KENGEN GREEN ENERGY PARK

IN OLKARIA GEOTHERMAL HUB IN NAIVASHA, KENYA

BIODIVERSITY STUDY REPORT

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CERTIFICATION

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REPORT TITLE:	Rapid Biodiversity Assessment Report
PURPOSE	Baseline Assessment for SEA Study
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LIST OF ABBREVIATIONS

AIPS	Alien Invasive Plant Species
CD	Conservation Dependent
CITES	Convention on International Trade of Endangered Species
CR	Critically Endangered
ESIA	Environment and Social Impact Assessment
EN	Endangered
IP	Industrial Park
ISO	International Standard Organization
IUCN	International Union for Conservation of Nature
LC	Least Concern
LR	Lower Risk
NE	Not Evaluated
NT	Near Threatened
SEA	Strategic Environment Assessment
VU	Vulnerable
BMU	Beach Management Unit

1. METHODOLOGY

1.1 Biodiversity Scoping Issues

After the literature reviews and reconnaissance, a rapid ecological survey was undertaken. The survey on the proposed Industrial Park focused on conservation and management issues on the invertebrates, mammals, birds, reptiles and amphibians and plant taxa.

1.2 Biodiversity Sampling Framework

Preliminary field visit (reconnaissance) was conducted at the propose Olkaria Industrial Park to determine biodiversity conservation issues in Naivasha and its environment. Detailed study of biodiversity for the area was conducted by desktop review and a rapid field survey. Interviews with selected local residents was used to improve knowledge on the distributions of fauna species that may not be possible to record within the study period. The resulting interview results regarding fauna distribution was validated using relevant guide books for each taxon. The study covered taxa of mammals, birds, invertebrates, fish, amphibians and reptiles in both terrestrial and aquatic habitats.

1.3 Field Reconnaissance

The first site reconnaissance was held on the 27th April, 2022 and it was attended by the Client team and the Feasibility Consultant team. Further site visits were held throughout the exercise. The SEA team site visits were mainly aimed at validating gathered secondary data, which was documented through the use of photographs, checklists, questionnaires among others. Key observations that were made included but are not limited to;

- Wildlife routes: Presence of elephant families have been recorded in the recent;
- Prevention of human-wildlife conflicts that are however at minimum level at the moment;
- Species diversity and population for both flora and fauna;
- Species movements: Local migration patterns;
- Species of conservation importance; and
- The biodiversity conservation hotspots and critical water resources.

1.4 Field Study

Survey for biodiversity taxa was distributed within the proposed Olkaria IP and outside near adjacent villages. The survey for mammals, plants, herpetofauna, birds, invertebrates were conducted on same point location in the study area (Figure 1).

(i) Mammal Survey: The small and large mammal species was considered for the survey. Effective approaches for rapid assessments of this taxon was employed. These include physical survey (visual) and local accounts using photographs. Data extraction from online database was used to enrich the list.

(ii) **Herpetofaunal Sampling:** Visual Encounter Survey protocol with time constrained searches (Heyer et al 1986) was used for systematic searches around major wetlands. Physical searches were involved checking on the tree trunks (bark) and turning stones.

(iii) **Bird Sampling:** Bird surveys were conducted using Point Counts on selected locations. The survey was conducted in the morning in the site. Bird species was identified based on direct observation and their unique calls. Opportunistic sampling of birds was also conducted throughout the day.

(iv) **Terrestrial Invertebrate Sampling:** Three methods of sampling terrestrial invertebrates were used. These include; physical observation; sweep net sampling, litter sampling and beating. However, the most effective method for a rapid assessment is the sweep net sampling. Sweep nets were used to trap flying species, while physical observation was used on butterflies, bees, dragonflies. Crawling insects such as beetles' spiders was searched on trees and under litters and stones.

(v) **Plant Sampling:** Plotless method using random sampling was used to assess richness of plant on sites. The plot-less method was employed along the transects in sites. The identification was done with reference to the field guide books. Photographs were taken for representative tree species or vegetation formations occurring in the riverine system.

(vi) **Aquatic Macroinvertebrate Survey:** Invertebrate considered for survey are species that can be retained by a 500 to 600-micron mesh screen. These species could include aquatic insects such 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. Observation of dragonflies and damselflies was performed along the main rivers and lakes within.

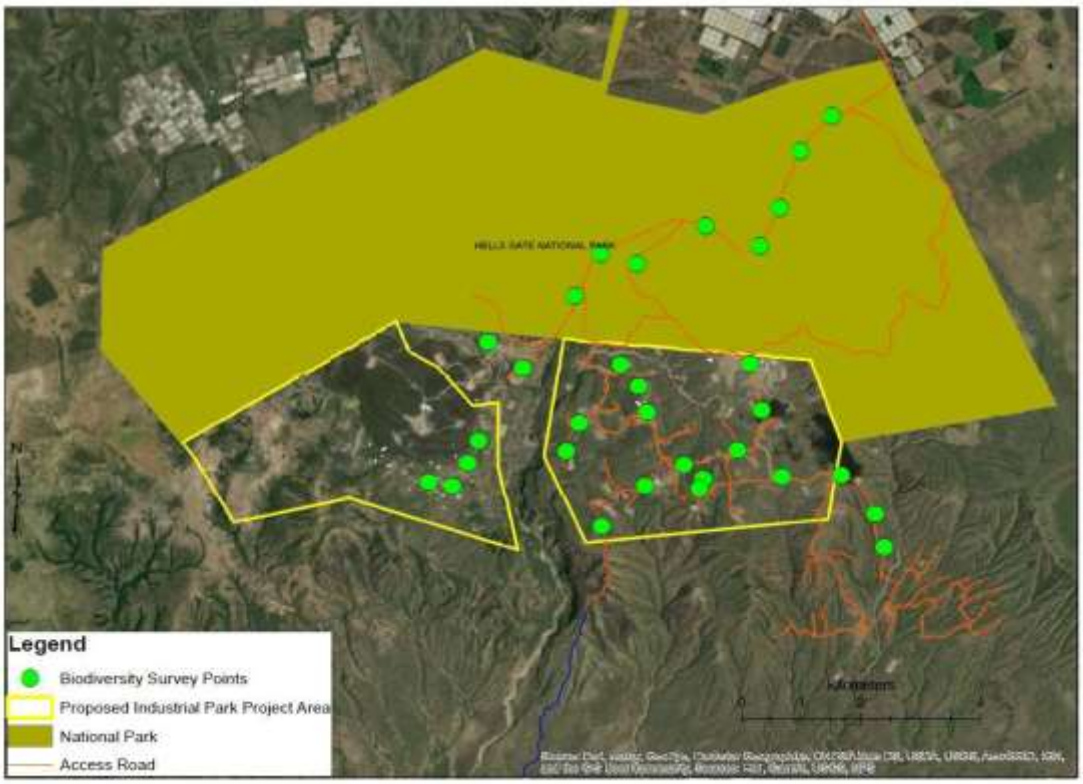

Figure 1 - Biodiversity sampling points in the proposed Olkaria Industrial Park

(vii) **Fish Diversity and Fisheries Survey:** Fisheries species was surveyed from landings from Beach Management Unit locations. More information on fisheries species was sought from the Kenya Fisheries Service.

(viii) **Local Accounts of Species:** Due to time limitation in the field, more species data was collected from interview with the local people with experience on species within the forest ecosystem (Plate 1). The information from the locals was verified and validated using literature distribution of species. The identification was done using the relevant guide books for each taxon.

Figure 1: Consulting with the local residents on wild animals observed around Olemayan Village

1.5 Validation of Species of Conservation Importance

These are threatened species listed under International Union for Conservation of Nature (IUCN) Red List, species endemic to the region, and species listed under CITES. Impact of the proposed Industrial Park was analysed against the ecology of species of conservation importance.

1.5.1 Validation with IUCN Red Listed Species

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

1.5.2 Validation with the Endemic Species list

The IUCN online database was used to validate species checklist generated from the field and literature search for status of endemicity. Other online database will also be used for verification.

1.5.3 Validation with the Convention on International Trade on Endangered Species (CITES)

Species checklist was 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.

IUCN Criteria:

A – Population decline, **B** – Restricted geographic range, **C** – Small population size and decline, **D** – Very small or restricted population, E – Extinction probability analysis

1.6 Methodology for Assessing Environmental Impacts

1.6.1 Approach for Assessing Potential Impacts

Figure 2 below illustrates the process used in assessing potential impacts of the proposed project. The process involved the following steps:

- Prediction: What will happen to the environment as a consequence of the project?
- 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?
- Mitigation: If the impact is of concern, can anything be done to avoid, minimize, or offset the impact? Or to enhance potential benefits?
- Assessment of Residual Impact: after mitigation, is the impact still of concern?

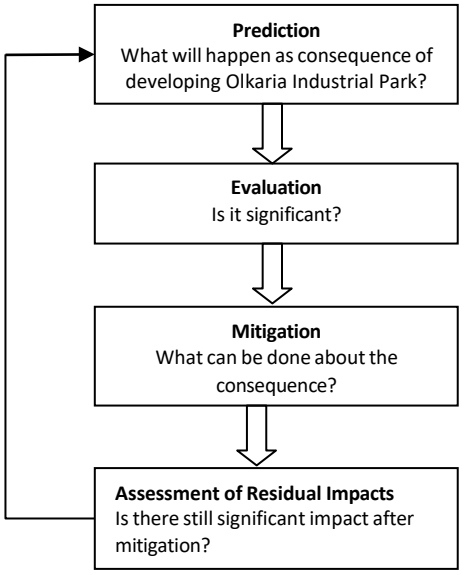

Figure 2: Impact Assessment Process

1.6.2 Project Activities and Impact

The Proposed Olkaria Industrial Park 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 aspects.” For example, operation 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 1.

