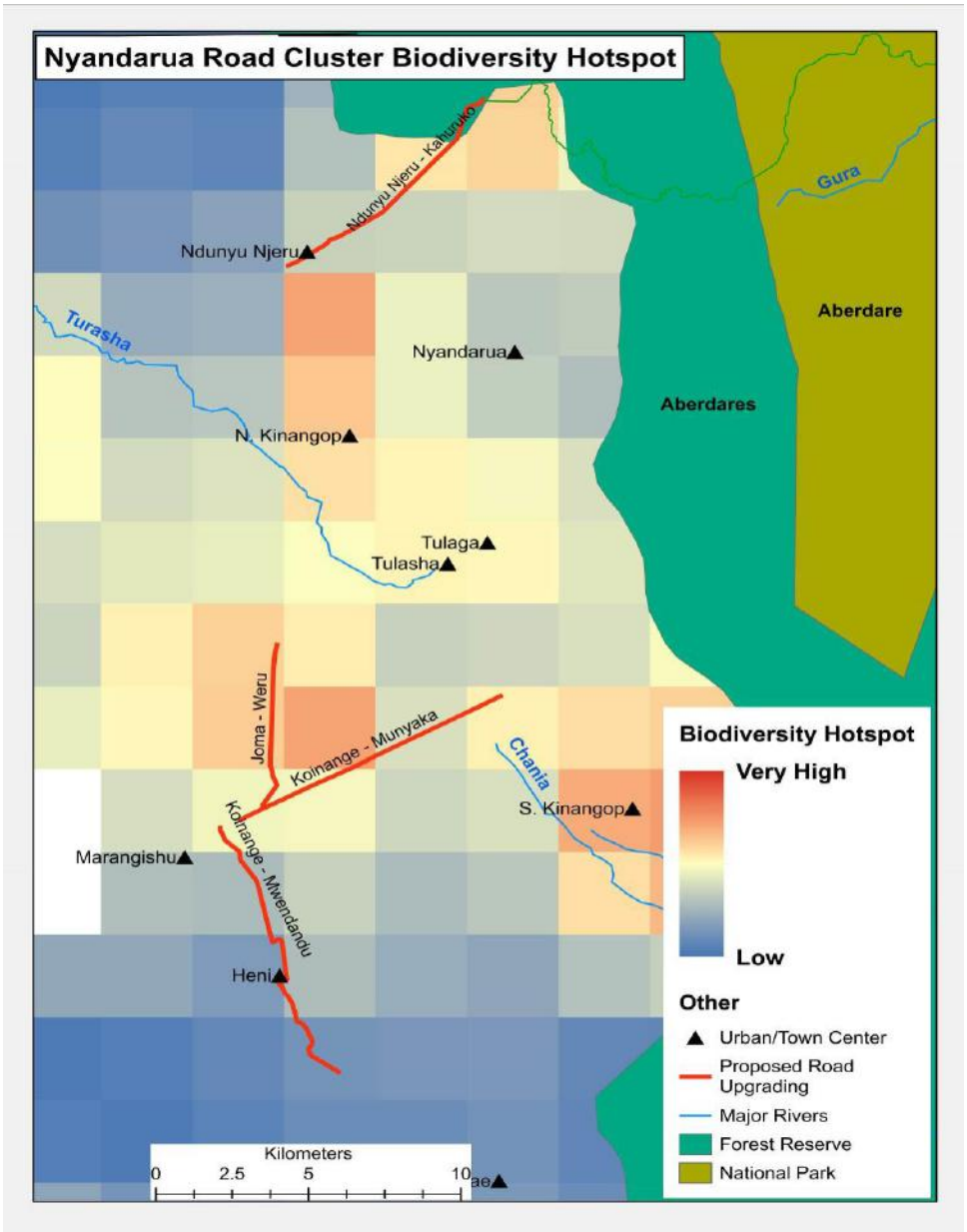


Figure 13-26 - Herpetofauna species richness hotspot in Nyandarua county spur roads

F. ECOSYSTEM SERVICES

i. Introduction

Structured questions were developed for the stakeholders' meetings to help in identifying how the construction of the proposed Mau Mau Lot 4 roads may have effect on the ecosystem services the locals are getting from the environment. With the help of the locals, we identified the major ecosystem services in the area, their location, beneficiaries and how the construction of the proposed roads might affect their use/ accessibility.

In order to go through all the ecosystem services, we divided the ecosystem services into three categories: provisioning services, regulation services and cultural services.

Provisioning services entails: agricultural potential and production, livestock and forage resources, fishery resources, hunting and bush meat, construction materials, lumber and craft, biofuels, natural food products, traditional medicine and water resources.

Regulation services include: air quality control, climate regulation, water regulation, water purification and treatment, soil erosion control, disease and pest control, pollination and control of natural disasters.

Cultural services include: sacred elements, recreation and tourism. Detailed contents of the questions for each and every ecological service are as shown in the attached Appendix I.

The meetings were held between dates 1st March 2022 to 4th March 2022 at different locations, at each and every meeting major issues raised were recorded and photos of the meeting were captured as shown in Appendix II.

ii. Amboni Meeting: Treetop -To- Amboni Section

The meeting was held on 1st March 2022 in the morning at Amboni chief camp.

Major concern: Drainage issue, accessibility of the road during construction and compensation of damaged properties.

Provisioning Services

Agricultural potential and production

Crops grown by the locals include: sweet potatoes, maize, beans, coffee, bananas, and nippier grass. Most of these crops are grown for subsistence except for the coffee and sweet potatoes which are for commercial purposes. All family members are involved in doing the work. Farming areas are on the individual owned plots and not on the forest reserves. The locals rely on the rain for farming. Planting is between March and April while harvesting is in August and September. Reduced soil fertility is the major challenge for the farmers.

Livestock and forage resources

Animals kept in the area are: goats, sheep, pigs, poultry (chicken, duck and turkey) and dairy (Friesian, Ashire and jersey). The locals are practicing zero grazing and paddocking hence no movement of the animals over long distance or into the forests. The animals are feed on natural fodders collected from within the farms. Some farmers are growing nippier grass for their livestock within the road reserves. Milk produced is sold to farmers' co-operative coolers. There are plenty of fodders during the harvesting periods. The animals are sold to meet the family needs especially when paying the school fees.

Fishery resources

No any fishery activity in the area.

Hunting and bush meat

The locals stated that hunting is prohibited in the area and there is no hunting activity. The Kenya Wildlife Service (KWS) through engagement with the local administration has ensured that no hunting activity is going on in the region.

Traditional medicine

Two species of plants were identified to be of medicinal value to the people of Amboni: these are "Muiri tree"- for treating allergy and "Mwarubaine tree"- for treating malaria. They use both the back and leaves of these trees. "Muiri tree" is randomly spread within the forest areas

and home steads while “Mwarubaine” is only found within homesteads. These medicinal plants are not for sale.

Construction materials

Amboni people construct their houses using timber; these timbers are harvested from individual farms since harvesting from the forest is prohibited. Tree species used are: cypress, pine and blue gum. Harvesting of these trees for construction depends on individual needs and can be done at any time of the year. Locals with tree plantations near the proposed road site requested to be compensated in case of any damage. No harvesting of minerals within their location.

Lumbering

No lumbering activities in the forest area, but individuals with tree plantations in their farms do lumbering once the trees are mature. It’s done for commercial purposes

Biofuels

Energy sources are: firewood, charcoal and biogas. Firewood is collected by women and children from within the farms. Pruned tree branches are the major source of firewood and there is no tree species of target. ‘Mukidori tree’ is used for preparing charcoal, this is done by men. Biogas is also prepared from the cow dung.

Water resources

River Gathabala / Ruhotie are the major source of water for the Amboni people. This water is trapped and channeled to tanks at Ark gate then piped to homes. The water flows naturally by gravity and no treatment is done to it. The pipes cross the road at Ark gate and at Kiguro primary. The water is dirty during the rainy seasons while during dry season it’s clean. The locals stated that the proposed road construction is likely to disrupt their water supply especially at the points where the water pipes crossed the road (Ark gate and at Kiguro primary). The water is used for all domestic activities and for the livestock.

Regulation Services

Air quality control

The locals noted that they have not seen any change in the air quality since their area has plenty of trees, but they anticipated that once the construction starts the air will get polluted with dust. To reduce this impact they requested the contractor to regularly sprinkle water to reduce dust produced from the construction site.

Climate regulation

Amboni people noted that amount of rainfall being received has decreased as compared to earlier years, dry season has also increased. They could not identify the reason why this is happening yet they have planted a lot of trees within their farms and homesteads.

Water regulation, purification and treatment

The amount of water received in the area vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is less but very clean. The Aberdare Forest and trees planted within the farms are the main reasons why the area receives a lot of rainfall. The piped water and river water is not treated.

Control of erosion and soil quality

Erosion in the area is influenced by the slope and vegetation cover. Soil erosion is very minimal in the area except at ArK gate region which has very steep slope. Areas where the locals have planted nippier grass and trees do not experience any soil erosion.

Diseases and pests control

Major pests are mites and stalk borer, the pests in the area have decreased and they suspect this is as a result of climate change. The members stated that proposed road construction will not have any effect on the pests in the area

Pollination

The locals stated that the area has variety of birds that are helping in pollination, but still on top majority of them are bee keepers which is also playing key role in the pollination. So far, they have not noticed any change in the production of crops that relies on pollination.

Control of natural disasters

The area receives hailstone once in a while which damages their crops whenever it occurs. The locals stated that whenever it rains, the field at Kiguru primary gets flooded with the storm water, due to this the locals stated that the contractor should put proper drainage channel on both sides of the road to avoid flooding of the neighboring homes and farms.

Cultural services

Sacred elements

There are two tree species that are considered sacred by the community, that's the Mugumo and Mukuyu tree. The locals stated that there is no any species of these two trees along the proposed road site.

Recreation and tourism

This only takes place within the Aberdare Park which is controlled and managed by the KWS, locals stated that they don't get any direct benefit from it as most tourist goes direct into the park without transacting any business with them.

The locals requested the contractor of the proposed road to put diversions/ access paths and culverts near churches, schools, hospitals and market canters to facilitate their accessibility to the services in these areas.

iii. Ihithe Meeting: Ithithe – To-Mukara Section

The meeting was held on 1st March 2022 in the afternoon at Ihithe shopping centre.

Major concern: Drainage, accessibility and compensation

Provisioning Services

Agricultural potential and production

Major crops grown in the area include; avocado, coffee, tea, sweet potatoes, maize, beans, bananas, nippier grass and arrow roots. crops grown for commercial purposes are; Avocado, sweat potatoes, coffee and tea while the rest are for family consumption. All family members are involved in doing farming work. Farming areas are on the individual lands not on the forest reserves. The locals rely on the rain for farming. Planting is between March and April while harvesting is in August and September. The locals use commercial fertilizers and compost manures on their farms to increase the yield.

Livestock and forage resources

Animals kept include: goats, sheep, and pigs, chicken, dairy (Friesian, Ashire and jersey), and rabbit. All these are for subsistence except the dairy. They practice zero grazing and paddocking hence no movement of the animals into the forests. The animals are feed on natural fodders collected from within their farms especially nippier grass and crop remains. Farmers neighboring Kiandongoro forest sometimes graze their animals within the forest or along the road reserves. Milk produced is sold to farmers' co-operative coolers at ihithe. There are plenty

of fodders during the harvesting periods. Animals are mostly sold to meet the family needs especially when paying the school fees and food

Fishery resources

Currently the area has two fish farms at Kiamutiga and Mukarara, these farms have only tilapia. These fish farms are managed by the community groups and they sell their produce within the community to diversify their food source. They are harvested only when fully mature using net. The proposed road construct will not have significant effect on the fish farming as most of the time these fish are feed on locally available food.

Hunting and bush meat

Ihithe people stated that hunting is illegal in the region and no one can risk doing it.

Traditional medicine

Trees used by the community for medications are ("Muiri tree", "Muringa tree", "mukarakinga tree"- all are used for treating allergy) and ("mwarubaine tree"- for treating malaria). These trees are randomly spread both within the forest and homesteads. They use both the back and leaves of these trees. They are not for sale; proposed road construction will not affect their use.

Construction materials

Timber is mainly used for building houses. Harvesting of timber is only from individual farms since harvesting from the forest is prohibited, no harvesting of minerals within their location. Tree species being used are: cypress, pine, blue gum and cider tree. Harvesting depends on individual needs and can be done any time of the year. Few individuals are getting their building materials from Kiandongoro forest even though it is illegal.

Lumber and craft

No lumbering from the forest but people with tree plantations on their lands can cut down and sell to their neighbors after getting permit from the Kenya forest service. The proposed road construction might have some effect on the tree plantations near road site. The stakeholders requested the contractor to compensate the owners of trees which might be damaged during the road construction work.

Biofuels

Energy sources are: firewood and charcoal. Firewood is collected by women and children from within the farms. Tree species used are 'Mukidori tree', eucalyptus and blue gum. Pruned tree branches are the major source of firewood. Charcoal use is on small scale since its tedious and time consuming to get the permit to prepare charcoal from the Kenya forest Service.

Water resources

The main water source is the Aberdare Forest. The water is collected from the forest at Titie where it is channeled to the reservoir tank before being piped downward. The pipes run along the road and cross the road at different sections (at Kairia Juncction, Kerangi area, Karandi area, Kiamutiga primary, Wahome Njuru area, Iria in tea buying centre, and at waithaka farm/ mukuyoin. The water flows naturally by gravity and no treatment is done to it. The water is dirty during the rainy seasons, during dry season the volume of water is small but very clean. The water is used generally for all domestic activities. Sometimes the movement of the wildlife (elephants and Buffalos makes the water dirty). The locals stated that the water supply maybe disrupted during road construction.

Regulation Services

Air quality control

The locals noted that they have not noticed any change in the air quality since their area has plenty of trees and boarders forest, but they anticipated that once the construction starts the air might get polluted with dust from the moving tractors and excavated building materials. To reduce this impact, they requested the contractor to regularly sprinkle water to reduce dust produced.

Climate regulation

Ihithe people stated that the area is no longer very cold as it used to be, they also stated that the amount of rainfall being received has decreased as compared to earlier years and the dry season last longer. They suggested that this could be due to the global warming and climate change. Another member suggested that this could also be attributed to cutting down of trees to create space for farming/ homesteads.

Water regulation, purification and treatment

Amount of water received in the area vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is less. The Aberdare Forest is the major water catchment in the region. The water is not treated.

Control of erosion and soil quality

Soil erosion is very minimal in the area as most people have planted nippier grass and trees within their farms and even in the road reserves. Once construction work begins, the locals requested the contractor to put in place proper drainage on the road sides so that erosion can be minimized whenever it rains especially on the farms bordering the road.

Diseases and pests control

A major pest is mite, the locals stated that these pests have decreased and their effect is very minimal on the crops.

Pollination

Bees and birds are the major pollinators to their crops. The locals stated that there are varieties of birds from the forest that are helping in pollination. To increase the pollination and to create source of income, they started bee keeping activity both individually and as groups within their farms.

Control of natural disasters

The area sometimes experiences hailstones, whenever this occurs their crops are damaged. The other problem experience in the area is flooding caused by the surface run off from the Aberdare Forest whenever it rains, the locals suspects that this flooding might increase when the construction begins hence, they request contractor to put proper drainage channels.

Cultural Services

Sacred elements

The community stated that “Mukuyu tree” and “mogumo tree” are sacred to them. Through our discussion with the locals, we noticed that there is Mukuyu tree at Thiriku farm but there is no any mugumo tree along the proposed road site. From the discussion, one member suggested that the burial sites which might lie along the proposed road site to be preserved by the contractor.

Recreation and tourism

This only takes place at Kiandongoro hills which is within the Aberdare Park. It is controlled and managed by the KWS. They stated that if the proposed road is constructed, the number of people visiting the park will increase.

Figure 13-27 Stakeholder engagement on ecosystem services in Amboni and Ihithe

iv. Kahuruko Meeting: Ihithe –To-Ndunyu Njeru Section

The meeting was held on 2nd March 2022 in the morning at Kahuruko Social Hall

Major concern: KWS resistance and co-oprate social responsibility (school, hospital or market)

Provisioning Services

Agricultural potential and production

This region is major food basket of the country, the farmers produce variety of food crops throughout the year; the crops include: sweet potatoes, maize, beans, bananas, nippier grass, arrow roots, Onions, groundnuts, kales, cabbage, spinach and Horticulture crops (Brocoli, mangetout, fine beans, garden peas, thai demon, carrots and fresno). Horticulture crops are mainly for the export while the rest are consumed locally. Potatoes, carrots and cabbage are both for sale and subsistence use. All family members are involved in doing farming work. Farming areas are on the individual lands not on the forest reserves. The locals rely on the rain for farming. The locals use commercial fertilizers and compost manures on their farms to increase the yield.

Livestock and forage resources

Animals kept include: goats, sheep, pigs, and rabbit, dairy (Friesian, Ashire and jersey) and beef cattle. All these are for subsistence except the dairy beef which are for commercial purposes. The locals are practicing zero grazing, paddocking and natural grazing of the animals within the forest. The animals are feed on natural fodders collected from within their farms (nippier grass and maize stacks and oats). Due to heavy rainfall in the region, there is plenty of fodder throughout the year. Source of water for the livestock is river Kitiri and the pipped water from the Aberdare Forest. Milk produced is taken to the milk collection centres thereafter transported to Kinangop milk processing plant. Animals are mostly sold to meet the family needs. The proposed road will help them to deliver their horticulture and milk to customers while still fresh. During the construction, Kahuruko people requested the contractor to put in place proper diversions/ alternative roots which will enable them to take their milk to the market in time.

Fishery resources

Currently the area has only one fish farm at Geita within the forest. This farm has trout fish species which was introduced by the Nyandarua County government. This fish farm was started with the objective of introducing this fish species to river Kitiri to increase and diversify food for the locals. The road work will have no effect on this fish farming since its location is very far from the proposed road site

Hunting and bush meat

No hunting activity is taking place in the area

Traditional medicine

The locals stated they don't know any traditional medicinal plant around since they all go to the hospital for medication

Construction materials

Harvesting of timber is only from individual farms since harvesting from the forest is prohibited, no harvesting of minerals within the location. Timber is mainly used for building houses. The species of trees being used are: cypress, pine, blue gum, grevillea. Harvesting depends on individual needs and can be done any time of the year. For those building with earth, the soil is harvested locally within homes

Lumber and craft

No lumbering from the forest but individuals with tree plantations on their farms are doing lumbering once the trees are mature and ready for harvesting.

Biofuels

Energy sources are: firewood and charcoal. Firewood is collected by women and children from within the farms and sometimes from the forest, collections from the forest are based only on dry woods and no machete is allowed into the forest. Tree species used are Cyprus, pine and blue gum). Charcoal use is on small scale since its tedious and time consuming to process the permit to prepare it from the Kenya forest Service.

Water resources

The main water source is the Aberdare Forest. The water is collected from the forest and channeled to reservoir at Kahuruko and Pekenya before being piped downward. The pipes run along the road and cross the road at several places hence need to involve the locals in identifying them to avoid damage by the contractors. The water flows naturally by gravity and no treatment is done to it. The water is dirty during the rainy seasons, during dry season its volume decreases. The water is used generally for all domestic activities. One member stated that the movement of the wildlife (elephants, eland and Buffalos makes the water dirty). Apart from the piped water, people of Kahuruko also fetch water from river kitiri for their domestic use. The proposed road construction is likely to have effect on the water supply mostly on the areas supplied by the piped water.

Regulation Services

Air quality control

The locals noted that they used to realize no change in the air quality in their area, but recently when the maintenance of the road sections from the park all the way to Ndunyu Njeru was started, they have noticed a lot of dust in the air, this change in air Quality they said is as a result of the construction work. They stated that the proposed road will bring the same effect in the environment.

Climate regulation

The Aberdare Forest is playing Key role of climate regulation in the area, they stated that since the forest is still in its original state, they have not noticed any change in their climate as the rainfall and temperature in the region have not changed over the years. They further stated that the proposed road construction will have no effect on their climate.

Water regulation, purification and treatment

Amount of water received in the area vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is decreased. The water is used directly without addition of any chemical/treatment. The Aberdare Forest is their main water catchment zone since all the water they are using is from the forest

Control of erosion and soil quality

The area has very minimal soil erosion; they stated that this could be due to the plenty of trees in the region. It was also noted that most of their land have cover crops which might also be helping to reduce erosion and maintaining the soil quality. The stakeholders stated that if the contractor does not put proper drainage channel along the road, then there are high chances soil erosion will increase.

Diseases and pests control

Some of the problematic pest and diseases to the farmers at Kahuruko region are: white flies, aphides, and worms. They stated that they are not in a position to relate the presence of these pests to any environmental factor or to road construction

Pollination

Bees and birds are the major pollinators to their crops; they stated that the amount of agricultural produce does not depend mostly on these pollinators.

Control of natural disasters

The locals stated that they have not witness any form of natural disaster in their area, but they requested that when construction of the road begins, the contractor should put up proper drainage in place so that their farms and homesteads are not flooded by the surface run off from the forest.

Cultural Services

Sacred elements

The community stated that "mogumo tree" is sacred to them. But in their region and within the area where the road is proposed to go through, there is no any Mugumo tree.

Recreation and tourism

This only takes place at Kipipiri camp site and within the Aberdare Park. Kipipiri camp site is privately managed and locals stated that they do not get any benefits from it. The locals stated that the Aberdare Park which is major tourist destination have been of hindrance for the development of the Ihithe-Ngunyu Njeru road which connects Nyeri to Nyandarua county. They requested for proper dialogue between the stakeholders involved (KWS, KFS, NEMA, KENHA, Rhino Ark and the Local communities) so that the road construction work can go on without being stopped as was witnessed in the year 2009. In order to get more benefits from the park, the locals requested the contractor to start the road construction from the Ndunyu Njeru site moving towards the park side since they anticipate the KWS might still delay the project.

The locals requested the contractor to put up at least one co-oprate social responsibility facility (school, hospital or market) within the proposed road site.

v. Weru Meeting: Joma –Weru Section

The meeting was held on 2nd March 2022 in the afternoon at Weru A.I.C

Major concern: Drainage, access paths to the main road and rehabilitation of the quarry sites and repair of bore hole at Kambi George)

Provisioning Services

Agricultural potential and production

Farmers at Weru region produce variety of food crops throughout the year; the crops include: sweet potatoes, maize, beans, nippier grass, leuceana tree, arrow roots, Onions, groundnuts, kales, cabbage, spinach, oats and tomatoes. Cabbage, sweet potatoes and peas are mostly for commercial purposes while the rest are for subsistence. Nippier grass and leuceana tree are grown as fodder for the animals. All family members are involved in farming. Farming areas are on the individual lands and are carried throughout the year. The locals rely on the rain for farming. The locals use commercial fertilizers and compost manures on their farms to increase the yield. Major challenge is insufficient water during the dry seasons

Livestock and forage resources

Animals kept include: goats, sheep, pigs, rabbit, and dairy (Friesian, Ashire and Jersey) and beef cattles. All these are for subsistence except the sheep and dairy farming which are for sale. The locals are practicing zero grazing and paddocking only as there are no grazing fields/ forest. The animals are feed on natural fodders collected from the farms (nippier grass, oats, maize stacks and leuceana tree leaves). This region does not receive too much rainfall hence farmers have to plant the fodders for their animals. Source of water for the livestock are harvested rain water, constructed dams, river Faru, river Kangoto, river Kihoro, and sometimes pippped water from the Aberdare Forest. Most of the rivers are seasonal. Milk produced is taken to the milk collection centers thereafter transported to Kinangop milk processing plant. Animals are mostly sold to meet the family needs. The proposed road when completed will enable their milk to reach the processing area in time while still fresh.

Fishery resources

Weru people stated that the only place with fish resource is Nguyai dam, they could not identify the exact fish species in the dam since they are not allowed to do any fishing activity in the dam.

Hunting and bush meat

Hunting is prohibited in the area and no one can dare try it.

Natural food product

Vegetables like “managu” and “Terere” are naturally growing in the area; they are harvested by the locals for family use. Some few individuals keep bees within their homes for honey.

Traditional medicine

The locals stated they don’t know any traditional medicinal plant around since they all go to the hospital for medication.

Construction materials

Timber is used for most construction work in the area, harvesting of timber is only from individual farms. The species of trees being used are: cypress, pine, blue gum, gravillea and eucalyptus. Harvesting depends on individual need s and can be done any time of the year. For those building with earth, the soil is harvested locally within homes. Building stones are mined from Cove quarry and Matundura quarry. Minning of the building stone at these two places clears the vegetation and exposes the soil for erosion. The stakeholders noted that the contractor

can get the building materials from these quarry sites with one condition of rehabilitating the sites upon completion.

Lumber and craft

No lumbering from the forest but individuals with tree plantations on their lands does lumbering. The trees are harvested when mature and ready but sometimes individual needs may push them to harvest the trees before fully matured. The proposed road construction will not affect lumbering since most of the tree plantations are far from the proposed road site.

Biofuels

Energy sources are: firewood and charcoal. Firewood is collected by women and children from within the farms and in most cases, they prune their trees. Tree species used are Cyprus, pine and blue gum). Men sometimes help in charcoal preparation and they use the wattle tree.

Water resources

Majority of the people use harvested rain water. Some few individuals use pipped water from the Aberdare Forest; the piped water is rationed and only reaches the locals once in a while. The piped water runs along the road and cross the road at Kambi George and at Derugo Bridge. The area also has seasonal rivers (river Kangoto, river Faru and river Kihoro) which are all supplementing water supply of the region. It was stated that some few individuals have diverted the river waters into personal man-made dams for their animals. The water water in the region is not treated. During the rainy seasons the water is dirty while during dry season there is insufficient water as most of the seasonal rivers dry up. This water is used generally for all domestic activities and for the livestock. The stakeholders stated that there is borehole at Kambi George with water but lucks pump; if it can be repaired it can act as an alternative source of water during construction.

Regulation Services

Air quality control

The locals noted that there is change in air quality, during the dry seasons (November to February) air is polluted with dust, but during the rainy seasons the air is very clean. When the proposed road construction begins, it is anticipated that more dust will be released into the air thereby affecting the air quality.

Climate regulation

The Aberdare Forest is playing Key role on the climate of their area and since the forest is still intact, the locals stated that they have not experience significant change on their climate. It was stated that the proposed road will not have any effect on climate since it will not touch onto the forest but instead use the already existing road reserve.

Water regulation, purification and treatment

The locals stated that amount of water vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is decreased. They stated that Aberdare Forest plays key role in the amount of water they receive in the area since it's the major water catchment zone in the area. The water is used directly without addition of any chemical/ treatment.

Control of erosion and soil quality

Soil erosion in the area occurs along the roads; they stated that areas along the road have loose soil with no vegetation cover hence prone to erosion. The proposed road is likely to increase soil erosion in the area due to the increased surface run off that will be generated.

Diseases and pests control

Some of the problematic pest and diseases are; ticks, aphids, moths and crow bird. They stated that they are not in a position to relate the presence of these pests to any environmental factor

Pollination

Bees and birds are the major pollinators to their crops; they stated that the amount of agricultural produce does not depend on these pollinators.

Control of natural disasters

During the rainy seasons, the seasonal rivers over flow bridge making the movement of the local residents difficult, they therefore advised that the contractor should put high bridge's to avoid the flooding of the road. They also advised that the contractor should put in place proper drainage channel for the storm water along the road to avoid flooding of the road and the neighboring farms.

Cultural Services

Sacred elements

The community stated that "mogumo tree" is sacred to them. But in their region and within the area where the road is proposed to go through, there is no any Mugumo tree.

Recreation and tourism

Tourism sites within the area are; Kidagi dam which has ducks and Nguyai dam which has both ducks and fish. These two sites are not generating any revenue to the community since they are free sites both to the locals and foreigners.

vi. Joma Meeting: Munyaka-Koinange-Heni-Mwendandu Section

The meeting was held on 3rd March 2022 in the morning at Njoma center.

Major concern: Drainage channels to facilitate storm water flow and the access paths to the main road

Provisioning Services

Agricultural potential and production

Farmers at this region produce variety of food crops throughout the year; the crops include: sweet potatoes, maize, beans, nippier grass, leuceana tree, carrots, peas, Onions, oat, kales, cabbage, spinach and tomatoes. Cabbage, carrots, sweet potatoes and peas are mostly for commercial purposes while the rest are for subsistence. Nippier grass, oat and Leucaena tree are grown for fodder to the animals. All family members are involved in farming. Farming areas are on the individual lands and are carried throughout the year. The locals rely on the rain for farming except for the tomatoes which are grown in the green house. The locals use commercial fertilizers and compost manures on their farms to increase the yield. Major challenge to the farmers is insufficient water during the dry season and frost during the rainy seasons

Livestock and forage resources

Animals kept include: donkey, goats, sheep, pigs, rabbit, and dairy cattle. All these are for subsistence except the sheep and dairy farming which are for commercial purposes. The locals are practicing zero grazing and paddocking. The animals are feed on natural fodders collected from within their farms (nippier grass and maize stacks and Leucaena leaves, oat plants). This region does not receive too much rainfall hence farmers must plant the fodders for their animals. Source of water for the livestock are harvested rain water, constructed dams, water pans, river karati, river kangutu and river Mariko. Milk produced is taken to the milk collection

centres thereafter transported to Kinangop milk processing plant. Animals are mostly sold to meet the family needs. Major challenge is insufficient water and an inadequate cattle dip

Fishery resources

No fishing activity in the area

Hunting and bush meat

No hunting activity in the area since it's prohibited.

Natural food product

Guava and honey from the nearby trees within homestead. Honey is harvested by smoking, no specific time for harvesting and it's done by men. It's only for personal consumptions.

Traditional medicine

The following plants were noted to be of medicinal value to people living around Njoma area: Aloevara plant- this is used for treating wounds and also used in poultry. The leaves are used. Another plant is "Wanjiru warurie plant" -this is used to treat malaria. Leaves are boiled. "Mwiri plant" -this is used to treat stomach ache. Leaves are used. Lastly neem tree (Mwarubaine)- the leaves and back of this plant treats around over forty diseases.

Construction materials

Timber is mostly used for construction, harvesting of timber is only from individual farms since harvesting from the forest is prohibited, the species of trees being used are: wattle tree, cypress, pine, blue gum, red cedar tree. Harvesting of these trees for construction depends on individual need s and can be done any time of the year. For those building with earth, the soil is harvested locally within homes. Building stones are mined from Karati quarry, Muruaki quarry and Ndunyu Njeru quarry. Sand is harvested at Kinungi. Only men are mining stone and sand. Most of the quarry sites are prone to both flooding and soil erosion when it rains.

Lumber and craft

Individuals with tree plantations on their farms are cutting down their trees once the trees are mature and ready for harvesting. These are then sold to meet the family needs. Men are the ones doing the work. The proposed road is likely not to affect it as most tree plantations are far from the proposed road site.

Biofuels

Energy sources are: firewood and charcoal. Firewood is collected by women and children from within the farms and in most cases, they prune their trees. Tree species used are Wattle tree, Cyprus, pine and blue gum). Men sometimes help in charcoal preparation and they use the wattle tree and blue gum.

Water resources

Majority of the locals use harvested rain water, to supplement the rain water, some people have constructed water pans and dams (Ngoma dam, Karaja dam, Gekeri dam and Gichagi dam). Some seasonal rivers in the area include (river Karati, river Kanguto and river Mariku). From our discussion the locals stated that some few individuals have diverted the river waters into man made dams for their animals and this in turn reduce the volume of water downstream. The water flows naturally by gravity and no treatment is done to it. River water are dirty during the rainy seasons (March to July) but clean and insufficient during dry season (November to February). This water is used generally for all domestic activities.

Regulation Services

Air quality control

The air quality in the region has changed with time, during the dry seasons (November to February) air is polluted with dust, but during the rainy seasons the air is very clean. The locals could not explain the cause of this change in air quality in the area.

Climate regulation

The Aberdare Forest is playing Key role on the climate of their area and since the forest is still in its original state, they have not noticed major change on the climate.

Water regulation, purification and treatment

Water supply in the region vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is decreased. The Aberdare Forest is the major water catchment for the people. The water is used directly without addition of any chemical. From the discussion, majority of the locals use harvested rain water.

Control of erosion and soil quality

The locals stated that there is soil erosion in the area especially along the roads; they stated that this could be due to the insufficient rainfall being received in the region which does not support full vegetation growth in most areas.

Diseases and pests control

Some of the problematic pest and diseases are; ticks, aphids, moths and crow bird. They stated that they are not in a position to relate the presence of these pests to any environmental factor

Pollination

Bees and birds are the major pollinators to their crops; they stated that the amount of agricultural produce does not depend mostly on these pollinators.

Control of natural disasters

The stakeholders stated that during the rainy seasons, the seasonal rivers over flow Bridge making their movement difficult, they therefore suggested that on the proposed road, the contractor should put high bridges to avoid flooding of the road. They also advised that the contractor should put in place proper drainage channel for the storm water along the road to avoid flooding of the road and the nearby farms. The other natural disaster experienced in the area is frost, this affects their crops whenever it occurs. They relate the occurrence of the frost to the cold temperature around Aberdare Forest.

Cultural Services

Sacred elements

The community stated that “mogumo tree” is sacred to them. But in their region and within the area where the road is proposed to go through, there is no any Mugumo tree.

Recreation and tourism

No tourism activity in the region.

vii. Munyaka Meeting:Munyaka-Koinange-Heni-Mwendandu Section

The meeting was held on 3rd March 2022 in the afternoon at Munyaka A.I.C.

Major concern: Drainage issue and access paths to the main road

Provisioning Services

Agricultural potential and production

Farmers produce variety of crops throughout the year; the crops include: Pyrethrum, Sweet potatoes, maize, beans, nippier grass, Leucaena tree, carrots, peas, Onions, oat, kales, cabbage,

spinach, bell pepper, capsicum green and tomatoes. Cabbage, carrots, sweet potatoes and peas are mostly for commercial purposes while the rest are for subsistence. Nippier grass, oat and Leucaena tree are grown as fodder to the animals. All family members are involved in farming. Farming areas are on the individual lands and are carried throughout the year. The locals rely on the rain for farming except for the tomatoes, capsicum green and bell pepper which are grown in the green house at Kamunyaka. The locals use commercial fertilizers and compost manures on their farms to increase the yield. Major challenge to the farmers is insufficient water during the dry season and frost during the rainy seasons.

Livestock and forage resources

Animals kept include: donkey, goats, sheep, pigs, rabbit, and dairy (Friesian and Ayrshire cattle). All these are for subsistence except the sheep and dairy which are for commercial purposes. The locals are practicing zero grazing, paddocking and free grazing into the forest. The animals are feed on natural fodders collected from within their farms (nippier grass and maize stacks and Leucaena leaves, oat plants, fetch). This region does not receive too much rainfall hence farmers must plant the fodders for their animals. Source of water for the livestock are harvested rain water, constructed dams, water pans, river Turasia, boreholes, and pipped water from the forest. Milk produced is taken to the milk collection centers thereafter transported to Kinangop milk processing plant. Animals are mostly sold to meet the family needs. Major challenge is insufficient water and inadequate fodder during dry season. The proposed road work is likely to have slight effect on the movement of the free grazing livestock as they move into the forest.

Fishery resources

Some individuals have fish ponds within their farms. Species of fish in these ponds are: common cat, tilapia and mud fish. They feed them with both commercial food and local produce from their homes. Fish farming is still on small scale and it's only for subsistence use. The proposed road work will not affect it as most of the fish farms are far from the main road.

Hunting and bush meat

Hunting is prohibited in the area

Natural food product

Honey and guava fruit are the natural food products in the area, honey is harvested by smoking, no specific time for harvesting and it's done by men. Guava fruits are randomly distributed in the area both within the farms and forest areas.