Table 1: Definition of terms for various forms of impacts

Term	Definition
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	Socio-economic 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. Whilst **receptor** represents 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.

1.6.3 Evaluation of Ecological Impacts

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. 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.

1.6.4 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 SEA Report, the significance of the impacts is assessed by rating each variable numerically according to defined criteria as outlined in Table 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 3), and it is determined whether mitigation is necessary using Table 4.

Table 2: Criteria for assessing consequence of impacts

Consequences					
Severity / Magnitude of Impact	**Rating**	**Spatial Scope / Geographic Extent of Impact**	**Rating**	**Duration of Impact**	**Rating**
Insignificant / non-harmful	1	Activity Specific	1	One day to one month	1
Small / potentially harmful	2	Area Specific	2	One month to one year	2
Significant / slightly harmful	3	Whole Site	3	One year to ten years	3
Great/ harmful	4	Regional/Neighbouring areas	4	Life of operation	4
Disastrous / Extremely harmful	5	National	5	Post closure / permanent	5

Table 3: Criteria for assessing likelihood of impacts

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 4: Significance Rating Matrix

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

Table 5: Positive/Negative mitigation ratings and associated colour codes

Significance Rating	**Value**	**Colour Code**	**Negative Impact Management Recommendation**	**Positive Impact Management Recommendation**
Very high	122-150		Propose mitigation measures	Maintain current management
High	106-120		Propose mitigation measures	Maintain current management
Medium high	76-105		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

1.6.5 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 1 below.

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.

1.6.6 Residual Impact/Mitigated Impact

The **residual impact** is what remains following the application of mitigation and management measures, and is therefore 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 EcIA Report.

2. BIODIVERSITY BASELINE INFORMATION

2.1 Habitat Characterization

The proposed KenGen Olkaria Industrial Park is located on hilly and deep and fragile volcanic ash soil. The unique landforms confer special habitats on the landscape. The area consists of top hills and cliffs that provide habitats and vantage points for Raptor birds. These hills also assist birds on local flights with navigation during local movement. The sloped areas of the hills are dominated by *Tarchonanthus* bushes (dryland bushland) with substantive cover of grasses that provide pasture for livestock and wild-herbivores. The landscape is unique with a gorge and is characterized by dense drainage channels that are constantly evolving due to erodible deep and loose volcanic ashes. Valleys have unique plant species that provide habitat and cover for some animal species. The rocky cliffs are habitat for the Rock Hyrax and unique for raptor birds

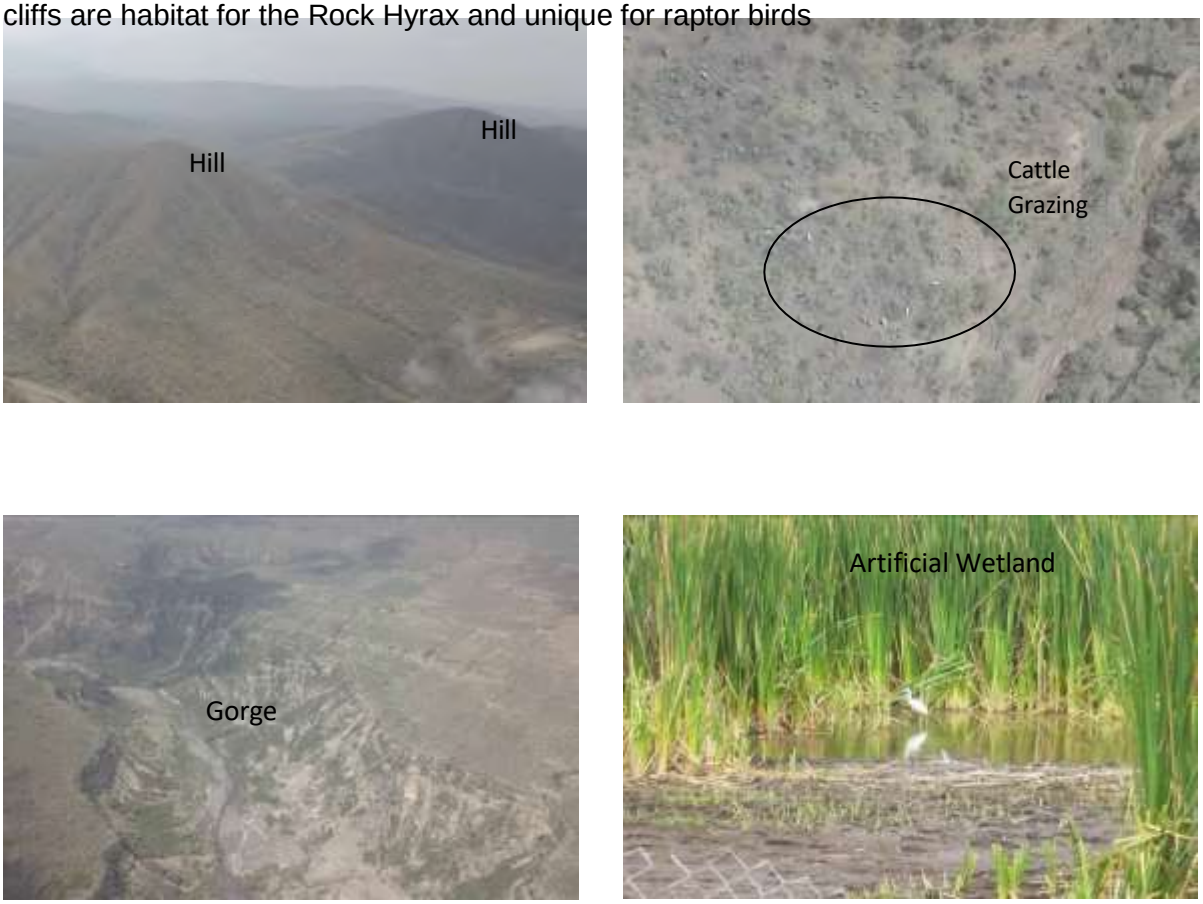

Figure 3: Habitat characteristics of proposed Olkaria Industrial Park.

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2.2 Plant Species Diversity

2.2.1 Plant Desktop Analysis

A total of 65 plant species records have been published within 10 km buffer. Few data publications observed from database indicate little studies have been carried out within the proposed Industrial Park location (Beentje H., 1994). However, there are several plant species envisaged to occur within the 10 km buffer. This can be attributed to objective of the study that could have discriminated overall plant diversity in the area. Out of the 65 plant species, 11 % of the species have been recorded within the project footprint including the 2 km buffer from the project centroid. Most of these occurred in the Hell's Gate National Park. Records of plant studies mostly occur far away from the project area > 8 km (Figure 4). Common species according to the database are *Acacia drepanolobium*, *Dicranopteris linearis*, *Farsetia undulicarpa*, and *Polygonum senegalense* (Agnew A.D.Q., 2013).

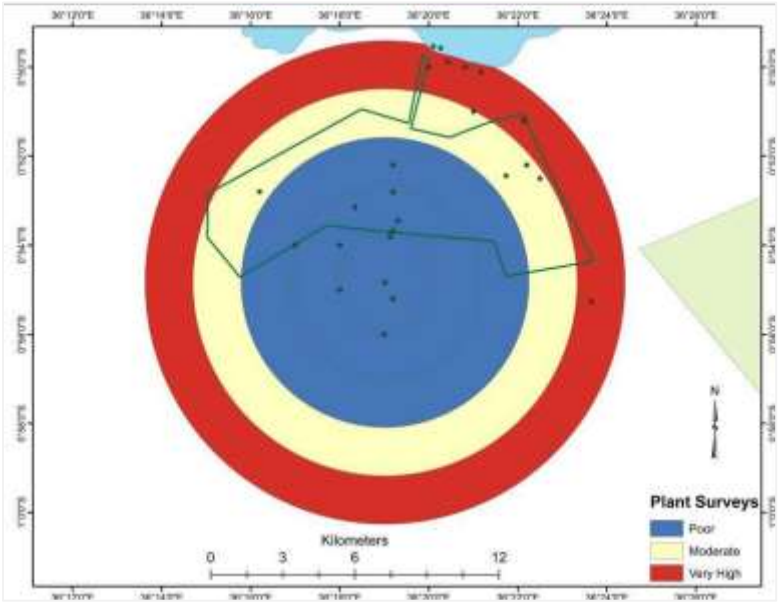

Figure 4: Plant Survey

2.2.2 Plant Field Observation

Rapid assessment of plant species yielded an estimated 57 number of plant species distributed within the proposed Olkaria KenGen Industrial Park. The proposed Olkaria KenGen Industrial Park is dominated by *Tarchonanthus camphoratus*. The species occurs on the hilly areas (on slopes) with undergrowth species dominated by Lemon grass (*Cymbopogon sp.*), *Sida sp.*, *Hypoestes sp.*, and *Ocimum sp.* The *Acacia drepanolobium* occur among *T. camphoratus*; however, its distribution

is scanty in most parts of the project area. Its distribution is apparently

affected by *T. camphoratus* cover dominance, herbivory by wildlife and livestock, and target felling by residents. Vernonia species grows as shrub in the area and has considerable distribution within the *T. camphoratus* mosaic. The diversity of plant life is relatively high towards and within the valleys. The valleys host plant species that are rarely observed on the hills and slopes in Olkaria. These include species such as *Olea sp. Lippia*, *Dodonea viscosa.* Vegetation is disturbed by livestock grazing that has causes destruction of undergrowth plant species especially during dry seasons.