Traditional medicine

Plants used by the locals for medication are Aloe Vara tree, "Wanjiru warurie tree", "Mwiri tree" and "Muri tree", Guava tree and neem tree. Aloevara is used for treating wounds, malaria and pneumonia in human. It is also used in poultry to treat several diseases. The leaves are used. The other plant is "Wanjiru warurie tree" this is used to treat malaria. Leaves are boiled. "Mwiri tree" this tree is used to treat stomach ache, its leaves are used. "Muri tree" this is used to treat cancer; the stem is used. Guava tree, its leaves is used in cancer treatment. Lastly neem tree- the locals stated that the leaves and back of this plant treats over forty diseases.

Construction materials

Houses are constructed using timber, harvesting of timber for construction is on individual farms since harvesting from the forest is prohibited. Harvesting of timber for construction depends on individuals need and can be done any time of the year. The species of trees being used are: wattle tree, cypress, pine, blue gum and red cedar tree. For those building with earth, the soil is harvested locally within homes. Building stones are mined from Chobe quarry and Dida quarry. Sand is harvested at Miharati, Murungaru and longonot. Only men are mining

stone and sand. The proposed construction will only affect the tree plantations that are on the road reserve. The quarry sites in the area can serve as source of the raw materials for the road construction work. The stakeholders suggested that all sites where construction materials will be extracted from should be rehabilitated by the contractor.

Lumber and craft

Individuals with tree plantations on their lands are cutting down their trees for sales in unprocessed forms. They are split with the power saw and then transported to the nearby saw mills and hardware's.

Biofuels

Energy sources are: Biogas, firewood and charcoal. Firewood is collected by women and children from the farms and in most cases, they prune their trees. Tree species used are Wattle tree, Cyprus, pine and blue gum). Men sometimes help in charcoal preparation and they use the wattle tree and blue gum. Biogas is used just by some few

Water resources

Sources of water supply at Munyaka and its surrounding are pipped water from the forest, Dams, water pans, boreholes and harvested rain water. Majority of the locals use harvested rain water in their tanks. To supplement the rain water, the locals have constructed water pans and dams (Douglas Dam, Kiahuho dam, Kijiku Dam, Kangutu Dam and water pans) which serves as source of water for their livestock. The area also has seasonal river known as river Turasia which is source of water for the community. The piped water from the hill flows naturally by gravity and crosses the road at Munyaka center and Kanguto area, there are also several small tap pipes connected to the main pipe. The water is not treated. During the rainy season the water is dirty while during the rainy seasons it's clean. The locals suggested that its erosion during rainy season that makes the water dirty. This water is used generally for all domestic activities.

Regulation Services

Air quality control

The locals noted that there is change in air quality, during the dry seasons (November to February) air is polluted with dust, but during the rainy seasons the air is very clean. The change in air quality is associated with global climate change

Climate regulation

From our discussion the locals stated that the Aberdare Forest is playing Key role on the climate of their area and since the forest is still in its original state, they have not noticed any major change on their climate

Water regulation, purification and treatment

The locals stated that amount of water vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is decreased. The water in the region (piped, rivers, dams and water pans) is used directly without addition of any chemical. The proposed road work is likely to increase soil erosion in the area which will affect the water quality in dams and river.

Control of erosion and soil quality

The locals stated that there is soil erosion in the mountain side during rainy season and this is what makes the water dirty. The proposed road work is likely to increase soil erosion in the region if the contractor doesn't put proper drainage channel for the storm water.

Diseases and pests control

Some of the problematic pest and diseases are; ticks, aphids, moths and crow bird. They stated that they are not in a position to relate the presence of these pests to any environmental factor

Pollination

Bees and birds are the major pollinators to the crops; they stated that the amount of agricultural produce does not depend mostly on these pollinators.

Control of natural disasters

Flooding from storm water is the major disaster at Munyaka area, The locals stated that during the rainy seasons, the seasonal river Kangutu over flow bridge making their movement difficult, they therefore advised that the contractor should put high bridges where river Kangutu crosses' the road to avoid the flooding whenever it rains. They also advised that the contractor should put in place proper drainage channel for the storm water along the road to avoid flooding of the road and homesteads. The other natural disaster realized in the area is frost and Hailstones, this causes damage to the crops.

Cultural Services

Sacred elements

The community stated that "Mugumo tree" is sacred to them. But in their region and within the area where the road is proposed to go through, there is no any Mugumo tree.

Recreation and tourism

Hiking at Aberdare hills and tourists visiting the Aberdare Park are the major activities. There is no any benefit the locals get from both hiking and visiting the park since both the areas are managed by KWS.

viii. Heni Meeting: Munyaka-Koinange-Heni-Mwendandu Section

The meeting was held on 4TH March 2022 in the afternoon at Heni Stadium.

Major concern: Proper drainage to facilitate storm water flow at Kaugi area

Provisioning Services

Agricultural potential and production

Heni area is agricultural productive area; farming is carried out throughout the year. Some of the crops grown include: sweet potatoes, maize, beans, nippier grass, Leucaena tree, carrots, peas, Onions, oat, kales, cabbage, spinach, bell pepper, capsicum green and tomatoes. Cabbage, carrots, sweet potatoes and peas are mostly grown for commercial purposes while the rest are for subsistence. Nippier grass, oat and Leucaena tree are grown for fodder to the animals. All family members are involved in farming. Farming areas are on the individual lands and are carried throughout the year. The locals rely on the rain for farming except for the tomatoes, capsicum green, bell pepper which are irrigated with the borehole water. The locals use commercial fertilizers and compost manures on their farms to increase the yield. Major challenge to the farmers is insufficient water during the dry season.

Livestock and forage resources

Animals kept include: donkey, sheep, pigs, rabbit, and dairy (Friesian, jersey and Ayrshire cattle) are kept. All these are for subsistence except the sheep and dairy farming which are commercial purposes. The locals are practicing zero grazing, paddocking and free ranging. The animals are feed on natural fodders collected from the farms (nippier grass and maize stacks and Leucaena leaves, oat plants, fetch). There is no communal grazing land for the free ranging animals, some people use the road reserve for tethering grazing. This region does not receive too much rainfall hence farmers must plant the fodders for their animals. Major source of water

for the livestock is water pans and dams, other sources include; harvested rain water and constructed boreholes. Milk produced is taken to the milk collection centers thereafter transported to Karate farmers cooperatives. Animals are mostly sold to meet the family needs. Major challenge is insufficient water and inadequate fodder during dry season. The proposed road construction will disrupt those who are using the road reserve for grazing their livestock.

Fishery resources

No any fishing activity in the area

Hunting and bush meat

No hunting activity in the area

Natural food product

The only natural food product stated the discussion is honey; some individuals are keeping bees in their farmlands for honey. It's practiced on small scale and for personal consumptions

Traditional medicine

Some of the natural vegetables are being used as medicine; "Managu" leaves is used to treat stomach ache, "Terere" leaves is used to treat fever, Aloevara leaves is used for treating wounds, malaria, pneumonia. "Wanjiru waruriet" leaves is used to treat malaria. "Mwiri plant" leaves are used to treat stomach ache. "Muri tree" stem is used to treat cancer. Guava tree leaves is used in cancer treatment. Lastly neem tree- the leaves and back of this plant is used to treat over forty diseases.

Construction materials

Timber is mainly used for building houses and they are harvested from individual tree plantations. The species of trees being used are: cypress and blue gum. Harvesting of these trees for construction depends on individual need s and can be done any time of the year. For those building with earth, the soil is harvested locally within homes. Building stones are mined from Karati quarry and Gichuhi quarry. Only men are involved in mining stone and Harvesting of the timber.

Lumber and craft

Individuals with tree plantations on their lands practicing lumbering, the harvested trees are split into timbers which are then sold to the nearby hardware's. Harvesting is mainly done when trees are mature.

Biofuels

Energy sources are: Biogas, firewood and charcoal. Firewood is collected by women and children from within the farms and in most cases, they prune their trees. Tree species used are Cyprus and blue gum. Men and youth help in charcoal preparation and they use blue gum. Biogas is used just by some few individuals

Water resources

Majority of Heni people use harvested rain water. To supplement the rain water, the locals have constructed water pans and dams (Douglas Dam, Kagieki dam, Kirihu Dam and Karuru Dam), some of these are seasonal and dry up during the dry season. In addition, there are community bore holes (Senior bore hole and Kaugi borehole), the water from these boreholes is pipped and crosses the road at Kiyo secondary and Kangundo area. During the rainy season the water is dirty while during the dry seasons it's clean. The locals suggested that its erosion during dry season that makes the water dirty. During the dry seasons the locals are buying water from other regions and it's transported using either donkeys or water boozers. To avoid disruption of water supply, the contactor should work with the locals to identify all the areas with the water pipes.

Regulatory Services

Air quality control

The locals noted that there is change in air quality, during the dry seasons (November to February) air is polluted with dust, but during the rainy seasons the air is very clean. they suggested that this could have been brought about by the prolonged dry season which used not to be there. They also suggested that the proposed road construction will produce more dust hence affecting the air quality in the region.

Climate regulation

The tree plantations in the area are playing key role in the climate regulation; especially the Aberdare Forest. The locals stated that nowadays their area have prolonged dry season and the rainfall pattern is unpredictable.

Water regulation, purification and treatment

The locals stated that amount of water vary with the season, during the rainy season the water is more and dirty while during the dry season the volume is decreased. The water is used directly without addition of any chemical. From the discussion, majority of the locals use harvested rain water, borehole water and water from the pans.

Control of erosion and soil quality

Soil erosion is minimal as most areas have tree plantations (blue gum and cypress).

Diseases and pests control

One of the problematic pest and diseases is ticks for the livestock. They stated that they are not in a position to relate the presence of these pests to any environmental factor

Pollination

Bees and birds are the major pollinators to their crops; majority of the birds are from the Aberdare Forest while the bees are kept within their farms. They stated that the amount of agricultural produce does not depend on these pollinators.

Control of natural disasters

Major natural disaster in the area is flooding at some specific regions; the locals stated that whenever it rains there is flooding at Kaugi area, due to this they request the contractor to put high bridge and proper drainage channel for the storm water to pass through in order to avoid flooding of the road and homesteads at Kaugi area.

Cultural Services

Sacred elements

The community stated that “mogumo tree and Mukuyu tree” are sacred to them. But there is none of these tree species in their area.

Recreation and tourism

There is no any tourism activity within the area

13.2 Appendix II: Bird Species Diversity

IHITHE-NDUNYU NJERU ROAD

Order	**Family**	***Species Name (IUCN Status)***
Accipitriformes	Accipitrida	*Accipiter badius(LC), Accipiter brevipes(LC), Accipiter melanoleucus(LC), Accipiter minullus(LC), Accipiter tachiro(LC), Aquila nipalensis(EN), Aquila rapax(VU), Buteo augur(LC), Buteo buteo(LC), Buteo rufofuscus(LC),Circaetus cinereus(LC), Circaetus pectoralis(LC), Circus aeruginosus(LC), Circus macrourus(NT), Circus pygargus(LC), Circus ranivorus(LC), Elanus caeruleus(LC), Gypohierax angolensis(LC), Haliaeetus vocifer(LC), Hieraaetus wahlbergi(LC), Lophaetus occipitalis(LC), Melierax metabates(LC), Milvus migrans(LC), Polyboroides typus(LC)*
	Pandionidae	*Pandion haliaetus(LC),*
Anseriformes	Anatidae	*Alopochen aegyptiaca(LC), Anas acuta(LC), Anas crecca(LC), Anas erythrorhyncha(LC), Anas hottentota(LC), Anas punctata(LC), Anas sparsa(LC), Anas undulata(LC), Dendrocygna bicolor(LC), Dendrocygna viduata(LC), Netta erythrophthalma(LC), Nettapus auritus(LC), Plectropterus gambensis(LC), Sarkidiornis melanotos(LC), Thalassornis leuconotus(LC)*
Apodiformes	Apodidae	*Apus affinis(LC), Apus apus(LC), Apus caffer(LC), Cypsiurus parvus(LC), Tachymarptis aequatorialis(LC)*
Bucerotiformes	Bucerotidae	*Bycanistes brevis(LC), Bycanistes subcylindricus(LC), Tockus nasutus(LC)*
	Phoeniculidae	*Phoeniculus purpureus(LC), Rhinopomastus minor(LC)*
	Upupidae	*Upupa epops(LC)*
Caprimulgiformes	Caprimulgidae	*Caprimulgus natalensis(LC), Caprimulgus poliocephalus(LC),*
Charadriiformes	Burhinidae	*Burhinus vermiculatus(LC)*
	Charadriidae	*Charadrius asiaticus(LC), Charadrius hiaticula(LC), Charadrius tricollaris(LC), Vanellus armatus(LC), Vanellus coronatus(LC), Vanellus crassirostris(LC), Vanellus lugubris(LC), Vanellus senegallus(LC), Vanellus spinosus(LC)*
	Glareolidae	*Cursorius temminckii(LC), Glareola nordmanni(NT), Glareola pratincola(LC), Rhinoptilus cinctus(LC),*
	Jacanidae	*Actophilornis africanus(LC),*
	Laridae	*Chlidonias hybrida(LC), Chlidonias leucopterus(LC), Chroicocephalus cirrocephalus(LC), Hydroprogne caspia(LC), Larus fuscus(LC), Rynchops flavirostris(LC), Sterna nilotica(LC), Sternula saundersi(LC)*
	Recurvirostridae	*Himantopus himantopus(LC)*
	Scolopacidae	*Actitis hypoleucos(LC), Calidris minuta(LC), Gallinago gallinago(LC), Gallinago nigripennis(LC), Lymnocryptes minimus(LC), Philomachus pugnax(LC), Tringa glareola(LC), Tringa nebularia(LC), Tringa ochropus(LC), Tringa stagnatilis(LC)*
Ciconiiformes	Ciconiidae	*Anastomus lamelligerus(LC), Ciconia abdimii(LC), Ciconia ciconia(LC), Ciconia episcopus(LC), Leptoptilos crumenifer(LC), Mycteria ibis(LC),*
Coliiformes	Coliidae	*Colius striatus(LC), Urocolius macrourus(LC),*
Columbiformes	Columbidae	*Columba arquatrix(LC), Columba delegorguei(LC), Columba guinea(LC), Columba livia(LC), Streptopelia capicola(LC), Streptopelia decipiens(LC), Streptopelia lugens(LC), Streptopelia semitorquata(LC), Streptopelia senegalensis(LC),* *Treron calvus(LC), Turtur afer(LC), Turtur chalcospilos(LC)*
Coraciiformes	Alcedinidae	*Alcedo cristata(LC), Ceryle rudis(LC), Ceyx pictus(LC), Halcyon leucocephala(LC), Halcyon senegalensis(LC), Megaceryle maxima(LC)*
	Coraciidae	*Coracias caudatus(LC), Eurystomus glaucurus(LC),*
	Meropidae	*Merops albicollis(LC), Merops bullockoides(LC), Merops oreobates(LC), Merops persicus(LC), Merops pusillus(LC), Merops superciliosus(LC),*

Cuculiformes	Cuculidae	*Centropus monachus(LC), Centropus superciliosus(LC), Chrysococcyx caprius(LC), Chrysococcyx klaas(LC), Chrysococcyx klaasi(LC), Clamator levaillantii(LC),*
Falconiformes	Falconidae	*Falco ardosiaceus(LC), Falco biarmicus(LC), Falco cuvierii(LC), Falco naumanni(LC), Falco subbuteo(LC), Falco tinnunculus(LC)*
Galliformes	Numididae	*Numida meleagris(LC)*
	Phasianidae	*Francolinus afer(LC), Francolinus jacksoni(LC), Francolinus leucoscepus(LC)*
Gruiformes	Gruidae	*Balearica regulorum(EN),*
	Rallidae	*Gallinula angulata(LC), Gallinula chloropus(LC), Porphyrio alleni(LC), Zapornia flavirostra(LC)*
Musophagiformes	Musophagidae	*Corythaixoides personatus(LC), Crinifer zonurus(LC), Musophaga rossae(LC), Tauraco hartlaubi(LC)*
Otidiformes	Otididae	*Lissotis melanogaster(LC)*
Passeriformes	Acrocephalidae	*Acrocephalus arundinaceus(LC), Acrocephalus baeticatus(LC), Acrocephalus gracilirostris(LC), Acrocephalus rufescens(LC), Acrocephalus schoenobaenus(LC), Acrocephalus scirpaceus(LC), Calamonastides gracilirostris(VU), Hippolais languida(LC), Iduna pallida(LC), Iduna similis(LC)*
	Alaudidae	*Calandrella cinerea(LC), Calendulauda poecilosterna(LC), Eremopterix leucopareia(LC), Mirafra africana(LC), Mirafra rufocinnamomea(LC)*
	Buphagidae	*Buphagus erythrorhynchus(LC)*
	Campephagidae	*Campephaga flava(LC), Campephaga quiscalina(LC)*
	Cisticolidae	*Apalis cinerea(LC), Apalis porphyrolaema(LC), Camaroptera brachyura(LC), Cisticola cantans(LC), Cisticola carruthersi(LC), Cisticola chiniana(LC), Cisticola erythrops(LC), Cisticola galactotes(LC), Cisticola hunteri(LC), Eminia lepida(LC), Hypergerus lepidus(LC), Phyllolais pulchella(LC), Prinia subflava(LC), Schistolais leucopogon(LC)*
	Corvidae	*Corvus albicollis(LC), Corvus albus(LC), Corvus capensis(LC),*
	Dicruridae	*Dicrurus adsimilis(LC),*
	Emberizidae	*Emberiza flaviventris(LC),*
	Estrildidae	*Amandava subflava(LC), Clytospiza monteiri(LC), Estrilda astrild(LC), Estrilda atricapilla(LC), Estrilda troglodytes(LC), Granatina ianthinogaster(LC), Lagonosticta rhodopareia(LC), Lagonosticta rubricata(LC), Lagonosticta senegala(LC), Lonchura bicolor(LC), Odontospiza griseicapilla(LC), Ortygospiza atricollis(LC), Pytilia melba(LC), Spermestes bicolor(LC), Spermestes cucullata(LC), Sporaeginthus subflavus(LC), Uraeginthus bengalus(LC), Uraeginthus ianthinogaster(LC)*
	Fringillidae	*Crithagra burtoni(LC), Crithagra citrinelloides(LC), Crithagra dorsostriata(LC), Crithagra hyposticta(LC), Crithagra koliensis(LC), Crithagra mozambica(LC), Crithagra reichenowi(LC), Crithagra striolata(LC), Crithagra sulphurata(LC), Serinus canicollis(LC), Serinus flavivertex(LC),*
	Hirundinidae	*Cecropis abyssinica(LC), Cecropis daurica(LC), Cecropis semirufa(LC), Cecropis senegalensis(LC), Delichon urbicum(LC), Hirundo angolensis(LC), Hirundo rustica(LC), Hirundo smithii(LC), Psalidoprocne albiceps(LC), Psalidoprocne holomelaena(LC), Psalidoprocne pristoptera(LC), Pseudhirundo griseopyga(LC), Riparia cincta(LC), Riparia paludicola(LC), Riparia riparia(LC)*
	Laniidae	*Lanius collaris(LC), Lanius collurio(LC), Lanius excubitoroides(LC), Lanius humeralis(LC), Lanius isabellinus(LC), Lanius mackinnoni(LC),*
	Leiothrichidae	*Turdoides hypoleuca(LC), Turdoides jardineii(LC), Turdoides plebejus(LC), Turdoides rubiginosa(LC), Turdoides sharpei(LC),*
	Locustellidae	*Bradypterus baboecala(LC), Bradypterus carpalis(LC), Bradypterus cinnamomeus(LC),*
	Macrosphenidae	*Sylvietta leucophrys(LC), Sylvietta whytii(LC),*

	Malaconotidae	*Bocagia minuta(LC), Chlorophoneus nigrifrons(LC), Chlorophoneus sulfureopectus(LC), Dryoscopus cubla(LC), Dryoscopus gambensis(LC), Laniarius aethiopicus(LC), Laniarius barbarus(LC), Laniarius erythrogaster(LC), Laniarius funebris(LC), Laniarius major(LC), Laniarius mufumbiri(NT), Tchagra australis(LC), Tchagra senegalus(LC),*
	Monarchidae	*Terpsiphone viridis(LC),*
	Motacillidae	*Anthus cinnamomeus(LC), Anthus leucophrys(LC), Anthus novaeseelandiae(LC), Anthus trivialis(LC), Anthus vaalensis(LC), Hemimacronyx sharpei(LC), Macronyx ameliae(LC), Macronyx croceus(LC), Motacilla aguimp(LC), Motacilla capensis(LC), Motacilla flava(LC),*
	Muscicapidae	*Agricola pallidus(LC), Bradornis microrhynchus(LC), Cossypha caffra(LC), Cossypha heuglini(LC), Dioptrornis fischeri(LC), Erythropygia leucophrys(LC), Melaenornis edolioides(LC), Melaenornis semipartitus(LC), Monticola rufocinereus(LC), Monticola saxatilis(LC), Monticola semirufus(LC), Muscicapa adusta(LC), Muscicapa aquatica(LC), Oenanthe isabellina(LC), Oenanthe oenanthe(LC), Oenanthe pleschanka(LC), Pinarochroa sordida(LC), Saxicola rubetra(LC), Turdus abyssinicus(LC), Turdus pelios(LC),*
	Nectariniidae	*Chalcomitra hunteri(LC), Chalcomitra senegalensis(LC), Cinnyris bifasciatus(LC), Cinnyris chloropygius(LC), Cinnyris cupreus(LC), Cinnyris erythrocercus(LC), Cinnyris mariquensis(LC), Cinnyris mediocris(LC), Cinnyris pulchellus(LC), Cinnyris reichenowi(LC), Cinnyris venustus(LC), Cyanomitra verticalis(LC), Drepanorhynchus reichenowi(LC), Hedydipna collaris(LC), Nectarinia johnstoni(LC), Nectarinia kilimensis(LC), Nectarinia tacazze(LC),*
	Oriolidae	*Oriolus oriolus(LC),*
	Paridae	*Parus afer(LC),*
	Parulidae	*Setophaga striata(NT),*
	Passeridae	*Passer domesticus(LC), Passer eminibey(LC), Passer griseus(LC), Plocepasser mahali(LC),*
	Pellorneidae	*Alcippe abyssinica(LC),*
	Phylloscopidae	*Phylloscopus trochilus(LC), Seicercus umbrovirens(LC),*
	Platysteiridae	*Batis minor(LC), Platysteira cyanea(LC),*
	Ploceidae	*Amblyospiza albifrons(LC), Anaplectes rubriceps(LC), Euplectes albonotatus(LC), Euplectes ardens(LC), Euplectes axillaris(LC), Euplectes gierowii(LC), Euplectes hordeaceus(LC), Euplectes macroura(LC), Euplectes orix(LC), Malimbus rubriceps(LC), Ploceus baglafecht(LC), Ploceus castanops(LC), Ploceus cucullatus(LC), Ploceus intermedius(LC), Ploceus jacksoni(LC), Ploceus luteolus(LC), Ploceus melanocephalus(LC), Ploceus ocularis(LC), Ploceus pelzelni(LC), Ploceus rubiginosus(LC), Ploceus spekei(LC), Ploceus superciliosus(LC), Quelea cardinalis(LC), Quelea quelea(LC), Sporopipes frontalis(LC)*
	Pycnonotidae	*Arizelocichla tephrolaema(LC), Atimastillas flavicollis(LC), Eurillas latirostris(LC), Phyllastrephus fischeri(LC), Pycnonotus barbatus(LC), Stelgidillas gracilirostris(LC),*
	Stenostiridae	*Elminia longicauda(LC)*
	Sturnidae	*Cinnyricinclus leucogaster(LC), Creatophora cinerea(LC), Lamprotornis chalybaeus(LC), Lamprotornis purpureus(LC), Lamprotornis purpuroptera(LC), Lamprotornis regius(LC), Lamprotornis superbus(LC), Notopholia corrusca(LC), Onychognathus morio(LC), Pholia sharpii(LC*
	Sylviidae	*Pseudoalcippe abyssinica(LC), Sylvia abyssinica(LC), Sylvia atricapilla(LC),*

	Turdidae	*Geokichla piaggiae(LC),*
	Viduidae	*Anomalospiza imberbis(LC), Vidua chalybeata(LC), Vidua fischeri(LC), Vidua hypocherina(LC), Vidua macroura(LC),*
	Zosteropidae	*Zosterops poliogastrus(LC), Zosterops senegalensis(LC),*
Pelecaniformes	Ardeidae	*Ardea alba(LC), Ardea cinerea(LC), Ardea goliath(LC), Ardea melanocephala(LC), Ardea purpurea(LC), Ardeola ralloides(LC), Ardeola rufiventris(LC), Bubulcus ibis(LC), Butorides striata(LC), Egretta garzetta(LC), Egretta intermedia(LC), Ixobrychus minutus(LC), Nycticorax nycticorax(LC)*
	Pelecanidae	*Pelecanus onocrotalus(LC), Pelecanus rufescens(LC),*
	Scopidae	*Scopus umbretta(LC),*
	Threskiornithidae	*Bostrychia hagedash(LC), Platalea alba(LC), Plegadis falcinellus(LC), Threskiornis aethiopicus(LC),*
Piciformes	Indicatoridae	*Indicator indicator(LC), Indicator minor(LC), Indicator variegatus(LC)*
	Picidae	*Campethera nubica(LC), Dendropicos fuscescens(LC), Dendropicos goertae(LC), Jynx ruficollis(LC)*
	Ramphastidae	*Lybius bidentatus(LC), Lybius guifsobalito(LC), Lybius leucocephalus(LC), Pogoniulus bilineatus(LC), Pogoniulus chrysoconus(LC), Pogoniulus leucomystax(LC), Tricholaema diadematа(LC), Tricholaema lacrymosa(LC)*
Podicipediformes	Podicipedidae	*Tachybaptus ruficollis(LC)*
Psittaciformes	Psittacidae	*Poicephalus meyeri(LC),*
Pteroclidiformes	Pteroclididae	*Pterocles gutturalis(LC),*
Strigiformes	Strigidae	*Bubo africanus(LC), Bubo capensis(LC), Bubo cinerascens(LC)*
Suliformes	Phalacrocoracidae	*Microcarbo africanus(LC), Phalacrocorax carbo(LC),*
Trogoniformes	Trogonidae	*Apaloderma narina(LC), Apaloderma vittatum(LC),*

NYERI SPUR ROADS

Order	Family	Species	IUCN Status
Charadriiformes	Scolopacidae	Actitis hypoleucos	LC
Charadriiformes	Jacanidae	Actophilornis africanus	LC
Anseriformes	Anatidae	Alopochen aegyptiaca	LC

Passeriformes	Estrildidae	Amadina fasciata	LC
Passeriformes	Motacillidae	Anthus leucophrys	LC
Apodiformes	Apodidae	Apus affinis	LC
Apodiformes	Apodidae	Apus horus	LC
Accipitriformes	Accipitridae	Aquila spilogaster	LC
Pelecaniformes	Ardeidae	Ardea alba	LC
Pelecaniformes	Ardeidae	Ardea cinerea	LC
Pelecaniformes	Ardeidae	Ardea melanocephala	LC
Pelecaniformes	Ardeidae	Ardeola ralloides	LC
Gruiformes	Gruidae	Balearica regulorum	EN
Pelecaniformes	Threskiornithidae	Bostrychia hagedash	LC
Pelecaniformes	Ardeidae	Bubulcus ibis	LC
Accipitriformes	Accipitridae	Buteo augur	LC
Passeriformes	Alaudidae	Calendulauda africanoides	LC
Passeriformes	Cisticolidae	Camaroptera brachyura	LC
Passeriformes	Hirundinidae	Cecropis abyssinica	LC
Cuculiformes	Cuculidae	Centropus superciliosus	LC
Coraciiformes	Alcedinidae	Ceryle rudis	LC
Charadriiformes	Charadriidae	Charadrius tricollaris	LC
Charadriiformes	Laridae	Chlidonias hybrida	LC
Charadriiformes	Laridae	Chlidonias leucopterus	LC
Charadriiformes	Laridae	Chroicocephalus cirrocephalus	LC
Passeriformes	Muscicapidae	Cichladusa guttata	LC
Coliiformes	Coliidae	Colius striatus	LC
Coraciiformes	Coraciidae	Coracias caudatus	LC
Passeriformes	Corvidae	Corvus albus	LC
Passeriformes	Corvidae	Corvus capensis	LC
Musophagiformes	Musophagidae	Corythaixoides personatus	LC
Passeriformes	Sturnidae	Creatophora cinerea	LC
Passeriformes	Fringillidae	Crithagra striolata	LC
Cuculiformes	Cuculidae	Cuculus solitarius	LC
Piciformes	Picidae	Dendropicos goertae	LC
Passeriformes	Dicruridae	Dicrurus adsimilis	LC
Passeriformes	Nectariniidae	Drepanorhynchus reichenowi	LC
Passeriformes	Malaconotidae	Dryoscopus gambensis	LC
Pelecaniformes	Ardeidae	Egretta garzetta	LC
Pelecaniformes	Ardeidae	Egretta intermedia	LC
Passeriformes	Muscicapidae	Empidornis semipartitus	LC
Passeriformes	Ploceidae	Euplectes progne	LC
Falconiformes	Falconidae	Falco tinnunculus	LC
Gruiformes	Rallidae	Fulica cristata	LC
Strigiformes	Strigidae	Glaucidium perlatum	LC
Passeriformes	Estrildidae	Granatina ianthinogaster	LC
Charadriiformes	Recurvirostridae	Himantopus himantopus	LC
Passeriformes	Hirundinidae	Hirundo rustica	LC
Passeriformes	Hirundinidae	Hirundo smithii	LC
Passeriformes	Estrildidae	Lagonosticta rubricata	LC
Passeriformes	Sturnidae	Lamprotornis chalybaeus	LC
Passeriformes	Sturnidae	Lamprotornis hildebrandti	LC

Passeriformes	Sturnidae	Lamprotornis purpuroptera	LC
Passeriformes	Sturnidae	Lamprotornis superbus	LC
Passeriformes	Malaconotidae	Laniarius aethiopicus	LC
Passeriformes	Laniidae	Lanius excubitoroides	LC
Accipitriformes	Accipitridae	Lophaetus occipitalis	LC
Coraciiformes	Meropidae	Merops apiaster	LC
Coraciiformes	Meropidae	Merops pusillus	LC
Suliformes	Phalacrocoracidae	Microcarbo africanus	LC
Accipitriformes	Accipitridae	Milvus migrans	LC
Passeriformes	Motacillidae	Motacilla aguimp	LC
Passeriformes	Motacillidae	Motacilla clara	LC
Passeriformes	Muscicapidae	Myrmecocichla aethiops	LC
Passeriformes	Nectariniidae	Nectarinia famosa	LC
Passeriformes	Nectariniidae	Nectarinia kilimensis	LC
Galliformes	Numididae	Numida meleagris	LC
Columbiformes	Columbidae	Oena capensis	LC
Passeriformes	Muscicapidae	Oenanthe oenanthe	LC
Passeriformes	Sturnidae	Onychognathus morio	LC
Passeriformes	Oriolidae	Oriolus larvatus	LC
Passeriformes	Passeridae	Passer gongonensis	LC
Pelecaniformes	Pelecanidae	Pelecanus onocrotalus	LC
Pelecaniformes	Pelecanidae	Pelecanus rufescens	LC
Suliformes	Phalacrocoracidae	Phalacrocorax lucidus	LC
Charadriiformes	Scolopacidae	Philomachus pugnax	LC
Phoenicopteriformes	Phoenicopteridae	Phoenicopterus roseus	LC
Bucerotiformes	Phoeniculidae	Phoeniculus purpureus	LC
Passeriformes	Sturnidae	Pholia sharpii	LC
Pelecaniformes	Threskiornithidae	Platalea alba	LC
Pelecaniformes	Threskiornithidae	Plegadis falcinellus	LC
Passeriformes	Ploceidae	Ploceus baglafecht	LC
Passeriformes	Ploceidae	Ploceus pelzelni	LC
Accipitriformes	Accipitridae	Polemaetus bellicosus	LC
Accipitriformes	Accipitridae	Polyboroides typus	LC
Passeriformes	Hirundinidae	Pseudhirundo griseopyga	LC
Passeriformes	Hirundinidae	Riparia paludicola	LC
Charadriiformes	Rostratulidae	Rostratula benghalensis	LC
Pelecaniformes	Scopidae	Scopus umbretta	LC
Passeriformes	Estrildidae	Spermestes bicolor	LC
Passeriformes	Estrildidae	Spermestes cucullata	LC
Columbiformes	Columbidae	Streptopelia decipiens	LC
Columbiformes	Columbidae	Streptopelia semitorquata	LC
Columbiformes	Columbidae	Streptopelia senegalensis	LC
Passeriformes	Sylviidae	Sylvia abyssinica	LC
Passeriformes	Muscicapidae	Thamnolaea cinnamomeiventris	LC
Pelecaniformes	Threskiornithidae	Threskiornis aethiopicus	LC
Piciformes	Ramphastidae	Tricholaema diademata	LC
Charadriiformes	Scolopacidae	Tringa nebularia	LC
Passeriformes	Leiothrichidae	Turdoides melanops	LC
Columbiformes	Columbidae	Turtur chalcospilos	LC

Bucerotiformes	Upupidae	Upupa epops	LC
Passeriformes	Estrildidae	Uraeginthus bengalus	LC
Passeriformes	Viduidae	Vidua macroura	LC
Gruiformes	Rallidae	Zapornia flavirostra	LC

NYANDARUA SPUR ROADS

Family	**Species Name (IUCN Status)**
Order: Accipitriformes	
Accipitridae	Lophaetus occipitalis (LC), Milvus migrans (LC)
Order: Anseriformes	

Anatidae	Alopochen aegyptiaca (LC), Anas sparsa (LC), Anas undulata (LC), Netta erythrophthalma (LC)
Order: Apodiformes	
Apodidae	Apus affinis (LC), Apus apus (LC)
Order: Charadriiformes	
Charadriidae	Charadrius hiaticula (LC), Vanellus armatus (LC), Vanellus coronatus (LC)
Scolopacidae	Actitis hypoleucos (LC)
Order: Coliiformes	
Coliidae	Colius striatus (LC)
Order: Columbiformes	
Columbidae	Columba guinea (LC), Streptopelia capicola (LC), Streptopelia semitorquata (LC), Streptopelia senegalensis (LC),
Order: Coraciiformes	
Alcedinidae	Alcedo cristata (LC), Ceryle rudis (LC)
Meropidae	Merops oreobates (LC)
Order: Cuculiformes	
Cuculidae	Centropus monachus (LC)
Order: Gruiformes	
Gruidae	Balearica regulorum (EN)
Order: Passeriformes	
Acrocephalidae	Iduna similis (LC)
Cisticolidae	Apalis cinerea (LC), Apalis porphyrolaema (LC), Camaroptera brachyura (LC), Cisticola cantans (LC), Cisticola hunteri (LC)
Corvidae	Corvus albus (LC), Corvus capensis (LC)
Estrildidae	Estrilda astrild (LC), Spermestes cucullata (LC)
Fringillidae	Crithagra burtoni (LC), Crithagra citrinelloides (LC), Crithagra striolata (LC), Crithagra sulphurata (LC), Serinus flavivertex (LC)
Hirundinidae	Cecropis daurica (LC), Cecropis senegalensis (LC), Delichon urbicum (LC), Hirundo angolensis (LC), Hirundo rustica (LC), Hirundo smithii (LC), Psalidoprocne albiceps (LC), Psalidoprocne pristoptera (LC), Riparia cincta (LC), Riparia paludicola (LC), Riparia riparia (LC),
Laniidae	Lanius humeralis (LC)
Locustellidae	Bradypterus cinnamomeus (LC)
Malaconotidae	Laniarius major (LC)
Monarchidae	Terpsiphone viridis (LC)
Motacillidae	Anthus cinnamomeus (LC), Anthus trivialis (LC), Hemimacronyx sharpei (LC), Macronyx croceus (LC), Motacilla aguimp (LC)
Muscicapidae	Cossypha caffra (LC), Dioptrornis fischeri (LC), Muscicapa adusta (LC), Turdus abyssinicus (LC)
Nectariniidae	Cinnyris mediocris (LC), Cinnyris venustus (LC), Drepanorhynchus reichenowi (LC), Nectarinia kilimensis (LC)
Passeridae	Passer domesticus (LC)
Phylloscopidae	Phylloscopus trochilus (LC)
Ploceidae	Ploceus baglafecht (LC), Ploceus cucullatus (LC), Ploceus jacksoni (LC)
Pycnonotidae	Eurillas latirostris (LC), Pycnonotus barbatus (LC)
Sturnidae	Lamprotornis superbus (LC)
Viduidae	Vidua macroura (LC)
Zosteropidae	Zosterops senegalensis (LC)
Order: Pelecaniformes	