Tarchonanthus comphoratus

Acacia drepanolobium

Cymbopogon citratus

Cyphostema

Figure 5: Plant Species in Dry Season

2.2.3 Alien Invasive Plant Species

There are four AIPS within the project footprint; these include *Nicotiana glauca*, *Cirsium vulgare*, *Datura stramonium* and *Lantana camara*. The most common AIPS is the *Nicotiana glauca* occurring along the network features such as roads, steam pipeline and near geothermal power plants. It is dispersed by seeds and runoffs that distribute its seeds along the drainage along the road. The species presents high risk of invasiveness due to its high seed production, formation of soil seed bank, ability to withstand drought and flooding, high ability to re-sprout and high germination rate. *Cirsium vulgare* is common on disturbed areas such as along the road and

steam pipeline. The species grows rapidly, it out-competes and shades many grass and herbaceous species. The seeds have high dispersal rates caused by wind and they can remain viable in the soil for up to 10 years. The distribution of *Lantana camara* is very scanty only observed near villages. It reproduces by seeds which are dispersed by birds and other animals (e.g. rodents) that eat the fruits. It can also reproduce asexually through suckers or branches getting in contact with the soil. *Datura stramonium* occur on road side near villages where deposition of eroded soil is dominant.

Datura stramonium

Nicotiana glauca

Cirsium vulgare

Figure 6: Alien Invasive Plant Species

2.3 Mammal Species Diversity

2.3.1 Mammal Desktop Analysis

A total of 32 mammal species have been observed within the 10 km buffer from the centroid of the proposed KenGen Olkaria Industrial Park. Most studies have been conducted within 4 km buffer distance with high distribution occurring in Hell's Gate National Park. About 22 mammal species have been recorded within 4 km buffer distance. The proposed project location which is within 4 – 6 km buffer has previously received considerable attention on mammal studies. The location apparently is a dispersal area for wildlife animals from Hell's Gate National Park, Longonot National Park and Mau Forest Complex. The 10 km buffer analysis of species distribution shows some species are commonly distributed on the landscape occurring in all buffer distance bands; while limited distribution also observed where species are observed in one band of the distance buffer. Species that are widely distributed within 10 km buffer distance are the Warthog, Spotted Hyena, Olive Baboon, Giraffes and Vervet Monkey. Species which are limitedly occur within the 10 km buffer distance are African bush elephant, Lion, Cape buffalo, Black-backed jackal, and others (Table 5).

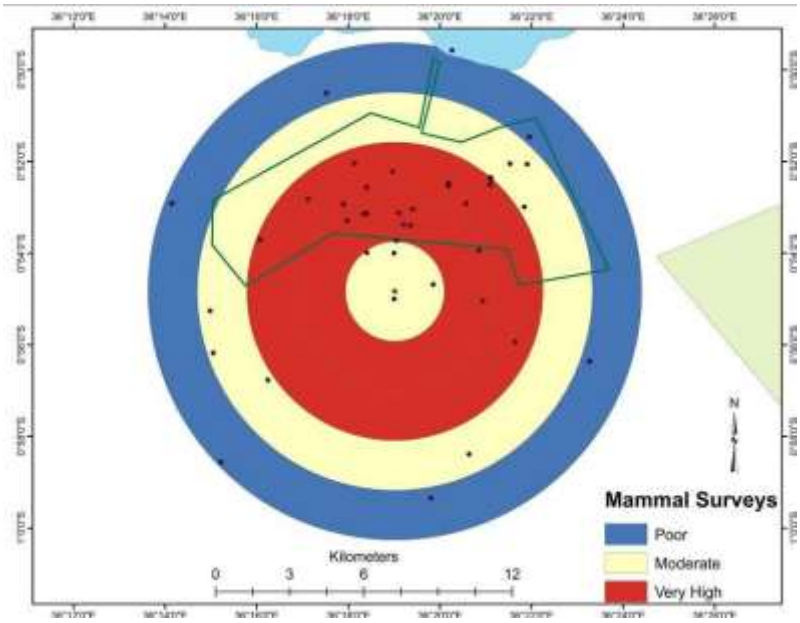

Figure 7: Mammal Surveys

Table 6: List of mammal species with the status of IUCN red list of threatened species

No.	Common Name	Scientific Name	IUCN Status	Distance Buffer (km)				
				2	4	6	8	10
3.	Impala	*Aepyceros melampus*	LC		√	√	√	
4.	Hartebeest	*Alcelaphus buselaphus*	LC			√		
5.	Coke's hartebeest	*Alcelaphus buselaphus cokii*	LC		√			
6.	Black-backed jackal	*Canis mesomelas*	LC			√		
7.	Russet free-tailed bat	*Chaerephon russatus*	DD	√				
8.	Vervet Monkey	*Chlorocebus pygerythrus*	LC		√	√		√
9.	Spotted Hyena	*Crocuta crocuta*	LC	√	√	√	√	√
10.	Common tsessebe	*Damaliscus lunatus*	LC		√	√		
11.	Plains Zebra	*Equus quagga*	NT				√	√
12.	Burchell's zebra	*Equus quagga burchellii*	NT			√		
13.	Red-fronted gazelle	*Eudorcas rufifrons*	VU			√		
14.	Thomson's gazelle	*Eudorcas thomsonii*	LC	√		√		
15.	Rusty-spotted genet	*Genetta maculata*	LC		√			
16.	Giraffe	*Giraffa camelopardalis*	VU				√	
17.	Masai giraffe	*Giraffa tippelskirchi*	EN	√	√	√	√	
18.	Yellow-spotted rock hyrax	*Heterohyrax brucei*	LC			√		
19.	Hippo	*Hippopotamus amphibius*	VU				√	√
20.	Striped polecat	*Ictonyx striatus albescens*	LC	√				
21.	Waterbuck	*Kobus ellipsiprymnus*	LC			√	√	√
22.	African bush elephant	*Loxodonta africana*	CR		√			
23.	Grant's gazelle	*Nanger granti*	LC		√	√		
24.	Klipspringer	*Oreotragus oreotragus*	LC	√				
25.	Lion	*Panthera leo*	VU	√				
26.		*Panthera leo melanochaita*	VU					√
27.	Leopard	*Panthera pardus*	VU					

No.	Common Name	Scientific Name	IUCN Status	Distance Buffer (km)				
				2	4	6	8	10
28.	Olive baboon	*Papio anubis*	LC		√	√		√
29.	Common warthog	*Phacochoerus africanus*	LC		√	√	√	
30.	Rock hyrax	*Procavia capensis*	LC		√	√		
31.	Bohor reedbuck	*Redunca redunca*	LC			√		
32.	African buffalo	*Syncerus caffer*	NT		√	√		
33.	East African mole-rat	*Tachyoryctes splendens*	LC	√				
34.	Common eland	*Taurotragus oryx*	LC		√			

2.3.2 Mammal Field Observation

During rapid assessment, about 19 species were observed through direct observation, droppings, tracks and local accounts. The distribution of most mammal species was associated with the landforms and vegetation habitats. Grasslands were common with Thomson gazelles, Impalas, Grant gazelles, Hartebeests, and Zebras. Bushlands (opened and dense) occurring in the hilly and sloped areas were associated with Giraffes and Warthogs. Buffaloes were observed in the bushed-grassland on hilly areas and valleys and their occurrence on open grassland is mostly in Hell's Gate National Park. The Olive baboons and Warthogs utilizes all vegetation habitats and landforms within the proposed KenGen Olkaria IP area.

There are signs of tracks and droppings (pellets) of Common Duiker in the area towards the valleys that provide cover for the animal. The valleys forms hiding and foraging places for buffaloes within the project areas; however, the species graze in the open grassland areas in Hell's Gate National Park. Hippos are visitors to the established lagoons in the geothermal power plants zone. They traverse the landscape from Lake Naivasha crossing the road to look for temporary foraging sites. The African Hare are found all over the place foraging in open areas in the bushland within the IP area. Activities of Aardvark and Spring Hare (mainly excavations) were observed in bushland on the hilly and sloped areas.

Olive Baboon

Warthog

Hyena (*Crocuta Crocuta*) track

Giraffe droppings

Figure 8: Mammal Species

2.4 Bird Species Diversity

2.4.1 Bird Desktop Analysis

A total of 336 bird species have been recorded within the 10 km buffer distance of the proposed KenGen Olkaria Industrial Park (John G Williams, 1983). The proposed IP area has few records of birds; which could be attributed to few studies that have been conducted in the area. About 5% of bird species recorded in database within the 10 km buffer have recorded within the proposed IP. Hell's Gate National Park and areas around Lake Naivasha (2 – 10 km) has more records of bird species indicating more studies have been conducted in the area. About 16 species of birds are common within the 2 – 4 km buffer, 8 species are common within 2 – 6 km buffer. Some of this species have been recorded throughout the 10 km buffer distance: these include the Common buzzard, Pied crow, Red-throated tit, Kenya sparrow (Zimmerman D.A. Turner and D. Pearson D.J. 1999).