Ardeidae	Ardea alba (LC), Ardea melanocephala (LC), Egretta garzetta (LC), Egretta intermedia (LC)
Scopidae	Scopus umbretta (LC)
Threskiornithidae	Bostrychia hagedash (LC), Platalea alba (LC), Plegadis falcinellus (LC), Threskiornis aethiopicus (LC)
Order: Piciformes	
Indicatoridae	Indicator indicator (LC)

13.3 Appendix III: Invertebrate Species Diversity

IHITHE-NDUNYU NJERU ROAD

	Common Group Name	Family	Species	IUCN Red List Status
	Order: Coleoptera			
1.	Beetles	Scarabaeidae	Epidrepanus kenyensis	–
2.		Carabidae	*Typhloscaris aberdarensis*	
	Order: Diptera			
3.	Earwig	Forficulidae	*Diaperasticus erythrocephalus*	LC
4.	Flies	Sarcophagidae	*Hoplacephala inermis*	LC
5.	Flies	Tephritidae	Bactrocera invadens	LC
6.	Flies	Tephritidae	Capparimyia melanaspis	LC
7.	Flies	Tephritidae	Ceratitis capitata	–
8.	Flies	Tephritidae	Ceratitis cosyra	–
9.	Flies	Tephritidae	Ceratitis podocarpi	–
10.	Flies	Tephritidae	Ceratitis venusta	–
11.	Flies	Mycetophilidae	Clastobasis sp.	–
12.	Flies	Tephritidae	Dacus apostata	–
13.	Flies	Tephritidae	Dacus bivittatus	–
14.	Flies	Tephritidae	Dacus siliqualactis	–
15.	Flies	Tephritidae	Dacus siliqualactis	–
16.	Flies	Tephritidae	Dacus tenebricus	–
17.	Flies	Tephritidae	Dacus triater	–
18.	Flies	Sarcophagidae	Hoplacephala inermis	–
19.	Flies	Asilidae	Lobus kenyae	–
20.	Flies	Agromyzidae	Melanagromyza heatoni	–
21.	Flies	Agromyzidae	*Chromatomyia seneciophila*	
22.	Flies	Agromyzidae	*Chromatomyia subnigra*	
23.	Flies	Sarcophagidae	Senotainia irwini	–
24.	Flies	Sarcophagidae	Senotainia patersoni	–
25.	Flies	Calliphoridae	Tricyclea bifrons	–
26.	Flies	Calliphoridae	*Pericallimyia immaculata*	CL
27.	Flies	Ephydridae	*Lamproscatella africana*	LC
28.	Flies	Tephritidae	Trirhithrum coffeae	–
29.	Flies	Tephritidae	Trirhithrum occipitale	–
	Order: Hymenoptera			
30.	Sawflies, wasps, bees, and ants	Formicidae	Anomma sp.	–
31.	Sawflies, wasps, bees, and ants	Eumenidae	Antepipona albocincta	–
32.	Sawflies, wasps, bees, and ants	Eumenidae	Antepipona defracta	–

33.	Sawflies, wasps, bees, and ants	Formicidae	Camponotus maculatus	–
34.	Sawflies, wasps, bees, and ants	Formicidae	Camponotus orinobates	–
35.	Sawflies, wasps, bees, and ants	Crabronidae	Cerceris andersoni	–
36.	Sawflies, wasps, bees, and ants	Crabronidae	Cerceris erythroura	–
37.	Sawflies, wasps, bees, and ants	Crabronidae	Cerceris trichionota	–
38.	Sawflies, wasps, bees, and ants	Crabronidae	Cerceris yngvei	–
39.	Sawflies, wasps, bees, and ants	Formicidae	Dorylus buyssoni	–
40.	Sawflies, wasps, bees, and ants	Formicidae	Monomorium westi	–
41.	Sawflies, wasps, bees, and ants	Formicidae	Pachycondyla berthoudi	–
42.	Sawflies, wasps, bees, and ants	Formicidae	Pachycondyla sp.	–
43.	Sawflies, wasps, bees, and ants	Formicidae	Pheidole crassinoda	–
44.	Sawflies, wasps, bees, and ants	Formicidae	Plectroctena mandibularis	–
45.	Sawflies, wasps, bees, and ants	Formicidae	Polyrhachis cephalotes	–
46.	Sawflies, wasps, bees, and ants	Formicidae	Polyrhachis viscosa	–
47.	Sawflies, wasps, bees, and ants	Formicidae	Technomyrmex albipes	–
48.	Sawflies, wasps, bees, and ants	Formicidae	Technomyrmex ilgi	–
49.	Sawflies, wasps, bees, and ants	Formicidae	Tetraponera ambigua	–
50.	Sawflies, wasps, bees, and ants	Formicidae	Tetraponera sp.	–
51.	**Order: Lepidoptera**			
52.	Butterflies and Moths	Sphingidae	Acherontia atropos	–
53.	Butterflies and Moths	Sphingidae	Acherontia atropos	–
54.	Butterflies and Moths	Nymphalidae	Acraea eponina	–
55.	Butterflies and Moths	Nymphalidae	Acraea lycoa	–
56.	Butterflies and Moths	Nymphalidae	Acraea sotikensis	–
57.	Butterflies and Moths	Sphingidae	Agrius convolvuli	–
58.	Butterflies and Moths	Arctiidae	Amphicallia sp.	–
59.	Butterflies and Moths	Sphingidae	Andriasa contraria	–
60.	Butterflies and Moths	Pieridae	Belenois aurota	LC
61.	Butterflies and Moths	Pieridae	Belenois creona	LC
62.	Butterflies and Moths	Hesperiidae	Celaenorrhinus galenus	–

63.	Butterflies and Moths	Nolidae	Celama melanoscelis	–
64.	Butterflies and Moths	Sphingidae	Cephonodes hylas	–
65.	Butterflies and Moths	Sphingidae	Cephonodes trochilus	–
66.	Butterflies and Moths	Sphingidae	Ceridia mira	–
67.	Butterflies and Moths	Sphingidae	Chaerocina dohertyi	–
68.	Butterflies and Moths	Nymphalidae	Charaxes ansorgei	–
69.	Butterflies and Moths	Nymphalidae	Charaxes cithaeron	LC
70.	Butterflies and Moths	Hesperiidae	Coeliades anchises	LC
71.	Butterflies and Moths	Hesperiidae	Coeliades forestan	LC
72.	Butterflies and Moths	Hesperiidae	Coeliades libeon	LC
73.	Butterflies and Moths	Sphingidae	Coelonia mauritii	–
74.	Butterflies and Moths	Pieridae	Colias electo	LC
75.	Butterflies and Moths	Pieridae	Colotis aurigineus	–
76.	Butterflies and Moths	Pieridae	Colotis euippe	LC
77.	Butterflies and Moths	Erebidae	Cyana sp.	–
78.	Butterflies and Moths	Nymphalidae	Danaus chrysippus	LC
79.	Butterflies and Moths	Sphingidae	Daphnis nerii	–
80.	Butterflies and Moths	Hesperiidae	Eagris sabadius	–
81.	Butterflies and Moths	Sphingidae	Falcatula falcatus	–
82.	Butterflies and Moths	Sphingidae	Hyles lineata	–
83.	Butterflies and Moths	Sphingidae	Leucostrophus alterhirundo	–
84.	Butterflies and Moths	Pieridae	Mylothris poppea	LC
85.	Butterflies and Moths	Pieridae	Mylothris rueppellii	LC
86.	Butterflies and Moths	Nymphalidae	Neocoenyra gregorii	–
87.	Butterflies and Moths	Sphingidae	Nephele accentifera	–
88.	Butterflies and Moths	Sphingidae	Nephele comma	–
89.	Butterflies and Moths	Sphingidae	Nephele funebris	–
90.	Butterflies and Moths	Sphingidae	Nephele oenopion	–
91.	Butterflies and Moths	Sphingidae	Nephele vau	–
92.	Butterflies and Moths	Nolidae	Nola sp.	–

93.	Butterflies and Moths	Papilionidae	Papilio demodocus	LC
94.	Butterflies and Moths	Papilionidae	Papilio sp.	–
95.	Butterflies and Moths	Nymphalidae	Phalanta phalantha	LC
96.	Butterflies and Moths	Pieridae	Pinacopteryx eriphia	LC
97.	Butterflies and Moths	Sphingidae	Poliana sp.	–
98.	Butterflies and Moths	Sphingidae	Polyptychoides grayii	–
99.	Butterflies and Moths	Nymphalidae	Precis sp.	–
100.	Butterflies and Moths	Sphingidae	Pseudoclanis postica	–
101.	Butterflies and Moths	Sphingidae	Rhodafra opheltes	–
102.	Butterflies and Moths	Noctuidae	Sesamia firmata	–
103.	Butterflies and Moths	Sphingidae	Temnora marginata	–
104.	Butterflies and Moths	Sphingidae	Temnora plagiata	–
105.	Butterflies and Moths	Sphingidae	Temnora scheveni	–
106.	Butterflies and Moths	Sphingidae	Theretra capensis	–
107.	Butterflies and Moths	Sphingidae	Theretra orpheus	–
108.	Butterflies and Moths	Hesperiidae	Zenonia zeno	LC
109.	**Order: Trombidiformes**			
110.	Mites	Hydrodromidae	Hydrodroma perreptans	–

NYERI SPUR ROADS

Common Group Name	Family	Species	IUCN Red List Status
Order: Coleoptera			
Beetles	Scarabaeidae	Epidrepanus kenyensis	–
Order: Diptera			
Flies	Tephritidae	Bactrocera invadens	–
Flies	Tephritidae	Capparimyia melanaspis	–
Flies	Tephritidae	Ceratitis capitata	–
Flies	Tephritidae	Ceratitis cosyra	–
Flies	Tephritidae	Ceratitis podocarpi	–
Flies	Tephritidae	Ceratitis venusta	–
Flies	Mycetophilidae	Clastobasis sp.	–
Flies	Tephritidae	Dacus apostata	–
Flies	Tephritidae	Dacus bivittatus	–
Flies	Tephritidae	Dacus siliqualactis	–
Flies	Tephritidae	Dacus siliqualactis	–
Flies	Tephritidae	Dacus tenebricus	–
Flies	Tephritidae	Dacus triater	–
Flies	Sarcophagidae	Hoplacephala inermis	–
Flies	Asilidae	Lobus kenyae	–
Flies	Agromyzidae	Melanagromyza heatoni	–
Flies	Sarcophagidae	Senotainia irwini	–
Flies	Sarcophagidae	Senotainia patersoni	–
Flies	Calliphoridae	Tricyclea bifrons	–
Flies	Tephritidae	Trirhithrum coffeae	–
Flies	Tephritidae	Trirhithrum occipitale	–
Order: Hymenoptera			
Sawflies, wasps, bees, and ants	Formicidae	Anomma sp.	–
Sawflies, wasps, bees, and ants	Eumenidae	Antepipona albocincta	–
Sawflies, wasps, bees, and ants	Eumenidae	Antepipona defracta	–
Sawflies, wasps, bees, and ants	Formicidae	Camponotus maculatus	–
Sawflies, wasps, bees, and ants	Formicidae	Camponotus orinobates	–
Sawflies, wasps, bees, and ants	Crabronidae	Cerceris andersoni	–
Sawflies, wasps, bees, and ants	Crabronidae	Cerceris erythroura	–
Sawflies, wasps, bees, and ants	Crabronidae	Cerceris trichionota	–
Sawflies, wasps, bees, and ants	Crabronidae	Cerceris yngvei	–
Sawflies, wasps, bees, and ants	Formicidae	Dorylus buyssoni	–

Sawflies, wasps, bees, and ants	Formicidae	Monomorium westi	–
Sawflies, wasps, bees, and ants	Formicidae	Pachycondyla berthoudi	–
Sawflies, wasps, bees, and ants	Formicidae	Pachycondyla sp.	–
Sawflies, wasps, bees, and ants	Formicidae	Pheidole crassinoda	–
Sawflies, wasps, bees, and ants	Formicidae	Plectroctena mandibularis	–
Sawflies, wasps, bees, and ants	Formicidae	Polyrhachis cephalotes	–
Sawflies, wasps, bees, and ants	Formicidae	Polyrhachis viscosa	–
Sawflies, wasps, bees, and ants	Formicidae	Technomyrmex albipes	–
Sawflies, wasps, bees, and ants	Formicidae	Technomyrmex ilgi	–
Sawflies, wasps, bees, and ants	Formicidae	Tetraponera ambigua	–
Sawflies, wasps, bees, and ants	Formicidae	Tetraponera sp.	–
Order: Lepidoptera			
Butterflies and Moths	Sphingidae	Acherontia atropos	–
Butterflies and Moths	Sphingidae	Acherontia atropos	–
Butterflies and Moths	Nymphalidae	Acraea eponina	–
Butterflies and Moths	Nymphalidae	Acraea lycoa	–
Butterflies and Moths	Nymphalidae	Acraea sotikensis	–
Butterflies and Moths	Sphingidae	Agrius convolvuli	–
Butterflies and Moths	Arctiidae	Amphicallia sp.	–
Butterflies and Moths	Sphingidae	Andriasa contraria	–
Butterflies and Moths	Pieridae	Belenois aurota	LC
Butterflies and Moths	Pieridae	Belenois creona	LC
Butterflies and Moths	Hesperiidae	Celaenorrhinus galenus	–
Butterflies and Moths	Nolidae	Celama melanoscelis	–
Butterflies and Moths	Sphingidae	Cephonodes hylas	–
Butterflies and Moths	Sphingidae	Cephonodes trochilus	–
Butterflies and Moths	Sphingidae	Ceridia mira	–
Butterflies and Moths	Sphingidae	Chaerocina dohertyi	–
Butterflies and Moths	Nymphalidae	Charaxes ansorgei	–
Butterflies and Moths	Nymphalidae	Charaxes cithaeron	LC
Butterflies and Moths	Hesperiidae	Coeliades anchises	LC
Butterflies and Moths	Hesperiidae	Coeliades forestan	LC
Butterflies and Moths	Hesperiidae	Coeliades libeon	LC
Butterflies and Moths	Sphingidae	Coelonia mauritii	–
Butterflies and Moths	Pieridae	Colias electo	LC
Butterflies and Moths	Pieridae	Colotis aurigineus	–
Butterflies and Moths	Pieridae	Colotis euippe	LC

Butterflies and Moths	Erebidae	Cyana sp.	–
Butterflies and Moths	Nymphalidae	Danaus chrysippus	LC
Butterflies and Moths	Sphingidae	Daphnis nerii	–
Butterflies and Moths	Hesperiidae	Eagris sabadius	–
Butterflies and Moths	Sphingidae	Falcatula falcatus	–
Butterflies and Moths	Sphingidae	Hyles lineata	–
Butterflies and Moths	Sphingidae	Leucostrophus alterhirundo	–
Butterflies and Moths	Pieridae	Mylothris poppea	LC
Butterflies and Moths	Pieridae	Mylothris rueppellii	LC
Butterflies and Moths	Nymphalidae	Neocoenyra gregorii	–
Butterflies and Moths	Sphingidae	Nephele accentifera	–
Butterflies and Moths	Sphingidae	Nephele comma	–
Butterflies and Moths	Sphingidae	Nephele funebris	–
Butterflies and Moths	Sphingidae	Nephele oenopion	–
Butterflies and Moths	Sphingidae	Nephele vau	–
Butterflies and Moths	Nolidae	Nola sp.	–
Butterflies and Moths	Papilionidae	Papilio demodocus	LC
Butterflies and Moths	Papilionidae	Papilio sp.	–
Butterflies and Moths	Nymphalidae	Phalanta phalantha	LC
Butterflies and Moths	Pieridae	Pinacopteryx eriphia	LC
Butterflies and Moths	Sphingidae	Poliana sp.	–
Butterflies and Moths	Sphingidae	Polyptychoides grayii	–
Butterflies and Moths	Nymphalidae	Precis sp.	–
Butterflies and Moths	Sphingidae	Pseudoclanis postica	–
Butterflies and Moths	Sphingidae	Rhodafra opheltes	–
Butterflies and Moths	Noctuidae	Sesamia firmata	–
Butterflies and Moths	Sphingidae	Temnora marginata	–
Butterflies and Moths	Sphingidae	Temnora plagiata	–
Butterflies and Moths	Sphingidae	Temnora scheveni	–
Butterflies and Moths	Sphingidae	Theretra capensis	–
Butterflies and Moths	Sphingidae	Theretra orpheus	–
Butterflies and Moths	Hesperiidae	Zenonia zeno	LC
Order: Trombidiformes			
Mites	Hydrodromidae	Hydrodroma perreptans	–

NYANDARUA SPUR ROADS

Order	Common Name	Family	Species Name	IUCN Status
Coleoptera	Beetles	Carabidae	*Typhloscaris aberdarensis*	LC
Coleoptera	Beetles	Scarabaeidae	*Epidrepanus kenyensis*	LC
Dermaptera	Earwig	Forficulidae	*Diaperasticus erythrocephalus*	LC
Diptera	Flies	Agromyzidae	*Chromatomyia seneciophila*	LC
Diptera	Flies	Agromyzidae	*Chromatomyia subnigra*	LC
Diptera	Flies	Agromyzidae	*Melanagromyza heatoni*	LC
Diptera	Flies	Calliphoridae	*Pericallimyia immaculata*	LC
Diptera	Flies	Ephydridae	*Lamproscatella africana*	LC
Diptera	Flies	Sarcophagidae	*Hoplacephala inermis*	LC
Diptera	Flies	Sarcophagidae	*Sarcophaga suffusa*	LC
Diptera	Flies	Tephritidae	*Bactrocera invadens*	LC
Diptera	Flies	Tephritidae	*Capparimyia melanaspis*	LC
Lepidoptera	Butterflies and Moths	Hesperiidae	*Coeliades forestan*	LC
Lepidoptera	Butterflies and Moths	Nymphalidae	*Acraea lycoa*	LC
Lepidoptera	Butterflies and Moths	Nymphalidae	*Neocoenyra gregorii*	LC
Lepidoptera	Butterflies and Moths	Nymphalidae	*Phalanta phalantha*	LC
Lepidoptera	Butterflies and Moths	Pieridae	*Colotis aurigineus*	LC
Lepidoptera	Butterflies and Moths	Pieridae	*Colotis celimene*	LC
Lepidoptera	Butterflies and Moths	Pieridae	*Mylothris rueppellii*	LC
Lepidoptera	Butterflies and Moths	Pieridae	*Pinacopteryx eriphia*	LC
Lepidoptera	Butterflies and Moths	Sphingidae	*Acherontia atropos*	LC
Lepidoptera	Butterflies and Moths	Sphingidae	*Agrius convolvuli*	LC
Lepidoptera	Butterflies and Moths	Sphingidae	*Cephonodes trochilus*	LC
Lepidoptera	Butterflies and Moths	Sphingidae	*Daphnis nerii*	LC
Lepidoptera	Butterflies and Moths	Sphingidae	*Hyles lineata*	LC
Coleoptera	Beetles	Gyrinidae	*Aulonogyrus centralis*	LC
Coleoptera	Beetles	Hydrophilidae	*Hydrochares flavipalpis*	LC
Coleoptera	Beetles	Psephenidae	*Afrobrianax ferdyi*	LC

Diptera	True flies	Tipulidae	*Nephrotoma sp.*	LC
Ephemeroptera	Mayflies	Baetidae	*Acanthiops griffithsi*	LC
Ephemeroptera	Mayflies	Baetidae	*Acanthiops spp*	LC
Ephemeroptera	Mayflies	Baetidae	*Baetis sp.*	LC
Ephemeroptera	Mayflies	Baetidae	*Dabulamanzia sp*	LC
Ephemeroptera	Mayflies	Baetidae	*Xyrodromeus africanus*	LC
Ephemeroptera	Mayflies	Caenidae	*Caenis spp*	LC
Ephemeroptera	Mayflies	Heptagenidae	*Afronurus spp*	LC
Ephemeroptera	Mayflies	Leptophlebiidae	*Euthraulus spp*	LC
Ephemeroptera	Mayflies	Oligoneuriidae	*Oligoneuriopsis dobbsi*	LC
Hemiptera	True bugs	Corixidae	*Micronecta spp*	LC
Hemiptera	True bugs	Naucoridae	*Laccocoris limigenus*	LC
Hemiptera	True bugs	Naucoridae	*Neomacrocoris spp*	LC
Hemiptera	True bugs	Veliidae	*Rhagovelia sp*	LC
Hemiptera	True bugs	Veliidae	*Xiphoveloidea sp.*	LC
Odonata	Dragonflies	Aeshnidae	*Aeshna ellioti*	LC
Odonata	Dragonflies	Aeshnidae	*Anax tritis*	LC
Odonata	Dragonflies	Aeshnidae	*Gynacantha manderica*	LC
Odonata	Dragonflies	Coenagrionidae	*Africallagma glauca*	LC
Odonata	Dragonflies	Coenagrionidae	*Ischnura senegalensis*	LC
Odonata	Dragonflies	Coenagrionidae	*Proischnura subfurcata*	LC
Odonata	Dragonflies	Coenagrionidae	*Pseudagrion gamblesi*	LC
Odonata	Dragonflies	Coenagrionidae	*Pseudagrion melanicterum*	LC
Odonata	Dragonflies	Coenagrionidae	*Pseudagrion sublacteum*	LC
Odonata	Dragonflies	Gomphidae	*Ceratogomphus sp*	LC
Odonata	Dragonflies	Gomphidae	*Ictinogomphus ferox*	LC
Odonata	Dragonflies	Gomphidae	*Onychogomphus supinus*	LC
Odonata	Dragonflies	Gomphidae	*Phyllomacromia picta*	LC
Odonata	Dragonflies	Lestidae	*Lestes dissimulans*	LC
Odonata	Dragonflies	Lestidae	*Lestes Pallidus*	LC
Odonata	Dragonflies	Libellulidae	*Nesciothemis farinosa*	LC
Odonata	Dragonflies	Libellulidae	*Trithemis arteriosa*	LC
Odonata	Dragonflies	Libellulidae	*Trithemis furva*	LC
Odonata	Dragonflies	Libellulidae	*Trithemis stictica*	LC
Odonata	Dragonflies	Libellulidae	*Zygonx torridus*	LC
Odonata	Dragonflies	Libelullidae	*Atoconeura biordinata*	LC
Odonata	Dragonflies	Libelullidae	*Diplocodes luminans*	LC
Odonata	Dragonflies	Libelullidae	*Hemistigma albipuctum*	LC
Odonata	Dragonflies	Libelullidae	*Orthetrum caffrum*	LC
Odonata	Dragonflies	Libelullidae	*Palpopleura graffei*	LC
Odonata	Dragonflies	Libelullidae	*Tetrathemis polleni*	LC
Plecoptera	Stoneflies	Perlidae	*Neoperia spio*	LC
Trichoptera	Caddisflies	Calamoceratidae	*Anisocentropus fulvus*	LC
Trichoptera	Caddisflies	Hydropsychidae	*Chematopsyche spp*	LC
Trichoptera	Caddisflies	Hydropsychidae	*Diplectronella sp.*	LC
Trichoptera	Caddisflies	Hydropsychidae	*macronemum capensis*	LC
Trichoptera	Caddisflies	Lepidostomatidae	*Georodes kaswabilenga*	LC

Trichoptera	Caddisflies	Leptoceridae	*Serodes sp.*	LC
Trichoptera	Caddisflies	Leptoceridae	*Trichosetodes sp.*	LC

13.4 Appendix IV: Plant Species Diversity

IHITHE-NDUNYU NJERU ROAD

Order	Family	Species Name	IUCN Status
Apiales	Apiaceae	*Afroligusticum elgonense*	LC
Apiales	Apiaceae	*Afrosciadium kerstenii*	LC
Apiales	Apiaceae	*Daucus incognitus*	LC
Apiales	Apiaceae	*Daucus melananthos*	LC
Apiales	Apiaceae	*Haplosciadium abyssinicum*	LC
Apiales	Apiaceae	*Oreoschimperella aberdarensis*	LC
Asparagales	Asphodelaceae	*Kniphofia thomsonii*	LC
Asparagales	Iridaceae	*Dierama cupuliflorum*	LC
Asparagales	Iridaceae	*Gladiolus watsonioides*	LC
Asparagales	Orchidaceae	*Aerangis thomsonii*	LC
Asparagales	Orchidaceae	*Habenaria keniensis*	LC
Asparagales	Orchidaceae	*Tridactyle furcistipes*	LC
Asterales	Asteraceae	*Anthemis tigreensis*	LC
Asterales	Asteraceae	*Bidens rueppellii*	LC
Asterales	Asteraceae	*Carduus millefolius*	LC
Asterales	Asteraceae	*Carduus sylvarum*	LC
Asterales	Asteraceae	*Crepis carbonaria*	LC
Asterales	Asteraceae	*Dendrosenecio battiscombei*	LC
Asterales	Asteraceae	*Dendrosenecio brassiciformis*	LC
Asterales	Asteraceae	*Echinops hoehnelii*	LC
Asterales	Asteraceae	*Guizotia jacksonii*	LC
Asterales	Asteraceae	*Helichrysum argyranthum*	LC
Asterales	Asteraceae	*Helichrysum chionoides*	LC
Asterales	Asteraceae	*Helichrysum citrispinum*	LC
Asterales	Asteraceae	*Helichrysum ellipticifolium*	LC
Asterales	Asteraceae	*Helichrysum forskahlii*	LC
Asterales	Asteraceae	*Helichrysum gloria-dei*	LC
Asterales	Asteraceae	*Senecio crispatipilosus*	LC
Asterales	Asteraceae	*Senecio schweinfurthii*	LC
Asterales	Asteraceae	*Sonchus luxurians*	LC
Asterales	Campanulaceae	*Lobelia bambuseti*	LC
Asterales	Campanulaceae	*Lobelia gregoriana*	LC
Asterales	Campanulaceae	*Lobelia telekii*	LC
Boraginales	Ehretiaceae	*Cordia africana*	LC
Brassicales	Brassicaceae	*Arabidopsis thaliana*	LC
Brassicales	Brassicaceae	*Arabis alpina*	LC
Brassicales	Brassicaceae	*Cardamine hirsuta*	LC
Brassicales	Brassicaceae	*Cardamine obliqua*	LC
Brassicales	Brassicaceae	*Subularia monticola*	LC
Caryophyllales	Caryophyllaceae	*Cerastium afromontanum*	LC
Caryophyllales	Caryophyllaceae	*Uebelinia crassifolia*	LC
Dipsacales	Adoxaceae	*Sambucus ebulus*	LC
Dipsacales	Caprifoliaceae	*Dipsacus pinnatifidus*	LC
Dipsacales	Caprifoliaceae	*Scabiosa columbaria*	LC
Dipsacales	Caprifoliaceae	*Valeriana kilimandscharica*	LC

Ericales	Balsaminaceae	*Impatiens fischeri*	LC
Ericales	Balsaminaceae	*Impatiens hoehnelii*	LC
Ericales	Balsaminaceae	*Impatiens rubromaculata*	LC
Ericales	Ericaceae	*Erica filago*	LC
Ericales	Ericaceae	*Erica rossii*	LC
Ericales	Ericaceae	*Erica whyteana*	LC
Ericales	Primulaceae	*Lysimachia serpens*	LC
Ericales	Primulaceae	*Rapanae melanophloeos*	LC
Ericales	Ericaceae	*Erica arborea*	LC
Ericales	Ericaceae	*Erica trimera*	LC
Ericales	Ericaceae	*Erica excelsa*	LC
Fabales	Fabaceae	*Astragalus atropilosulus*	LC
Fabales	Fabaceae	*Crotalaria agatiflora*	LC
Fabales	Fabaceae	*Indigofera brevicalyx*	LC
Gentianales	Gentianaceae	*Swertia volkensii*	LC
Gentianales	Rubiaceae	*Anthospermum herbaceum*	LC
Gentianales	Rubiaceae	*Anthospermum usambarense*	LC
Gentianales	Rubiaceae	*Canthium oligocarpum*	LC
Gentianales	Rubiaceae	*Galium kenyanum*	LC
Gentianales	Rubiaceae	*Galium ossirwaense*	LC
Gentianales	Rubiaceae	*Oldenlandia friesiorum*	LC
Gentianales	Apocynaceae	*Tabernaemontana stapfiana*	LC
Geraniales	Geraniaceae	*Geranium arabicum*	LC
Hymenophyllales	Hymenophyllaceae	*Hymenophyllum capillare*	LC
Hymenophyllales	Hymenophyllaceae	*Hymenophyllum kuhnii*	LC
Lamiales	Acanthaceae	*Hypoestes triflora*	LC
Lamiales	Lamiaceae	*Leucas volkensii*	LC
Lamiales	Lamiaceae	*Stachys aculeolata*	LC
Lamiales	Lamiaceae	*Stachys alpigena*	LC
Lamiales	Orobanchaceae	*Hedbergia longiflora*	LC
Lamiales	Stilbaceae	*Nuxia congesta*	LC
Lamiales	Stilbaceae	*Nuxia congesta*	LC
Lamiales	Oleaceae	*Olea europaea (africana)*	LC
Laurales	Lauraceae	*Ocotea usambarensis*	LC
Lycopodiales	Lycopodiaceae	*Phlegmariurus saururus*	LC
Malpighiales	Euphorbiaceae	*Euphorbia cussonioides*	LC
Malpighiales	Euphorbiaceae	*Euphorbia engleri*	LC
Malpighiales	Euphorbiaceae	*Euphorbia wellbyi*	LC
Malpighiales	Hypericaceae	*Hypericum kiboense*	LC
Malpighiales	Hypericaceae	*Hypericum revolutum*	LC
Malpighiales	Passifloraceae	*Passiflora mollissima*	LC
Malpighiales	Passifloraceae	*Passiflora subpeltata*	LC
Malpighiales	Peraceae	*Clutia kilimandscharica*	LC
Malpighiales	Phyllanthaceae	*Phyllanthus boehmii*	LC
Malpighiales	Violaceae	*Viola eminii*	LC
Malpighiales	Violaceae	*Viola nannae*	LC
Malpighiales	Rhizophoraceae	*Cassipourea malosana*	LC
Malpighiales	Euphorbiaceae	*Neoboutonia macrocalyx*	LC

Malpighiales	Euphorbiaceae	*Macaranga kilimandscharica*	LC
Malpighiales	Hypericaceae	*Hypericum revolutum*	LC
Malpighiales	Hypericaceae	*Helichrysum nandense*	LC
Marchantiales	Dumortieraceae	*Dumortiera hirsuta*	LC
Oocystales	Oocystaceae	*Eremosphaera viridis*	LC
Orthotrichales	Orthotrichaceae	*Macrocoma abyssinica*	LC
Orthotrichales	Orthotrichaceae	*Macrocoma tenuis*	LC
Pallaviciniales	Pallaviciniaceae	*Symphyogyna podophylla*	LC
Pinales	Podocarpaceae	*Podocarpus milanjianus*	LC
Pinales	Podocarpaceae	*Podocarpus latifolius*	LC
Pinales	Cupressaceae	*Juniperus procera*	LC
Pinales	Podocarpaceae	*Podocarpus falcatus*	LC
Poales	Cyperaceae	*Carex bequaertii*	LC
Poales	Cyperaceae	*Carex conferta*	LC
Poales	Cyperaceae	*Carex elgonensis*	LC
Poales	Cyperaceae	*Carex monostachya*	LC
Poales	Cyperaceae	*Carex simensis*	LC
Poales	Cyperaceae	*Cyperus albosanguineus*	LC
Poales	Cyperaceae	*Cyperus kerstenii*	LC
Poales	Eriocaulaceae	*Eriocaulon mesanthemoides*	LC
Poales	Eriocaulaceae	*Eriocaulon volkensii*	LC
Poales	Juncaceae	*Juncus dregeanus*	LC
Poales	Poaceae	*Agrostis volkensii*	LC
Poales	Poaceae	*Andropogon chrysostachyus*	LC
Poales	Poaceae	*Andropogon lima*	LC
Poales	Poaceae	*Andropogon mannii*	LC
Poales	Poaceae	*Aristida adoensis*	LC
Poales	Poaceae	*Bothriochloa insculpta*	LC
Poales	Poaceae	*Bromus leptoclados*	LC
Poales	Poaceae	*Cenchrus polystachios*	LC
Poales	Poaceae	*Chloris gayana*	LC
Poales	Poaceae	*Dactyloctenium aegyptium*	LC
Poales	Poaceae	*Digitaria abyssinica*	LC
Poales	Poaceae	*Ehrharta erecta*	LC
Poales	Poaceae	*Eleusine africana*	LC
Poales	Poaceae	*Eleusine jaegeri*	LC
Poales	Poaceae	*Eleusine multiflora*	LC
Poales	Poaceae	*Enneapogon persicus*	LC
Poales	Poaceae	*Eragrostis amanda*	LC
Poales	Poaceae	*Eragrostis brainii*	LC
Poales	Poaceae	*Eragrostis olivacea*	LC
Poales	Poaceae	*Eragrostis tenuifolia*	LC
Poales	Poaceae	*Eriochloa procera*	LC
Poales	Poaceae	*Eulalia polyneura*	LC
Poales	Poaceae	*Festuca abyssinica*	LC
Poales	Poaceae	*Festuca pilgeri*	LC
Poales	Poaceae	*Harpachne schimperi*	LC
Poales	Poaceae	*Hyparrhenia anamesa*	LC

Poales	Poaceae	*Hyparrhenia collina*	LC
Poales	Poaceae	*Hyparrhenia papillipes*	LC
Poales	Poaceae	*Melinis repens*	LC
Poales	Poaceae	*Microchloa kunthii*	LC
Poales	Poaceae	*Oplismenus compositus*	LC
Poales	Poaceae	*Panicum deustum*	LC
Poales	Poaceae	*Panicum maximum*	LC
Poales	Poaceae	*Pentameris borussica*	LC
Poales	Poaceae	*Phalaris arundinacea*	LC
Poales	Poaceae	*Setaria kagerensis*	LC
Poales	Poaceae	*Setaria sphacelata*	LC
Poales	Poaceae	*Sporobolus agrostoides*	LC
Poales	Poaceae	*Sporobolus macranthelus*	LC
Poales	Poaceae	*Sporobolus natalensis*	LC
Poales	Poaceae	*Sporobolus pyramidalis*	LC
Poales	Poaceae	*Stipa dregeana*	LC
Poales	Poaceae	*Themeda triandra*	LC
Poales	Poaceae	*Arundinaria alpina*	LC
Polypodiales	Aspleniaceae	*Asplenium anisophyllum*	LC
Polypodiales	Aspleniaceae	*Asplenium praegracile*	LC
Polypodiales	Dryopteridaceae	*Bolbitis gemmifera*	LC
Polypodiales	Dryopteridaceae	*Dryopteris antarctica*	LC
Polypodiales	Dryopteridaceae	*Elaphoglossum deckenii*	LC
Polypodiales	Dryopteridaceae	*Elaphoglossum hybridum*	LC
Polypodiales	Polypodiaceae	*Pleopeltis macrocarpa*	LC
Polypodiales	Pteridaceae	*Adiantum capillus-veneris*	LC
Polypodiales	Pteridaceae	*Adiantum hispidulum*	LC
Polypodiales	Pteridaceae	*Adiantum poiretii*	LC
Polypodiales	Pteridaceae	*Aleuritopteris farinosa*	LC
Polypodiales	Pteridaceae	*Pteris cretica*	LC
Polypodiales	Pteridaceae	*Pteris dentata*	LC
Polytrichales	Polytrichaceae	*Polytrichum subpilosum*	LC
Porellales	Lejeuneaceae	*Drepanolejeunea clavicornis*	LC
Porellales	Radulaceae	*Radula quadrata*	LC
Ranunculales	Berberidaceae	*Berberis holstii*	LC
Rosales	Rhamnaceae	*Rhamnus prinoides*	LC
Rosales	Rosaceae	*Alchemilla abyssinica*	LC
Rosales	Rosaceae	*Alchemilla fischeri*	LC
Rosales	Rosaceae	*Alchemilla pedata*	LC
Rosales	Rosaceae	*Rubus friesiorum*	LC
Rosales	Rosaceae	*Rubus keniensis*	LC
Rosales	Rosaceae	*Prunus africana*	VU
Rosales	Rosaceae	*Hagenia abyssinica*	LC
Rosales	Rosaceae	*Cliffortia nitidula*	LC
Sapindales	Sapindaceae	*Lecaniodiscus fraxinifolius*	LC
Sapindales	Rutaceae	*Calodendrum capense*	LC
Sapindales	Rutaceae	*Teclea nobilis*	LC
Sapindales	Meliaceae	*Ekebergia capensis*	LC