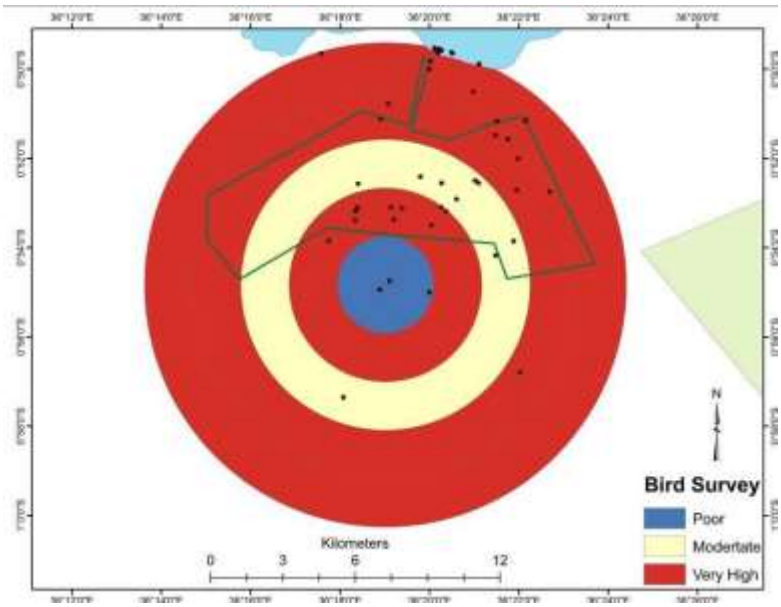

Figure 9: Bird Survey

2.5 Bird Field Observation

An estimated 51 bird species were recorded during rapid survey within the proposed KenGen Olkaria Industrial Park. The distribution of bird in the location is associated by the vegetation habitats in the area. Most of these birds are associated with the type of bush habitat; that within the area consist of *Tarchonanthus* bushes with few open areas. These species can be distinguished by their feeding behaviours within the *Tarchonanthus* bushland. Group of species observed feeding on the ground consisted of Arrow-marked Babbler, Ring-necked Dove, White-browed Scrub Robin. Other group of species perches on trees and feed on insect on crawling and flying insects such as the Black-back Puffback, African Dusky Flycatcher, Northern Anteater Chat etc. Some groups were feeding on flying insects such as the Swallows (e.g. Sand Martin). Sunbird species were observed in areas with flowering plants such as the Nicotiana glauca (an invasive species). Wetland birds are dependent on wetland habitats where they forage on invertebrates, tadpoles and frogs. These groups included the Hammerkop, Hadada Ibis, Egyptian Geese, and Cattle Egret.

Black-back Puffback

Northern Anteater Chat

Ring-necked Dove

Cattle Egret

Figure 10: Bird Species Identified

2.6 Invertebrate Species Diversity

2.6.1 Desktop analysis

Few records of invertebrate species occurring within the 10 km buffer of the proposed KenGen Olkaria Industrial Park were retrieved from database. From these records, about 21 species of invertebrates have been published in the database; with most data distribution occurring in Hell's Gate National Park (< 4km buffer). Besides this area, most studies on invertebrates have been conducted around Lake Naivasha. The number invertebrate species published in the databases is however, not a reflection of the diversity on the landscape but an indication of limited studies in the areas. A total of 6 invertebrate species has been published in database for the proposed project location. These include the *Tetraponera penzigi* commonly found on the *Acacia drepanolobium*, flies (*Ceratitis cristata*), and stalk-eyed flies such as Sphyracephala*, Diasemopsis*, and *Diopsis* etc. (Martins D.J., 2014).

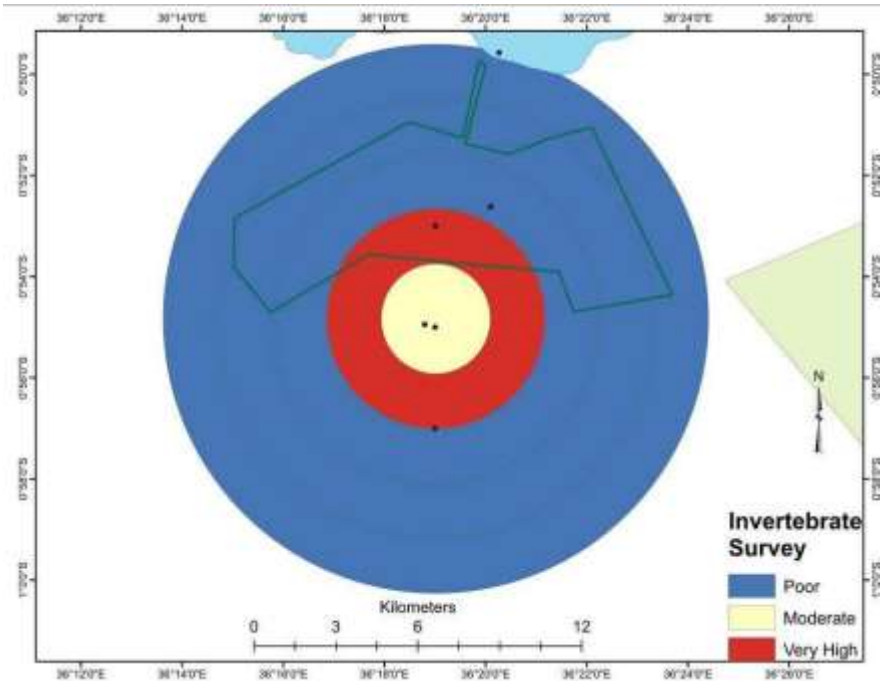

Figure 11: Invertebrates Survey

Table 7: List of observed invertebrates with status of IUCN conservation status

Species Scientific Name	IUC Conservation Status	Distance (km)			
		2	4	6	10
Bactria sp.	-		√		
Belenois aurota	LC				√
Betasyrphus adligatus	LC		√		
Ceratitis cristata	LC	√			
Colotis hetaera	LC				√
Ctenusa varians	LC				√
Diasemopsis sp.	-	√			
Diopsis sp.	-	√			
Episyrphus trisectus	LC		√		
Eristalinus lineifacies	LC		√		
Eristalinus myiatropinus	LC		√		
Eristalinus taeniops	LC		√		
Melanostoma annulipes	LC		√		
Melanostoma infuscatum	LC		√		
Mylothris agathina	-			√	
Promachus sp.	-	√			

Species Scientific Name	IUC Conservation Status	Distance (km)			
		2	4	6	10
Sphaeroceridae	-		√		
Sphyracephala	-	√			
Tachytrechus bracteatus	LC		√		
Tetraponera penzigi	LC	√			

2.6.2 Field Observation

An estimated 24 species of invertebrate species were recorded within the proposed KenGen Olkaria Industrial Park area. Among these species, there are groups of invertebrates that are associated with flowers and droppings of animals for forage. Bees were associated with the flowering plants and plants that produces wax for production of honey (reserve food) and storage structure (e.g honey comb). Common bee species are the Honeybees (*Apis mellifera*) that produces honey; while others included the Common carpenter bee (*Xylocopa spp.*) and ground nesting bees. Butterflies recorded in the field were observed foraging on flowers and droppings of animals. Other large butterflies such as Citrus Swallow tail butterfly (*Papilio demodocus*) were observed on active flights. The most common butterfly species is the African emigrant *Catopsila florella* while some spectacular ones include the Diadem *Hypolimnas misippus*, and the Yellow Pansy *Junonia hierta*. Flowering plants during the time of the rapid field survey within the proposed project area were the invasive plant species *Nicotiana glauca* which is depended on by nectar foraging species. More flowering plants are expected to emerge during rainy season.

Other invertebrate species were associated with water habitats (or points) for foraging, breeding and collection of building materials. Few dragonflies were observed around the water resources (lagoons) and streams; these include *Trithemis kirbyi* – busking on stones with dropping wings, *Anax imperator* – dragonfly with powerful flight, the Globe Skimmer (Wandering glider) *Pantala flavascens* – always on flight in day light. Two wasp species were observed; the Large mud-dauber wasp – collecting mud for buidingits nest, and the spider- hunting wasp observed carrying butterfly larva (caterpillar) in the Tarchonanthus bushlands. The *Acacia drepanolobium* draws attention with presence of different ant species; the Cocktail acacia ants (*Crematogaster spp.*), Skinny black acacia ant (*Tetraponera penzigi*), Singing ant (*Pachycondyla spp.*), and the Polyrachis ant (*Polyrachis spp.*). The distribution of dung beetles is associated with the distribution of livestock and/or wildlife droppings. Most of observation were on areas with presence of dungs from cattle or buffaloes.

Junonia hierta

Scarabaeus satyrus

Pantala flavascens

Trithemis kirbyi

Figure 12: Invertebrate species Identified

2.7 Herpetofauna Diversity

2.7.1 Desktop analysis

Herpetofauna species are poorly studied within the 10 km buffer of the proposed KenGen Olkaria Industrial Park location. Records in the database shows limited publication of herpetofauna species data within the proposed project location. Only three herpetofauna species have been published from the proposed project location. These are amphibians; *Amietophrynus kerinyagae*, *Kassina senegalensis*, and *Tomopterna cryptotis* (Spawls S. et al., 2006).

2.7.2 Field observation

Herpetofauna species were rarely observed on the landscape within the proposed project area. About 2 species of amphibians and 4 reptiles were observed during the rapid field assessment. About 6 reptile species (snakes) were recorded by an account from the local community. These included the African Rock Python, Puff Adder, Black Mamba, Spitting Cobra, the Green Mamba that are occasionally seen in the fields. Most the snakes occur in the valleys where they forage,

and areas with rocks or stones that forms their habitats. Tadpoles were observed in some lagoons or water points indicating presence of frogs in areas with streams and water points (Plate 2).

Kirk's Rock Agama (*Agama kirkii*)

Tadpoles crowded in a water pool

Figure 13: Photographs of Agama kirki (left) observed crossing the road and pool of water wth tadpoles (right)

2.8 Ecosystem Services

2.8.1 Introduction

The ecosystem services in the project area to the people around the industrial park have been classified in accordance to the ecosystem. The area being a terrestrial ecosystem the most common type within and around the industrial park is the Grassland ecosystem and Forest ecosystem.

They therefore provide a number of services such as habitat, food supply, air purification, medicine, soil erosion control and research among others.

The area provides varying ecological conditions making it suitable for inhabitancy by human, animals and plants. Some of these animals and plants have been domesticated while others remain within the environment as wild plants and animals. Despite living things occupying this place the ecosystem has been influenced by a number of parameters which are contributed naturally or by human and such parameters include temperature change, rainfall distribution, soil type, wind, over stocking, encroachment and gaseous emission.

The supply of such resources has decreased over time as compared to the past and this is as a result of climate change and human inversion. This study was mainly interested on the services offered by the ecological system of this environment and to check on the availability of the various

natural resources, their distribution, factors affecting their distribution and changes that have taken place within the environment.

The study has been conducted in three locations bordering the area to be occupied by the proposed industrial park and they include Rapland Olomayiana Kubwa and Narasha.

2.8.2 Rapland

This place is located to the south east of Hells Gate National Park and it is characterized by steep rugged terrain, with increased numbers of dry river valleys which have been formed as a result of high rates of erosion as this is highly facilitated by the type of soil (ash volcanic) and reduced vegetation cover in the area.

2.8.2.1 Ecological Services to the People Agriculture (Crop Farming)

The residence here practices mostly subsistence crop farming. The main type of crops grown here are maize, beans, banana and kales. Farming is only done within the individual parcels since this community is made up of people who have been relocated from their original land and are now new inhabitants of this place. The land here is subdivided into smaller portions limiting the community from extensive large-scale farming.

Most crops grown here are mainly rain feed crops. Such crops are only grown during the long rainy seasons which occur from April to July. During this long rainy season, the crops grown are maize and beans. Beans are harvested within the first three months of the planting period while maize is harvested in the six-month period after they have dried in the field.

Kale farming is done at very small scale basically at household level and besides the rain water kales are supplied by waste kitchen water which is sprinkled to provide the moist condition during the dry periods of the year.

Problems Facing Crop Farming in the Area

Crop farming in Rapland is not doing successfully as a result of a number of challenges facing the community, some of these challenges are natural while some are human induced.

- ✓ **Prolonged Drought:** This condition is brought about by increased periods of dry conditions with little or unreliable rainfall in the area, this therefore affects the crops in the farms as some are even forced to dry up before maturity.

- ✓ **Wildlife-Human Conflict:** The area being next to the park, some of the animals moves out of the park and feed on the crops before getting back to the park. Such animals include antelopes, buffalo, and elephants.
- ✓ **Mudflow:** The flash floods experienced in the area, sometimes results in a mudflow which destroys the crop lands covering them and sometimes carrying the farms away.
- ✓ **Erosion:** Soil erosion is a common problem in the area since the area is located on the steep slopes and the soils are easily eroded into the valleys leaving the crop field bare. The ash volcanic soil being light and lose, it is easily washed away by rainfall, this sometimes result to loss of soil fertility.
- ✓ **Pest and Disease Attack:** The increase in the spread of pest attack, especially by the armyworm, reduce the productivity of maize planted in the region, diseases also result in stunted growth of crops. Diseases like blight and bacterial stalk rot also reduce the quality of the crops in the field and in turn reduces the quantity and quality of farm produce.

These problems identified above have been responded to by a number of ways like;

- Reporting the cases of attack of wildlife to the Kenya wildlife service office;
- Using manure to restore the soil fertility of the soil;
- Introducing fast maturing crops like Duma maize species; and
- Cultivating areas with relatively gentle slopes.

The dynamic sequence of cultivation prevents the locals from infringing into the neighbouring lands, this allows them to cultivate one land over and over for a long period of time which sometimes result in loss of soil fertility. This is sometimes addressed by leaving the land fallow and uncultivated turning them into gazing field for a period of time for the land to regain its fertility. Crop farming here has no limitations to any family member and instead can be done by anyone but are most preferred by women since most of the time they stay behind at home.

2.8.2.2 Agriculture (Animal Keeping)

Being a pastoral community, the Maasai have a long history of cattle keeping in which large heads of animals are kept by various individuals. Such animals kept include cows, goats and sheep which are kept as a sign of wealth and for food, donkey for transport purpose and dog for security purposes.

The cattle kept by the various individuals can sometimes be sold to get money which is in turn used to provide for other family needs.

The Maasai are known for seasonal movements, this is because of the large heads of animals kept that are fed on natural pasture. In this region, the animals kept are fed on the natural pastures on the slopes of the hills around, alongside the pasture the animals also feed on other natural plants and weeds. The locals have a common water point where water is supplied to the locals for both human and animal use since within the region there are a number of dry river valleys with very little natural water points. Flash floods sometimes collect in the depressions and on rocks which are then used by the animals but this only occurs during the rainy season. The dry season changes environmental factors such as, rainfall and temperature which determine the grazing land of the pastoralist as the animals are grazed faraway places in search of pasture in areas like Naivasha, Suswa, Narok and Mahiu mahiu.

The movement into these foraged land areas does not have specific routes but are done mostly during the day using places where there is ease of movement with the cattle. Some families also buy the maize stacks to feed the animals during the drought period but only when there is prolonged drought within the region. The animals kept are mainly sold in the local markets but sometimes the external buyers come and get them using lorries. Animal meat forms the main dietary source of protein, they also provide the locals with milkand hides. Herding is commonly carried out by men, particularly boys.

Problems Facing Animal Keeping in the Area

Cattle keeping in Raplandare influenced by a number of factors which in turn lowers the production level within the area. Some of which are caused by nature and some by humanfactors and they include;

- ✓ **Inaccessibility of Grazing Land:** The area being hilly, the terrain appears to be rugged making it difficult to access some of the areas within which has pasture to feed the animals. Animals also find such places difficult to walk on thus avoiding such slopes during the grazing periods.
- ✓ **Prolonged Drought:** Prolonged dry periods result to drying of pasture which is used by the local community to feed their cattle.
- ✓ **Attack by Wild Animals:** Animals such as hyenas invade individual homes and kill the goats and sheep such occurrences result to loss to individual farmers. Hyenas are said

to be more frequent during the rainy period but in dry seasons the attacks are rare in the area. Other animals that attack the farmers include the leopards and pythons.

- ✓ **Pest and Disease Attack:** Ticks are a common pest that attack cattle in the region, it causes ill health in the animals and also reduces the quality of skin and hide. Fever and foot and mouth diseases are example of diseases common in the region.

Such problems have been addressed by the farmers by various measures like;

- Fencing the compounds;
- Avoiding dangerous fields and routes during grazing periods;
- Temporal constant movement with the animals; and
- Use of local herbs in control and seeking veterinary services.

2.8.2.3 Hunting and Gathering

Hunting is illegal in the area since Rap lands is a community located next to a Hells gate game park. The community also by their culture they do not accept consumption of wild meat. These factors make it difficult to hunt in the region.

Gathering and picking is practiced but not common in the area, it is therefore done in small scale mostly by the boys who are in the grazing fields and girls who are collecting firewood to be used for fuel.

The wild fruits are said to be more common in the industrial park but not within the settled environments and there they are mainly consumed by the wild animals and birds.

Hunting and gathering constitute to less than 5% of the meals taken by the community.

Table 8: Example of plants and animals in the area

Taxa	English Name	Local Name	Use
Plants	Cape fig	Ol-ngabali	• Produces edible green fruits with fleshy berry and numerous seeds (either white or red when ripe)
	Wild berries	olamai	• Green with milky sticky juice but turn Red-black fruit when ripe • Treatment of running nose and common cold (water from boiled root)
	Acacia sp	Ol-jarbolani	• Green fruit with two thorny projection (eaten

Taxa	English Name	Local Name	Use
			when green)
	Leleshwa bush	Ol-leleshwa	• Animal feed • Medicine (skin disease) roots • Fencing • Add fertility to soil
	Kirks acacia sp	Ol-lerai	• Roots used for decoction • For firewood and construction
	Peanut butter cassia	osenetoi	• Leaf infusion used as emetic in malaria treatment • Boiled leaf applied in body for measles treatment
	Acacia sp Whistling thorn	eluai	• Use in soup to help digestion (roots) • Boiled roots are mixed with milk and given to women after birth as diuretic • Animal feed
	lantana		• Animal feed
Animals	Baboon	oyekenyi	'-'
	Buffalo	olaro	'-'
	Hyena	organoi	'-'
	Python	olasarai	'-'
	azells	eronko	'-'
	Rabbit	enkitejo	'-'
Birds	Eaver	olodokasho	'-'
	Ox pecker	olariak	'-'
	Hen	Olkuku	'-'

2.8.2.4 Construction

The household buildings in this area are 95% permanent with very few people settling in Manyatta houses. The houses were constructed by KenGen before the relocation of over 330 households into the area. The houses are constructed using stones, cement, sand, and timber and iron sheet.

The raw materials were obtained from Naivasha and Karagita and the neighbouring town and its centres with the stones obtained locally from the KenGen quarry which is located within anindustrial park a few kilometres from the Rap lands.Sand obtained from the valley bottom within the region to supplement the one from Narok. The area does not have large and tall trees that can be used for modern construction of houses. For Manyata there are local trees andvegetation that could be used like 'Olopitaq'used as ropes to tie the ''Oringa'' used as the twigs and poles for construction of Manyatta in Rapland.