Sapindales	Rutaceae	*Teclea simplicifolia*	LC
Saxifragales	Crassulaceae	*Sedum crassularia*	LC
Solanales	Solanaceae	*Solanum agnewiorum*	LC
Solanales	Solanaceae	*Solanum anguivi*	LC
Solanales	Solanaceae	*Solanum mauense*	LC
Solanales	Solanaceae	*Solanum nigriviolaceum*	LC
Solanales	Solanaceae	*Solanum phoxocarpum*	LC

NYERI SPUR ROADS

Family	**Species**	**IUCN Red List Status**	**Other Conservation Importance**
Order: Asparagales			
Amaryllidaceae	Allium neapolitanum	LC	
Asparagaceae	Agave americana	–	
Asparagaceae	Agave angustifolia	LC	
Asparagaceae	Agave sisalana	–	
Asparagaceae	Albuca virens	–	
Asparagaceae	Asparagus asiaticus	–	
Asparagaceae	Furcraea foetida	–	
Iridaceae	Gladiolus watsonioides	–	
Orchidaceae	Aerangis confusa	–	CITES Appendix II
Orchidaceae	Angraecopsis breviloba	–	
Order: Asterales			
Asteraceae	Cirsium vulgare	–	Noxious Weed
Asteraceae	Parthenium hysterophorus	–	AIPS
Asteraceae	Sonchus luxurians	–	
Asteraceae	Sonchus stenophyllus	–	
Asteraceae	Tithonia diversifolia	–	
Campanulaceae	Lobelia bambuseti	–	
Order: Boraginales			
Boraginaceae	Cynoglossum aequinoctiale	–	
Boraginaceae	Cynoglossum coeruleum	–	
Ehretiaceae	Cordia africana	LC	
Heliotropiaceae	Heliotropium longiflorum	–	
Heliotropiaceae	Heliotropium scotteae	–	
Order: Brassicales			
Brassicaceae	Cardamine hirsuta	–	
Capparaceae	Capparis viminea	LC	
Order: Caryophyllales			
Aizoaceae	Delosperma nakurense	–	
Amaranthaceae	Caroxylon africanum	–	
Amaranthaceae	Chenopodiastrum fasciculosum	–	
Cactaceae	Austrocylindropuntia subulata	LC	

Cactaceae	Opuntia ficus-indica	DD	
Cactaceae	Opuntia monacantha	LC	AIPS
Order: Commelinales			
Commelinaceae	Tradescantia pallida	–	
Order: Fabales			
Fabaceae	Acacia mearnsii	–	AIPS
Fabaceae	Caesalpinia decapetala	LC	AIPS
Fabaceae	Calliandra houstoniana	LC	
Fabaceae	Indigofera brevicalyx	–	
Fabaceae	Senna didymobotrya	LC	
Fabaceae	Senna spectabilis	LC	
Fabaceae	Tephrosia athiensis	–	
Fabaceae	Vigna parkeri	LC	
Order: Gentianales			
Apocynaceae	Cascabela thevetia	LC	
Gentianaceae	Swertia scandens	–	
Rubiaceae	Oldenlandia friesiorum	–	
Rubiaceae	Tennantia sennii	–	
Order: Lamiales			
Bignoniaceae	Jacaranda mimosifolia	VU	
Lamiaceae	Ocimum kilimandscharicum	–	
Verbenaceae	Duranta erecta	LC	
Verbenaceae	Lantana camara	–	AIPS
Order: Malpighiales			
Euphorbiaceae	Croton megalocarpus	LC	
Euphorbiaceae	Ricinus communis	–	
Passifloraceae	Passiflora subpeltata	–	
Rhizophoraceae	Cassipourea celastroides	LC	
Salicaceae	Dovyalis caffra	LC	
Order: Poales			
Poaceae	Aristida adoensis	–	
Poaceae	Avena sterilis	LC	
Poaceae	Bothriochloa insculpta	–	
Poaceae	Cenchrus polystachios	LC	
Poaceae	Chloris gayana	–	
Poaceae	Dactyloctenium aegyptium	–	
Poaceae	Digitaria abyssinica	–	
Poaceae	Ehrharta erecta	–	
Poaceae	Eleusine africana	LC	
Poaceae	Eleusine jaegeri	LC	
Poaceae	Eleusine multiflora	LC	
Poaceae	Enneapogon persicus	–	
Poaceae	Eragrostis brainii	–	
Poaceae	Eragrostis tenuifolia	–	
Poaceae	Eriochloa procera	LC	
Poaceae	Harpachne schimperi	–	

Poaceae	Hyparrhenia anamesa	–	
Poaceae	Hyparrhenia papillipes	–	
Poaceae	Melinis repens	–	
Poaceae	Microchloa kunthii	–	
Poaceae	Oplismenus compositus	LC	
Poaceae	Panicum deustum	–	
Poaceae	Panicum maximum	–	
Poaceae	Phalaris arundinacea	LC	
Poaceae	Setaria kagerensis	–	
Poaceae	Setaria sphacelata	LC	
Poaceae	Sorghum bicolor	LC	
Poaceae	Sporobolus agrostoides	–	
Poaceae	Sporobolus macranthelus	–	
Poaceae	Sporobolus natalensis	–	
Poaceae	Sporobolus pyramidalis	–	
Poaceae	Stipa dregeana	–	
Poaceae	Themeda triandra	–	
Order: Polypodiales			
Pteridaceae	Actiniopteris semiflabellata	–	
Order: Proteales			
Proteaceae	Grevillea robusta	LC	
Order: Solanales			
Convolvulaceae	Ipomoea hildebrandtii	–	
Order: Rosaceae			
	Rubus steudneri	LC	
Solanaceae	Datura stramonium	–	AIPS
Solanaceae	Nicotiana glauca	–	
Solanaceae	Solanum anguivi	LC	
Solanaceae	Solanum campylacanthum	LC	
Solanaceae	Solanum mauritianum	–	
Solanaceae	Solanum nigrum	–	
Order: Zingiberales			
Cannaceae	Canna indica	–	

13.5 Appendix V: Herpetofauna (Amphibians and Reptiles) Species Diversity

IHITHE-NDUNYU NJERU ROAD

Order	Family	Species Name	IUCN Status
Anura	Bufonidae	Amietophrynus kerinyagae	LC
Anura	Bufonidae	Mertensophryne lonnbergi	VU
Anura	Hyperoliidae	Hyperolius montanus	LC
Anura	Phrynobatrachidae	Phrynobatrachus keniensis	LC
Anura	Phrynobatrachidae	Phrynobatrachus kinangopensis	VU
Anura	Phrynobatrachidae	Phrynobatrachus scheffleri	LC
Anura	Pipidae	Xenopus laevis	LC
Anura	Ptychadenidae	Ptychadena mascareniensis	LC
Anura	Pyxicephalidae	Cacosternum boettgeri	LC
Anura	Ranidae	Rana angolensis	LC
Anura	Ranidae	Rana mascareniensis	LC
Anura	Ranidae	Rana wittei	LC
Squamata	Agamidae	Agama agama	LC
Squamata	Chamaeleonidae	Chamaeleo hohneli	LC
Squamata	Chamaeleonidae	Trioceros hoehnelii	LC
Squamata	Chamaeleonidae	Trioceros jacksonii	LC
Squamata	Colubridae	Dasypeltis scabra	LC
Squamata	Lacertidae	Adolfus masavaensis	NT
Squamata	Lamprophiidae	Boaedon fuliginosus	LC
Squamata	Lamprophiidae	Duberria lutrix	LC
Squamata	Lamprophiidae	Lycophidion capense	LC
Squamata	Lamprophiidae	Pseudaspis cana	LC
Squamata	Scincidae	Trachylepis bayonii	LC
Squamata	Scincidae	Trachylepis irregularis	NT
Squamata	Scincidae	Trachylepis striata	LC
Squamata	Scincidae	Trachylepis varia	DD
Squamata	Viperidae	Atheris hindii	LC
Squamata	Viperidae	Montatheris hindii	NT

NYERI SPUR ROADS

Class	Order	Family	Species	IUCN Red List Status
Amphibia	Anura	Ranidae	*Rana sp.*	–
Amphibia	Anura	Hyperoliidae	*Hyperolius viridiflavus*	LC
Amphibia	Anura	Ptychadenidae	*Ptychadena sp.*	–
Amphibia	Anura	Pipidae	*Xenopus laevis*	LC
Amphibia	Anura	Hyperoliidae	*Hyperolius sp.*	–
Amphibia	Anura	Phrynobatrachidae	*Phrynobatrachus sp.*	–
Amphibia	Anura	Pipidae	*Xenopus muelleri*	LC
Amphibia	Anura	Hyperoliidae	*Kassina senegalensis*	LC
Amphibia	Anura	Ptychadenidae	*Ptychadena sp.*	–
Amphibia	Anura	Hyperoliidae	*Hyperolius montanus*	LC
Reptilia	Squamata	Chamaeleonidae	*Trioceros bitaeniatus*	LC
Reptilia	Squamata	Scincidae	*Trachylepis striata*	LC
Reptilia	Squamata	Agamidae	*Agama agama*	LC
Reptilia	Squamata	Colubridae	*Dasypeltis scabra*	LC
Reptilia	Squamata	Colubridae	*Philothamnus sp.*	–
Reptilia	Squamata	Chamaeleonidae	*Trioceros jacksonii*	LC
Reptilia	Squamata	Lamprophiidae	*Pseudaspis cana*	LC
Reptilia	Squamata	Gekkonidae	*Hemidactylus mabouia*	LC
Reptilia	Squamata	Lamprophiidae	*Lycophidion capense*	LC
Reptilia	Squamata	Chamaeleonidae	*Trioceros hoehnelii*	LC
Reptilia	Squamata	Viperidae	*Bitis arietans*	LC

NYANDARUA SPUR ROADS

Order	Family	Species	IUCN Status
Anura	Bufonidae	*Amietophrynus kerinyagae*	LC
Anura	Bufonidae	*Bufo sp.*	-
Anura	Bufonidae	*Mertensophryne lonnbergi*	LC
Anura	Hyperoliidae	*Hyperolius sp.*	-
Anura	Hyperoliidae	*Hyperolius montanus*	LC
Anura	Phrynobatrachidae	*Phrynobatrachus sp.*	LC
Anura	Phrynobatrachidae	*Phrynobatrachus keniensis*	LC
Anura	Phrynobatrachidae	*Phrynobatrachus kinangopensis*	LC
Anura	Phrynobatrachidae	*Phrynobatrachus scheffleri*	LC
Anura	Ptychadenidae	*Ptychadena sp.*	-
Anura	Ptychadenidae	*Ptychadena mascareniensis*	LC
Anura	Pyxicephalidae	*Cacosternum sp.*	LC
Anura	Pyxicephalidae	*Cacosternum boettgeri*	LC
Anura	Ranidae	*Rana sp.*	-
Anura	Ranidae	*Rana angolensis*	LC
Anura	Ranidae	*Rana mascareniensis*	LC
Anura	Ranidae	*Rana wittei*	LC
Squamata	Chamaeleonidae	*Chamaeleo dileps*	LC
Squamata	Agamidae	*Agama agama*	LC
Squamata	Scincidae	*Trachylepis striata*	LC
Squamata	Scincidae	*Trachylepis varia*	DD

13.6 Appendix VI: Ecosystem Services Discussion Guideline for the Proposed Mau Mau Roads; Lot 4

13.7 Appendix VII: Socio-Economic Questionnaires for the Proposed Mau Mau Roads Lot 4

PROPOSED MAU MAU LOT 4: IHITHE - NDUNYU NJERU ROAD PROJECT

MINUTES OF BIODIVERSITY STAKEHOLDERS' ENGAGEMENT MEETING

Date: 12/04/2022 Virtual Meeting via Microsoft Teams	**Start Time**: 10:08 AM **End Time:** 11:50 AM

ATTENDANCE	**ORGANIZATION**
1. Christian Lambrechts	Rhino Ark
2. Micah Aiyabei	Road Engineer- Kenya Wildlife Service
3. Michael Wanjau	Director in harge of Parks and Reserves - Kenya Wildlife Service
4. Peter Mwangi	Principal Research Scientist - Wildlife Research Training Institute-
5. Bernard Omware	Representing Director of Infrastructure - Kenya Wildlife Service
6. Richard Magosi	Senior Environmentalist - KeNHA
7. Mercy Githaiga	Environmentalist - KeNHA
8. George Osuri	Senior Assistant Director Mountain Conservation area based in Aberdares - Kenya Wildlife Service -
9. Joseph Dadacha	Senior Warden Aberdare National Park
10. Japheth Kipsang	Environmentalist - Norken International Ltd (Taking minutes)
11. **L**oise Kioko	Environmentalist - Norken International Ltd
12. Isaiah Kegora	Lead EIA/EA Expert - Norken International Ltd
13. Beatrice Githinji	Sociologist - Norken International Ltd
14. Meshack Muthini	Sociologist - Norken International Ltd
15. Eng. Alex Wawire	Highway Engineer - Norken International Ltd
16. Dickens Odeny	Ecologist - Norken International Ltd

AGENDA

1. Introduction
2. Opening Remarks
3. Remarks by the consultant
4. Concerns/Issues from participants and responses to the issues raised

Item No	**Description**	**Action by**
Min 1/22	**INTRODUCTION**	
	Online meeting for the Stakeholders of Ihithe - Nduntu Njeru road started at 10:08AM. In attendance were representatives from Norken International ltd (**Firm of experts contracted to do EIA/ESIA**), Kenya Forest Service, Rhino Ark, Kenya Wildlife Service, Kenya National Highways Authority and Wildlife Research and Training Institute. The moderator of the meeting Ms Loise Kioko welcomed and thanked all the attendees for taking part of their time to attend the meeting, she in turn gave each attendee an opportunity to introduce themselves and the organization they work for.	*Consultant* *Loise Kioko*
Min 2/22	**Remarks by consultant**	

	After introductions, Ms Kioko proceeded to state the agenda of the meeting. She stated that the meeting was a Stakeholder engagement meeting for the construction of Ihithe - Ndunyu Njeru road. In detail, Loise expounded that the Government of Kenya through its implementation agency KeNHA commissioned a NEMA registered firm Norken International Limited to undertake consultancy services for the provision of design review, construction, supervision of Mau Mau road lot 4; Ihithe - Ndunyu Njeru Road project through Aberdare forest and therefore the meeting was purposely meant to solicit their opinion regarding the project. As anchored in the Constitution of Kenya 2010, Public Participation Bill of 2018 and Environmental Management and Coordination Act (EMCA), 1999, (amended in 2015) Loise stated that stakeholder management was at advanced level as the consultancy firm had already done EIA/ESIA at public participation forum with the people likely to be affected by the road project. After her remarks Loise welcomed Alex Wawire project engineer.	*Loise - Norken International Limited*
Min 3/22	**ESIA process**	
	Description of the Project Eng. Alex briefly explained to stakeholders that he is member of a team of Engineers who are working on the Ihithe - Ndunyu Njeru road project. He stated that the main road project was approximately 52kms long with other spur roads of approximately 46kms situated in Nyeri and Nyandarua counties. He noted that the main road started at Ihithe and takes westerly course through Nyayo tea zones and enters through Aberdare National Park. He highlighted that the area between Ihithe and Kahuruko would be the focus of the meeting as it touches on the Park. He stated it is anticipated that the road reserve would have a span of 40 meters and the carriageway, drainage and other road accessories. He however clarified that the road can fit within a 15-25m width **Biodiversity studies** Dr. Dickens Odeny explained that screening was done as a first step in the ESIA process. He noted that the screening process findings were that the proposed Ihithe - Ndunyu Njeru road project is regarded as a threat to biodiversity as it passes through Aberdare National Park. Dr. Odeny further noted that there was need to do a careful study and assessment so as to come up with clear mitigation measures to minimize on biodiversity loss. He outlined the ESIA methodology including physical observation and collection of relevant baseline data, stakeholder consultation., compilation of the ESMP to mitigate potential impacts on the environment. He further elaborated on the detailed methodology for collecting biological data and conducting biodiversity surveys. He expounded on potential impacts that are likely to happen during the construction phase of the project. These include biodiversity loss, degradation of water resources, potential increased poaching, soil erosion, human-wildlife conflicts, diversion of wildlife movement, Potential accidents (Loss of wildlife), pit falling effects of animals, and noise pollution. Dickens stressed that Biodiversity is an issue that affects everyone and therefore and there was need to create awareness on effect on biodiversity loss. He encouraged the stakeholders and government to educate people on living in equilibrium with the environment citing that it was important to make sure that laws in place ensure biodiversity for the future and not focus on shortsighted economics. He assured the Stakeholders that continuous Assessment will be done to address issues that affect the National reserve. **ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT** Loise welcomed Beatrice – Sociologist to make her presentation.	*Eng. Alex Wawire*

	Beatrice added that it was therefore crucial that stakeholders in any given development are identified and engaged at various levels with an aim of obtaining their views, concerns, suggestions and recommendations, to be incorporated in the project thus the engagement with various parties including national government institutions, county government, civil society organizations, professional bodies, roadside traders and large establishments fronting the proposed alignment, residents along the corridor and various road users including, PSVs vehicle drivers, cyclists, and pedestrians etc. She further outlined the methodology followed in conducting stakeholder engagement including public meetings, key informant meetings and focus group discussions. She informed the participants that public consultations for the Ihithe –Ndunyu Njeru road had already been conducted with the community, and continuous engagement with other stakeholders was ongoing.	***Sociologist***