Figure 14: Permanent House

2.8.3.5 Biofuel

The commonly used biofuels are firewood and charcoal with very little use of cow dung. The commonly used plant for firewood is the 'Oleeleshwa'. It forms good firewood and is spread all over the region. Charcoal burning is not allowed in the region but this is done unlawfully by the community members.

2.8.2.6 Water Resources

Water in the region is supplied at a common point where it is taken for the household use and to water the animals. Surface streams are not in the area as water infiltrate at a faster rate into the ground after the rain, the water is also harvested and stored into tanks for local use but the quality of the rain water depends on the amount of rainfall received in the area. The first rain is said to be more harmful as it collects all the atmospheric pollutants from the area and therefore the successive rain water is preferred compared to the first rain.

2.8.3 Olemayiana Kubwa

The village is located directly to the south of Hells Gate National Park and it is at the periphery of the industrial park in accordance with the masterplan. A number of ecosystem services are provided by nature to the locals living in the areaandare discussed below.

2.8.3.1 Agriculture (Crop Farming)

Crop farming is practiced in the area at both small and large-scale levels; the common crops grown in the area include maize beans. Cultivation is done once in a year and this is done only during the long rainy season that normally occurs from April to August. Since the crops are mainly rain fed a faster maturing breed of the crops are grown in the area; these include pioneer, sergeant and duma breeds for maize (Plate 3), and rose coco and yellow beans breed for beans.

Figure 15: Maize plantation in Olomiayian village

The relatively gentle slopes of the surrounding make it easy for cultivation for both large scale and small-scale crop farming. There is use of manure in improvement of soil fertility and this is more preferred to the use of chemical fertilizers since it is relatively cheaper to obtain and also readily available within the environment. The community also utilises manure help improve the soil quality by binding together the particles and neutralise the soil pH. Crop farming is done by any family members as there are no cultural beliefs restricting agricultural farming. Kitchen gardening is mostly practiced by the women in the society since they are mostly available at home, kales is the common vegetable grown in this kitchen garden and are mostly supplied with waste water from the households, the vegetables here are sold locally to the household around

but are supplemented with other imported species from the neighbouring regions like Naivasha. The plants remain are used in most cases as animal feed during the dry periods. The production level has however changed over time and this is accounted for by a number of factors.

Factors Affecting Crop Farming

Both large scale and small-scale production of crops in Ol-omayiana kubwa have been affected by a number of factors some being natural while some are human induced and they include;

- ✓ **Prolonged Drought** – This is the major and common problem experienced within the area. This condition sometimes results to massive failures of crop production in the field, the little and unreliable rainfall amount in the area discourages a number of people in the area therefore shifting to cattle keeping.
- ✓ **Wildlife Human Conflict -** Olomayiana kubwa being located next to the park animals sometimes walk out of the park and destroy the cultivated land by feeding on the crops. Animals like zebras, baboons, buffalos and gazelles attack more frequently. Buffalo which walk in pairs are mostly seen during the daytime of the dry season once in a while but for the zebra they spent more time outside the park and this enables them to destroy the cultivated crops in the field repeatedly, baboons on the other hand have periodic visit to the location during the day but mostly during the harvesting period. The number of buffalos has continued to reduce over time as evidenced by the number seen as compared to old days when they use to come in large number. On the other hand, Zebras population seems to increase in the area over time as compared to the past periods when they use to appear once in a while. These animals mostly attack the maize field as compared to the bean farms and sometimes they can destroy the whole farm or part of the farm.
- ✓ **Pest and Disease Attack** – This has become a common phenomenon in the area and it causes the farmers to register massive loss, attack by pest like the armyworms affect the growth of the maize crops in the field, birds like the weaver also are threat to the maize crops in the field as they destroy the leafs and the developing maize within the farm. Diseases like the blight and stalk rot slows the rate of growth in maize which in turn lowers the productivity of the

fields.

- ✓ **Erosion** – The area being characterized by the volcanic soil, is highly eroded since the soil here is held loosely on the ground. Washing away of the top soil by the flash flood in the region reduces the nutrient supply in the farm field. High rate of erosion also has resulted to development of canyons within the farming lands.

- ✓ **Mono-cropping –** The practice of planting same crops on the piece of lands over long period of time has resulted to depletion of certain nutrients in the soil making it to lose its fertility. This has been evidenced by reduced production in the farm in successive years when compared to previous years.

  These problems however, have been addressed at various levels by the farmers in both small and large scale by taking various measures;

  - The community have introduced cultivation of fast maturing crops like pioneer and sergenta maize species.
  - Reporting the cases of attack of wildlife to the Kenya Wildlife Service Office and also establishing of fences on cultivated lands to prevent penetration of the animals into the cultivated land.
  - Addition of manure to restore fertility within the area.
  - Cultivating over flat areas or areas with relatively gentle slopes.

2.8.3.2 Farming (Livestock Keeping)

In Ol-omayiana kubwa animal keeping is practiced in large scale and the most common animals kept here are cattle. The area being relatively gentle with most surfaces covered with pasture this makes it easy for animals like cows, goats and sheep to thrive well in the environment (Plate 4). Alongside cattle donkey and dogs are also kept for various reasons. Cattle are kept as a sign of wealth by the community while donkey is used by the community for transport services. The dog on the other hand is used for security purposes; the inhabitants being pastoralist community the animals kept are feed on natural pasture and other vegetation in the region but sometimes supplemented by maize stalk during the dry and harvesting period. due to water scarcity in the area, KenGen provides for tap water for domestic consumption and water livestock.

Figure 16: Lactating sheeps grazing in open grassland near Olomayian village

During the dry seasons the animals are moved into new pasture region, the Naivasha-Suswa and the Suswa-Narok belt are some of the regions of high forage pasture and are mostly utilized by the community. The movement of animals are done collectively in groups using the specified known routes. This help to reduce the risk of attack by the wild animals within the region, such routes are also good for the animals due to ease of movement and availability of water within the region. In search of pasture pastoralist sometimes covers a distance of up to 40 km together with the animals. The community also is faced by a number of challenges with regards to animal keeping and such challenges include;

- Attack by wild animals such as lions, hyenas, pythons and baboons. Lions however do not attack frequently but whenever they attack they leave the community with great lose behind and they mostly come out of the park during the dry period and normally attack during the night time, pythons mostly attack in the field during the grazing period where they mostly trap and catch the goats, baboons attack is more frequent during the wet seasons where they strike homes in late evening attack and kill the young goats and the lambs taking the flesh with them into the bush.
- Prolonged drought consequently affects the quantity and quality of the pastures. Reduction in quantity of pasture forces the farmers to migrate into new environments in

search of pasture and water, which may also expose the animals to attack by the tropical diseases and pest found in new environments.

- Contraction of new tropical diseases like mouth and foot disease and attack by pest like the tick also affect the level of production. Pest transmit diseases to animals and such diseases causes ill health to the animals this sometimes may lead to mass death of the Cattles or reduction in quality of the products.
- Competition from wild animals on natural resources like food (vegetation) and water also affects the livestock farming in the area as some of the herbivorous animals walk out of the park and feed in nearby areas.
- The canyons in the area makes some areas inaccessible thereby locking such environments to be used by the pastoralist to feed their animals, development of such features also reduces the area of pasture that could otherwise be used to feed the animals

Poultry farming is done in small scale level by a small number of households; the common bird kept is the chicken which is used mainly to supplement the protein supply to household members.

2.8.3.3 Construction

The household buildings in this area are 90% semi-permanent with a few people settling in manyatta houses. The houses are made using the iron sheet for the roof and wall with cemented floors, the houses have been constructed by various individuals following the relocation by the KenGen Company from the ancestral lands where new geothermal fields have been identified. The houses are constructed using cement, sand, timber and iron sheet.

The raw materials were obtained from Naivasha and Karagita towns and the neighbouring towns.

Figure 17: Semi Permanent Housing

Figure 18: Manyatta

2.8.3.4 Hunting and Gathering

Hunting is not practised by the community this is done in relation to the custom belief of the Maasai Community, as the community only belief in consumption of the domesticated animals, the area being located next to the park the community members also tries to abide by the laws enacted by the Kenya wildlife service that prohibits hunting within and around the parks.

Gathering is practised but only for the wild fruits and herbs. The fruits that are gathered by the local community are mostly found within the proposed industrial park but this is done at small scale level, gathering of fruits is done mostly during the wet periods, for the herbs collection this is done at large scale since the community believed in the use of such medicine for the treatment purposes. Gathering of herbs is done throughout the year, most of the herbs are found locally within the ecosystem but much supply is within the proposed industrial park.

2.8.3.5 Traditional Medicine

The collected herbs are mostly used while fresh and this limits the storage of such herbs except when the herbs are to be exported to the neighbouring towns. The herbs collected are used in curation of different diseases; administrated orally and others applied on body. Concoction is sometimes made from different herbs to use for curing. Since the area is not close to any modern medical facility's the community therefore have relied fully on the traditional herbal medicine for curing diseases.

Different parts of these plants including roots, stems and leaves can be used in treatment of various diseases. Some plants are boiled together with the food and served with the soup during the meals while some are just boiled alone to help in treatment of the digestive and bone related diseases. Some are chewed and the juice obtained swallowed into the body system to help in curing of body diseases. Some are also crushed and the mixed with body lotion and applied on the skin to help in treatment of the skin diseases.