Min 4/22	**Stakeholder feedback and responses**			
	Issue raised/Question	*Name*	*Response given*	*Name*
Min 4.1	Christian inquired on whether an analysis of project alternatives was expected to be done as part of the ESIA ToR especially on alternative routes and design.	***Christian***	*Isaiah explained that discussion of the project alternatives is required in the ESIA process. The consultant will analyze project alternatives in terms of location, design, and routes for the road.*	Isaiah Kegora
Min 4.2	Christian noted that the wilderness value was not discussed in the presentations. He highlighted that each habitat has a unique wilderness value, and that there is a need to provide mitigations on the impact on wilderness value. The value is determined by how much a habitat is developed. He gave an example of the Nairobi National Park before and after the development of the SGR project where the wilderness value was reduced by the project.	***Christian***	*Critical Habitat Analysis would be followed as per IFC requirements to show how the habitat will be impacted. The Aberdare is listed as a critical Habitat as per IFC ranking.* *Further, Dickens added that the aesthetic value impacts would be considered and mitigation measures would be proposed*	Dickens Odeny *(Biodiversity expert)*
Min 4.3	Having confirmed that KeNHA was the proponent for the subject project, Mr Mwangi sought to know whether issues raised by WRTI and other stakeholders during the initial ESIA (2007/2008) would be addressed differently in the current ESIA. He strongly emphasized on the importance of determining the social impact of having the road passing through the Aberdare Forest which is an important water tower. He sought to know the economic significance of the water catchment. He cited that there will be an impact on the water catchment. He stated that the economic loss will be higher than the gain once the project is implemented.	***Peter Mwangi*** ***Peter Mwangi***	*The project proponent Is the GOK through it implementing agency the KENHA, Isaiah Assured the him that referenced in report writing will be based on the available information as well as the observations made in the field.* *Mr Mogesi appreciated the comments and concerns raised by the stakeholders. He emphasized on the importance of recognizing the significance and magnitude of the impacts identified.*	*Isaiah Kegora* ***Richard Mogesi***

	He stated that he was not yet convinced about the need to construct the road within the park since there are many other alternative roads to navigate from Ndunyu Njeru to Nyeri County.		*He expressed confidence that the consultant would look at the studies that have already been conducted to determine the economic feasibility of the road.*	
Min 4.4	He further emphasized that there is a need to conduct a socioeconomic impact analysis in the ESIA both in terms of water catchment value and as a national park.	***Peter Mwangi***	*Richard acknowledged that KeNHA was aware of the concerns raised previously by the various stakeholders about the proposed project. He assured the participants that there would be a stakeholder workshop in the near future to discuss the findings of the ESIA and the way forward.*	
Min 4.5	Mr Mwangi raised a concern about the steep gradient of the road terrain within the forest. He explained that the steep terrain would necessitate deep cut and fills that would result in heavy pollution of water resources through sedimentation. He also emphasized that this also needs to be addressed in the ESIA	***Peter Mwangi***	*Dr Odeny assured the participants that the concerns raised in the meeting have been recorded and would be addressed*	***Dickens Odeny***
Min 4.6	Further, Peter expressed concern that the vehicle traffic on the road would increase deposition of oil especially from lorries would result in pollution of soil and water resources	***Peter Mwangi***		
Min 4.7	Mr Mwangi concluded by remarking that there was not enough justification for developing the project vis a vis using the available road alternatives. He cited that the negative impacts such as impacts on biodiversity, carbon sinks and ecosystem services.			
Min 4.7	Christian affirmed Mr Mwangi's comments, and recommended that there should be a strong justification as to why the road is being developed in terms of socioeconomic benefits.	***Christian***		
Min 4.8	He sought to know the mechanism that will be made for KWS in terms of payment/park fees for vehicles accessing the park.	***Christian***		

Min 4.9	On legal framework, Christian made reference to the National Spatial plan that was formulated in 2015 effective for a period of 30 years. He cited that the plan does not allow development in the forest except for purposes of ecotourism or research. He requested clarification as to why the highway was being proposed to be developed in the forest which is not in line with the 2015-2045 National Spatial Plan and the Management Plan established for the Aberdare Forest under the Wildlife Management and Conservation (2014).	***Christian***	*Isaiah explained that the legal framework would include a review of the national and international requirements applicable to the project. He further added that the forementioned National Spatial Plan and Wildlife Management and Conservation (2014) would also be reviewed. Isaiah then invited Richard to comment on Christian's input.*	***Isaiah Kegora***
Min 4.10	Mr Wanjau recommended in depth consultations with the officers based within the park. He expressed that he looked forward to receiving the draft report in order to analyze the impacts identified and mitigation measures recommended.	***Michael Wanjau***	*Richard explained that most projects fit into plans which are already established.* *Loise explained that this meeting was the first of many, and it was an introductory session to be followed by individual meetings for the key stakeholders.*	
Min 4.11	George advised the Consultant team to review the formal correspondences and comments shared by the stakeholders previously about the project even as they prepare to engage them further in individualized consultations.			
Min 4.12	Further, George acknowledged that KWS had received the request from the consultant to access the park in order to conduct studies for the project. He however requested that the agency should be furnished with an intricate schedule detailing the study team and the specific study itinerary to inform their permit and making logistical arrangements to support the team.	***George Osuri***	*Isaiah acknowledged receipt of the response given by KWS on the permit to access the park. He committed to share the schedule as requested*	
Min 4.13	Peter requested that the ESIA should be more detailed. He noted that the biodiversity studies appear to be research which requires a permit to conduct the same. He highlighted that for this project there was a need to provide adequate data for decision making such as an			

Min 4.14	inventory of the wildlife along the alignment, hydrologic study, etc. Micah requested that KWS should be furnished with the proposed project design. He further sought to know whether County Governments of Nyeri and Nyandarua, KWTA were engaged in the consultations process.	***Peter Mwangi*** ***Micah***	*Isaiah highlighted that the ESIA study approach would be detailed to capture the information requested. He also added the draft ESIA would be shared with the stakeholders for review and comments before submission to NEMA.* *Loise reported that County Government of Nyandarua had been engaged in the consultation process and committed to engage more stakeholders as part of the ESIA process.*	

Min 6/22	**Adjournment**	
	The meeting was adjourned at 11:50 AM after a vote of thanks from Isaiah Kegora and Richard Mogesi	

Minutes **Prepared** by:
Name : JAPHETH KIPSANG BOR. Position: ENVIRONMENTALIST
Sign : …….. Date : ……

Minutes **Confirmed** by:

1. Name :. ……. Position: ……
   Sign : …….. Date : ……

2. Name : …….. Position: ……

   Sign : …….. Date : ……

PROPOSED MAU MAU LOT 4: IHITHE - NDUNYU NJERU ROAD PROJECT

MINUTES OF SATKEHOLDER ENGAGEMENT MEETING

Date: 06/10/2022 Venue: 4th Floor Boardroom, Block A of Barabara Plaza-KeNHA Headquarters Stakeholders: KeNHA, WRTI and KFS	**Start Time**: 1040 HRS **End Time:** 1300HRS

ATTENDANCE	**ORGANIZATION**
17. Eng. Charles Obuon	Director Development - Kenya National Highways Authority
18. Eng. Muita Ngatia	Deputy Director Development - Kenya National Highways Authority
19. Eng. Henry Gakuru	Deputy Director Design - Kenya National Highways Authority
20. Mogesi Richard	Senior Environmentalist- Environmental and Social Safeguards - Kenya National Highways Authority
21. Robert Kyalo	Engineer – Kenya National Highways Authority
22. Benedict Omondi	PC- Kenya Forest Service
23. Andrew Muriithi	CoF- Kenya Forest Service
24. Peter Mwangi	Wildlife Research and Training Institute
25. Eng. John Ndemi	Team Leader – Norken International Ltd
26. Isaiah Kegora	Senior Environmentalist – Norken International Ltd
27. Eng. Alex Wawire	Highway Engineer - Norken International Ltd
28. Dr. Dickens Odeny	Biodiversity and Environment Expert – Norken International Ltd
29. Meshack Muthini	Sociologist - Norken International Ltd
30. Loise Kioko	Associate ESIA Expert - Norken International Ltd

AGENDA

5. Introductions
6. Opening Remarks
7. Remarks by KeNHA
8. Presentation by Consultant
9. Way Forward

10. Adjournment

Item No	Description	Action by
Min 1/22	**Introduction**	
1.1	The meeting was called to order at 10.40am and opened by Eng Obuon. He welcomed the attendees and then led them in a round of introductions.	*All*
Min 2/22	**Opening Remarks by KeNHA**	
2.1 2.2	Eng Obuon explained that the main objective of the meeting was to consult on the Ihithe-Ndunyu Njeru Project around matters conservation. Further, he added that consultations have been held by the consultant and some key stakeholders. Eng Obuon invited the consultant to give a brief update on the progress made on the assignment.	
Min 3/22	**Proposed Project Road Design**	
3.1 3.2	Eng Ndemi informed the meeting that the consultant was on the tenth month of the assignment schedule. He added that the EIA report preparation was currently underway, and that the study has been divided into 3 packages; package 1 covering Nyandarua County section, package 2 covering Nyeri County section and package 3 covering the section falling with Aberdares National Park. Eng. Ndemi then invited Eng. Wawire to make a presentation on the design. Eng. Wawire took the	*Consultant*

	participants through the presentation detailing the design and ESIA aspects of the project. In summary, the road has a total length of 93km with the total length of the spur roads being 46km. Eng. Wawire highlighted that the road has been divided into 3 packages as follows: 1. Nyandarua Side– 47.5km 2. Nyeri Side– 23.3km 3. Aberdares KWS Section – approx 23.5km Eng. Wawire noted that the road has varying cross-section. The average right of way is 18m with some sections being 23m wide and others being 11m. Further, with an aid of a satellite image, Eng Wawire presented the proposed animal crossing locations along the road alignment. He then illustrated a typical animal crossing using a drawing and a 3-D model. Eng Wawire clarified that there would be some fenced sections on high points like embankments especially around the animal crossing points. He then invited the attendees to ask questions or seek clarifications on the presentation made on the proposed road design.	
3.3		*Consultant*
3.31	**Reactions from Road design presentation** Mr. Peter Mwangi (WRTI) sought to know which animal species were considered for the animal crossings; and whether elephants would be able to cross from those points	
3.32	Dr Odeny clarified that elephants had been considered in the design of the animal crossings. He elaborated that the crossings were designed based on: i) Concentration of the animal species ii) Nearness to water points iii) Visibility	*Consultant*
3.33	Mr. Mwangi requested to be furnished with the location coordinates of the proposed crossing points as his main concern was the high gradient of the road. He was	

3.34	interested in the volumes of cut and fill contributed by the high gradient.	*Mr Mwangi*
3.35	Mr. Mogesi requested Mr. Mwangi to furnish the team with data on animal routes that will support the design of the crossing points.	*Consultant*
3.36	Eng. Muita expressed concern that the crossing points may attract the presence of predators which may prey on the herbivores as they cross. He proposed that the design should include a fence to mitigate this possibility.	
3.37	Dr Odeny clarified that the suitability analysis of the crossing points included visibility where the animals should be able to see across the points. Further, he added that most animals adapt to new conditions to avoid predators.	*Consultant*
3.39 3.40	Mr Omondi sought clarification on whether the spur roads are within the protected area, and whether the alignment length within the protected area has reduced from 54km to 49km. He further calrified that KFS had submitted its concerns regarding the proposed project during the meeting held between KFS and the Consultant at Geta Forest Station. Eng Wawire confirmed that indeed the new alignment measures 49km. Mr Mwangi gave an explanation on the reservations KWS had against the development of the proposed project as follows: - The ecosystem is a key water catchment area and it possibly would be significantly impacted by the project - The cut and fills would affect the quality of water - Truck repairs would result in grease and oil spilling to the water points; contaminating it - Some overpasses should be considered	*Consultant*

3.41 3.42	- The ecosystem has key tourist attractions that may be impacted by the project - Potential restriction of animal movement - Accidents - Poor visibility during the cold season - The steep gradient of the road may not make it easy to control truck speed Further, Mr Mwangi observed that the road should continue to be considered a park road so that users pay an entry fee and thus, limit traffic within the park. Mr Omondi added that conservation efforts of Aberdare Forest Ecosystem are heavily funded by donors in partnership with KFS. The donor funding is usually affected by concerns on management of the forest when mega projects are proposed inside the forest..	*KeNHA/ Consultant*
Min 4/22	**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT**	
4.1 4.2 4.3 4.31	Dr Odeny took the participants through the presentation on the ESIA study. He explained that the approach included conducting a reconnaissance visit, stakeholder engagement, field assessments, impact identification and assessment. He further explained the significance criteria ranking used for the impacts identified for the project as measured using their likelihood and magnitude. Dr Odeny reported that the biodiversity team identified various plant and animal species along the road corridor including in both aquatic and terrestrial ecosystems. Dr Odeny took the participants through some of the impacts identified for the project, including their magnitude and mitigation measures. Some of the impacts identified included: - Barriers to movement of elephants - Loss of plant species and above ground carbon **<u>Reactions from the ESIA presentation</u>**	*Consultant*

	Mr Omondi (KFS) appreciated the presentation made and noted that it was well done. He also noted that although biodiversity survey had been done there are several additional requirements that KFS had for the study: - A hydrometeorological assessment needs to be conducted for both wet and dry season - The element of mist and fog needs to be studied to determine the period within a year which the road would be useful to the users - There is a need to conduct a cost-benefit analysis indicating the use of the current road, alternative routes - There is a need for the KFS team to visit the site along with the design team - Contractors cause huge damage to the forest ecosystem when mega projects are approved for implementation within the forest - On stakeholder engagement, Mr Omondi advised that stakeholder mapping should be well done. Such stakeholders as Nyayo Tea Zones, Green Belt Movement, Rhion Ark and general Public should be adequately consulted for their views and concerns to inform the EIA study process.. - He emphasized on exhaustive assessment of the legal framework including policies, National, Regional and International Legal Framework.	
4.42		*KeNHA*
4.43	- The consultant team should consider including a case study of a similar road passing through a forest/park	*Consultant*
4.44	Mr Omondi expressed concern that KFS was yet to receive a letter of intention to develop the project from the proponent (KeNHA)	
4.45	Eng Muita advised the consultants to include the impact on the water table due to the cut and fill and thus effects on the drainage system.	*KeNHA/*

4.46	Dr Odeny confirmed that the aspect of drainage has been covered in the ESIA report.	*Consultant*
4.47	Eng Obuon invited the consultant to respond to matters of Cost-Benefit Analysis	
4.48	Eng Ndemi requested for this item to be discussed in a future technical meeting with the consultant. He also observed that as an existing road some of the adverse impacts on the environment have already occurred.	*KeNHA/ Consultant*
4.49	Mr Omondi highlighted that although the road is existing, it is currently used as a park road. Improving it would increase the impacts to the forest ecosystem.	*Consultant*
4.50	Eng Ndemi informed the attendees that the concern of Contractor misconduct would be addressed during the supervision period by a team made up of the consultant and client.	
4.51	Eng Muita clarified that the concern of soil cuts and fills would impact the quality of water would be addressed by good road design. Proper design ensures that cuts and fill balance and that there is minimal spoil.	Consultant
4.52	Mr Mogesi assured the attendees that KeNHA is very strict when it comes to mitigation measures in critical habitats.	*Consultant*
4.53	Mr. Muriithi noted that carbon emissions would be increased in the project footprint. He requested the proponent to ensure that this aspect is addressed by the ESIA study. Further, he recommended that Kenya Water Towers should be consulted as part of stakeholder engagement.	*Consultant*
4.54	Eng. Obuon encouraged the consultant to make practical mitigation measures for impacts identified by the ESIA.	
4.55		

4.56 4.57	Dr Odeny clarified that specific practical mitigation measures have been proposed and responsibilities assigned to particular stakeholders. Eng. Muita noted that KWS and KFS may not allow materials to be sourced outside the park and forest to mitigate introduction of invasive species. He proposed that the ESIA reports should be shared with the KWS and KFS team for review before submission to NEMA. Mr Kegora (Consultant) clarified that the approach was to share the draft reports with KWS and KFS before submitting to NEMA for review. Further, the Terms of Reference would be submitted to NEMA for approval (for the section within the Park) Mr Mogesi informed the stakeholders that it was concluded in previous stakeholder engagements that there would be a workshop to be held to present findings of the ESIA. He then advised the attendees that the presentation of the ESIA findings should be well framed. Mr Mwangi emphasized that the ESIA should be well articulated to enhance project buy-in. For instance, its significance should be well elaborated, its scope needs to be clear, biodiversity inventory should be well documented, engineering solutions should be included, and stakeholder engagement should be exhaustive. He emphasized stakeholders such as Ark Lodge, Tree Tops, Water Resource Authority and Nyayo Tea Zones need to be consulted.	*Consultant* *Consultant*
Min 5/22	**Way Forward**	
5.1 5.2	Eng Obuon proposed that a committee should be formed to deliberate and steer the pertinent issues arising from the proposed project and ESIA study. He added that it should be composed of representatives form KWS/WRTI, KFS and KeNHA, chaired by Dr Walter Nyatwanga (KeNHA).	*KeNHA*

5.3	Mr Omondi requested that Rhino Ark should be included in the committee. This was deferred to allow for technical evaluation of the project. Eng Obuon emphasized on the need to move with speed; making compromises such as payment of park fees. It was concluded that: - the committee should be composed within a week from the day of the meeting. - A workshop should be arranged for key stakeholders - The outcome of the Committee deliberations should be submitted in three weeks' time including the Terms of Reference for the Committee. - It was suggested that the committee should be composed of: i) Road Engineer and Senior Warden from KWS ii) Regional Conservator and Heads of Conservancy from Nyeri and Nyandarua Counties	*Consultant/ KeNHA*
Min 6/22	**Adjournment**	
	Eng Obuon thanked the stakeholders and the meeting was adjourned at 1300hrs.	