Table 9: Trees Used as Medicine in the area

Taxa	English Name	Local Name	Description
Plants	Cape fig	Ol-ngabali	• Produce edible green fruits with fleshy berry and numerous seeds (either white or red when ripe)

Taxa	English Name	Local Name	Description
	Kale	masuru	• Leaves used as vegetables
	Grapes	olamai	• Tick control when mixed with water and sprayed to cattle • green with milky sticky juice but turn Red-black fruit when ripe • Treatment of running nose and common cold
	Acacia sp White thorn	Ol-jarbolano	• Green fruit with two thorny projection (eaten when green)
	Leleshwa bush	Ol-leleshwa	• Animal feed • Medicine (skin disease) Roots • Fencing and building • Add fertility to soil • Medicine to produce smoke inhalant for asthma or common cold)
	Castro Oil Palm	Ol-dule	• Decoction from boiled roots taken as appetite stimulant
	Acacia sp Whistling thorn	eluai	• Use in soup to help digestion • Boiled roots are mixed with milk and given to women after birth as diuretic • Animal feed
	Sodom apple	endulelei	• Fruit used for treatment of toothache • Root decoction used to treat abdominal pain.
		olopitaq	• Food for sheep and goat • Used as rope in manyatta construction
		olosida	• Medicine for new bones
	Arrowroot	eloropij	• Edible fruit similar to carrot but white in colour
Animals	Baboon	oyekenyi	• Attack and Feeds on small animals like goats and seep

Taxa	English Name	Local Name	Description
	Buffalo	olaro	• Destroys the maize field
	Hyena	orgonoi	• Attacks on goats and hyena

	Python Snake sp	olasarai	• Are found mostly in the bushes within the industrial park region
	Viper Snake sp	entara	• Found in bushes and not commonly seen
	Frog sp	Ol tuaa	• Small and green always found at water points
	Lion	orngatum	• Attack and feeds on cows
	Gazells	eronko	• Are seen more frequent in the area during the evening and morning hours
	Rabbit	enkitejo	• Are seen more frequently in the area during the evening hours
Birds	Weaver	olodokasho	• A crop pest that always seen towards the harvesting periods
	Ox pecker	olariak	• Commonly seen during the day alongside the cattle in the field
	Hen	Olkuku	• Domesticated by man for food supplement
	Rock martin	Esarampali	• Are mostly seen during the day but within the cave region
	Owl	oloibaintare	• Are only seen during the night time.
Insects	Spider	olkedi	'-'
	Tick	'-'	'-'

2.8.3.6 Water Resources

Water being an essential commodity for plants and animals, the Olomayian community has been served by tapped water by the KenGen Company. The water is purified and treated and can be used for human consumption. The water is collected at a common point by the community members and it is at that point where the animals are watered (Plate 5). This has help to solve the problem of water since the area is not served with natural water systems like rivers and ponds.

Figure 19: Olomayian water point

2.8.4 Narasha

Narasha is located to the south west of the Hells Gate National Park and is to the west of the proposed industrial park. The community here enjoys a number of ecological services by utilization of the natural resources within the environment to meet their daily needs. The settlement here takes both the modern and traditional structures. The population is concentrated next to the water point but as it spreads outwards it becomes sparse. There area has relatively larger tracks with gentle sloping terrain. Most of the surface is covered by the short vegetation which is indigenous species. The locals have also introduced the exotic tree species like pine, cypress and gravellier which have been planted within the homestead and at the margin of the farm lands.

2.8.4.1 Construction

The area is composed of variety of structures as some of the residence has tried to modernise and have established permanent structures as others have semi-permanent leaving a smaller proportion in the traditional structures (Manyatta). The traditional structures are built using the locally available materials obtained from the vegetation around while construction of the permanent structures involves importation of materials from the neighbouring towns like Naivasha.

2.8.4.2 Crop Farming

The relative flat land in the region makes it suitable for both large- and small-scale cultivation of crop in the region. The common plants grown include maize and beans (Plate 6). Other crops grown in the region include vegetables, banana and orange but these are done at small scale level to meet the household need. Since the farming totally relies on rain, cultivation is done once in a year with the land preparation starting from January to march before the onset of the rainy season in April when planting is done followed by the field management practices, harvesting of maize is done in August when they have completely dried in the field but beans are harvested three months after the planting period. The common species grown are duma, sergenta and punda for the maize and rose coco and yellow beans. The vegetable species grown include the kale and spinach which are done at small scale level for family consumption. Vegetables are grown in small plots where they can be watered during the dry periods using the taped water from the water point. Crop farming in the area has not been successful due to a number of factors limiting the process which are outlined below in Figure 20 below.

Figure 20: Maize plantation ready for harvesting Narasha village

Factors Affecting Crop Production

Pest and Disease Attack: Crop fields are highly affected by the attack by pest like rodents, birds and insects. Rabbit invading the vegetable farms feed on the leaves which would have otherwise be harvested for consumption, birds like weavers attack the maize field and destroy

the plant leaves they also feed on the plant produce while still in the field thereby reducing the farm output during the harvesting period. Termites and stalk bores also attack the maize crops cut the stem and in turn reduces the output.

Disease attacks like the leaf blight and stalk rot are common in the area and more often they result into crop fail and reduced production from the field.

Wildlife Human Conflict: Narasha being a village onto the edge of a game park there are frequent attack by wild animals like Giraffe, Zebra, Warthog and Gazelles. The number of these animals has increased in the village with Zebras (Plate 7) spending most of their life outside the park and therefore interfering mostly with the human activities in the farm as compared to the past when they could only be seen during the dry periods. Since the animals feed on green vegetation they cause destruction on crop field leaving farmers with very little or no crops left in the field.

Figure 21: Plains Zebra grazing on road side

Soil Erosion: The flash floods experienced in the region during the rainy season washes away the top soil used for farming, this sometimes consequently follows with the development of canyons across the farm lands reducing the area to be used in crop production.

Occurrence of the flash floods sometimes result to mud flaw which wash away the crops in the field, leaving farmers with nothing in the farm.

Prolonged Drought: The change in the climatic condition has resulted to reduced rainfall in the area and also the change in rainfall pattern that has affected the production of the rain fed crops

and sometimes it results to total fail of the crops in the field. Since the area has a volcanic soil which is poor in water retention this discourages the use of irrigation in the production process of the food crops.

Forest Fire: The occurrence of forest fires which is occasionally experienced during the dry periods such fires sometimes spread into the cultivated lands consuming the crops leaving the farmers with nothing to count on.

Soil Infertility: Production of same type of crop on the agricultural farms results to depletion of certain minerals this renders the soil to be infertile which intern lowers the farm output during the harvesting periods.

2.8.4.3 Agriculture (Lifestock Keeping)

The main animals kept here are the cattle which are kept in large scale level. These animals are mainly fed by use of natural pasture and other plant vegetation within the region. The animals here graze in open fields and sometimes within the park, during the dry periods the animals are constantly moved from one region to another in search of pasture and water. The forage quality and quantity in the area are affected by a number of factors such as;

- The number of animals within the area;
- The type of soil in the region; and
- The amount and distribution of rainfall in the area.
- Steep slopes have more pastures as to gentle slopes that are easily accessible.

The movement is done using the specified known routes which are said to be safe for the animals. These routes include Narasha-Naivasha, Naivasha-Suswa, Naivasha-Nakuru and Suswa-Narok. These routes however are said to be having gentle slopes making it easy for animal movement. The movement of animals are done in groups. The animals are mainly watered at common water taps but during the dry periods they are watered at the rivers and pools at the valley bottoms within the grazing environments. The pasture is supplemented by the maize stalks during the dry periods and these are however purchased from crop farmers.

Figure 22: Goats and Sheep in the field

Since the animals are kept as a sign of wealth they can sometimes be sold in the local and external market to generate income to the farmers. During the sales the age, size and health of the animal becomes the determining factor of the animal price. Adult animals fetch higher prices as to the young animals. Fat animals are also sold at high price compared to thin animals and also healthy animals are more expensive compared to sick animals. Since the animals are the major source of protein to the people they are also slaughtered for food. The animals are also used during the rituals by the community for various purposes.

Animal keeping in the region faces a number of problems like;

- Contraction of new tropical diseases like mouth and foot disease lowering the quality of the animals by causing ill health in animals;
- Attack by pest like the tick also affect the level of production by transmitting diseases like anaemia to the animals;
- Prolonged drought is likely to affect the quantity and quality of the pasture this forces the farmers to migrate into new farming environments;
- Attack by wild animals such as lion, hyena, and python both at home and in grazing fields causes fear in farmers as these animals kill and feed on the cattle; and
- Forest fires also burns the vegetation that would otherwise be used to feed the animals causing starvation.

2.8.4.4 Bee Keeping

Bee keeping is not practised in the region but during gathering the hives in the forest are harvested and the honey obtained is used for various purposes. The honey can be used in making tea as a sweetener, it is also believed by the community that honey can be used as a medicine for treatment for digestive related problems. Bee hives are mostly located within the proposed industrial park forest. Bees also aid the community as they help with the pollination of flowering crops grown in the cultivated lands. Harvesting of hives however is not popular with majority of the community and is only done by specific individuals.

2.8.4.5 Hunting and Gathering

Hunting: This practice is not carried out by the community as they only belief in the consumption of meat from domesticated animals, consumption of wild meat is prohibited by the community as it is against their cultural beliefs and norms.

Fruit Gathering: This practice involves the collection of wild fruits which only occurs during the wet season. The practice is not common with community however, it is done in small scale by the Moran's who are in the field grazing the animals. The fruits picked are consumed raw while in the field and such fruits include grapes (Olamai), arrow root (Oloiropij) guava (Orngabali) and acacia fruit (Lumuriak).

Birds Gathering: Narasha being next to the park a number of birds are found in the region. The community however do not take part in hunting and gathering of wild birds for they believe that eating of bird is against the community culture.

Example of common birds includes weaver (ol odokashi), ox pecker (ol ariak), guinea fowl, dove (enturukulu), hornbill and pigeon.

2.8.4.6 Cultural Services the Sacred Places

The residence of Narasha considers the caves located in the Hells Gate Gorges a few kilometres away within the proposed industrial park area to be one of the sacred places where the communities can conduct ceremonies. The main cave near the central towers is associated with variety of activities like selling of beads and oral narration of mythical stories behind the features in the area. Areas characterised by the red ores which is the soil used during the ceremonies are also considered sacred as they are not all over but at specific points within the industrial park. The red soil is mixed with other substances to produce different colours needed and are used for decoration during ceremonies like circumcision. Long ago circumcision used to be done in the

forest but over time this practice has changed and is today conducted at individual homes.

2.8.4.7 Recreation and Tourism

The area is characterised by a number of recreational facilities like the Gorges, Caves, Fissures, Rocks and Wild animals. Several tourists visit the place to see the rocks like the central towers (engaibartan) (Plate 8), caves and the gas fissures. Rock climbing is also done in the areas with the towers. The caves are communal resource and entrance fee paid are used to develop the region. Local tour guides are also paid from which they get their daily income.

Figure 23: Central tower consisting of protruding rock

2.9 Natural Disaster and Control

In the three study areas the most common disasters experienced in the region include;

- Rock fall, soil creep and mud flow are more often during the rainy season water infiltrate into the soil and make it be more loose making it slides down the slopes to the residents thus causing destruction of properties, rock fall on the other hand sometimes occurs on the steep slopes resulting to loss of life and destruction of properties; and
- Harmful gases like sulphur dioxide and hydrogen sulphide produced by the fissures and geothermal wells within the region are harmful for human as some are poison when inhaled. Some gases also result to development of complications like miscarriage and respiratory diseases. Residents are advised to avoid areas of fissure eruptions as the geothermal station officers' safeguards and monitors the geothermal wells and also treating the gasses before allowing them to escape into the air (Plate 9).

Figure 24: Emissions from Geothermal Operations

- Prolonged droughts in the area lower the quality and quantity of pastures, this condition is avoided by pastoralist migrating into new environments in search of pasture and water. The households have also been provided with tapped water for domestic use.
- Forest fires that burn the forage pastures during the dry periods poses the community to great threats as the animals are left with no grass to feed on (Plate 10). Such wild fires are avoided by restricting the burning of charcoal within the forested environment.

Figure 25: Bushfire destroying pastoral areas

- Attack by wild animals like lions are avoided by use of safe routes during the grazing and also by fencing the premise to keep of such wild animals from attacking the homestead.

2.10 Soil Erosion and Control

Soil erosion is a mutual problem in Olomayian, Rapland and Narasha villages during the rainy season. Trees species like pine and cypress are planted at the edge of the farms to reduce the rate of soil erosion. Stones and rock fragments are also used to fill the ditches on the path of runoff water within the farms. Along the road sides water channels have also been constructed to reduce the rate of erosion and also to guide the movement of water.

2.11 Pollination

The process is facilitated by the presence of birds, insects and wind. Both the agents play a major role in gene transfer from one plant to another. Beans and maize are the common plants in the area that are highly pollinated. Insects like bees and butterflies are actively involved in the process, birds like tail wagon also helps the pollination process. Over time there has been a significant decrease in the insect and bird population, this is accounted by increase of predation by other organism and change in climate making them to migrate into new environments. Decrease in pollinators however has not resulted to crop failure in the area.

2.12 Climate Change and Regulation

From the studies conducted in Olomayian, Rapland and Narasha villages it is clearly evidenced that climate change is taking place within the environment. Reduced number and sizes of vegetative cover indicates some of the changes taking place in the natural environment. The change in climate in this area is contributed by a number of activities like charcoal burning, overgrazing, forest fire and emission of toxic gases from the fissures and geothermal plants. Afforestation and agroforestry programs have been introduced in the areas to help in reducing the impacts of climate change in the natural environment.

2.13 Disease and Pest Control

Pest and disease attacks are a common problem in the three areas. Both animals and plants at a greater extent are affected by the phenomenon. Pest attack have the potential to transmit diseases to the plants and animals reducing their immune systems. Tropical diseases like common cold, headache, skin and respiratory diseases are also common within these environments. The use of herbs as medicine has help to maintain good health. The communities around use the natural vegetation to generate herbs used in disease and pest control. Most of the plants used are obtained locally some being located within the area to be used as the industrial park, this makes the medicine to be more available and affordable. Being within the maasai community the knowledge of herbal medicine is a cultural practice that is passed from one generation to another. Various parts of these plants like roots, stem, leaf and fruits are extracted and used in treatment. Example of such plants include; Whistling thorn, Leleshwa and Peanut butter cassia as seen in Plate 11.

Cassinia arcuata

Peanut butter cassia

Sodom apple

Leleshwa plant

Whistling Thorn

lantana camara

Figure 26: Herbal medicinal plants use for curing diseases among the local community

2.14 Conclusion

From the study conducted a number of ecological services have been identified in the areas of study. The services are directly attached to the industrial park and therefore a consideration should be taken during the implementation phase of the programme to ensure continued existence of the bio-organisms within the area, and also to ensure balance in the ecosystem.

3. IMPACT ASSESSMENT

3.1 Impact Identification

During field observation the proposed Olkaria Industrial Park project location was surveyed to identify potential environmental issues that would be affected negatively or positively. Potential impacts identified included;

Table 10: Potential Impacts

No.	Environmental Issue	Impacts in Phases of the Project		
		Construction	**Operation**	**Decommissioning**
	Loss of Vegetation Cover	Clearing of vegetation on industrial sites and on access roads	Will be contributed by land degradation	None
	Accidental Road Kills	Collision of crossing animals especially herpetofauna and rodents	Increased collision of crossing animals especially on low flying birds, herpetofauna and rodents	Reduced collision of crossing animals especially on low flying birds, herpetofauna and rodents
	Collection of Live Specimens of Species	New incidences of poaching or collection of whole specimens or part of species	Increased incidences of poaching or collection of specimens or part of species	Reduced incidences of poaching
	Alien Invasive Plant Species	Introduction of new AIPS seeds or propagules	Spread of existing and new AIPS	Spread of AIPS
	Barrier to movement of elephants and other wild animals	Physical prevention of movements caused by objects, and noise from machines	Prevention of crossing across roads by vehicle movements and running engines	Increased movements of animals across the landscape
	Human – Wildlife Conflict	• Physical prevention of wild animals from dispersing holding them near human settlement • Physical confrontation of	• Physical prevention of wild animals from dispersing holding them near human settlement • Physical confrontation of	Physical confrontation of human with wild animals
No.	**Environmental**	**Impacts in Phases of the Project**		

	Issue	Construction	Operation	Decommissioning
		human with wild animals • Diversion of wild animals to cropped areas	human with wild animals	
	Land Degradation	Clearing of vegetation by excavation	Increased overgrazing on the steep slopes	Increased overgrazing on the steep slopes
	Storm Water Generation	Slight increase in runoff water collection	Increase is runoff collections	High runoff collections

3.2 Environmental Impact Assessment

3.2.1 Potential Collection of Live Specimens

Collection live specimens of amphibians and reptiles is likely to occur; 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. Most of these species are enlisted under CITES in Appendix II due to potential live collection for trade as pet.

Extent of Impact: The extent of collection of live specimens will occur within in project 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: Collection of live specimens will potentially occur along the road.

Duration of Impact: Collection of live specimens was 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.

Table 11: Unmitigated impacts of collection of live specimens of species 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	Proposed 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 the collection of live specimens of species during the 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

Table 12: Unmitigated impacts of collection of live specimens of species during operation phase

Extent of Impact	4
Magnitude of Impact	4
Duration of Impact	4
Likelihood of Impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (96)
Recommendation	Proposed Mitigation Measures
Comments/Mitigation • Vehicles getting into and out of the IP area should be inspected by KWS • All vehicles to sign for where they are going and host should also countersign to confirm their intention • The vehicles should not allow carrying of wild animals or specimen or part of the species in the vehicle.	
Mitigated impacts of the collection of live specimens of species during the operation 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

3.2.2 Impact on the Introduction of New Alien Invasive Plant Species (AIPS)

The proposed Olkaria Industrial Park currently has a distribution of two notable Alien Invasive Plant Species, *Nicotiana glauca* and *Cirsium vulgare* around sites previously constructed or disturbed. These include 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: New AIPS propagules will be introduced into the site where construction will be active in the proposed Olkaria Industrial Park. The introduction will be limited to the active construction area (Table 12).

Magnitude of Impact: Large number of AIPS propagules will be introduced on construction site. These propagules will be redistributed over the landscape by surface runoffs (Table 12).

Duration of Impact: The introduction of AIPS propagules will occur in different sites during construction period that may range between 1 – 3 years was observed mostly during the operation phase of the project. The spread of AIPS will take place even post project life span (Table 12).

Likelihood of Impact: AIPS are observed along all roads and sites where construction is completed. **It is, therefore, obvious** AIPS propagules will be introduced on construction site (Table 12).

Table 13: Rating of significant impact of introduction of Alien Invasive Species during operation phase of the project

Unmitigated Impacts on the Introduction of Invasive Alien Plant Species during the construction Phase

Extent of impact	4
Magnitude of impact	2
Duration of impact	3
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (81)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Equipment to be used should be decontaminated e.g. washing equipment to remove soil potentially carrying AIPS propagules before brought on site. 2. 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,	
Mitigated impacts on introduction of invasive 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

AIPS will spread on the landscape along the roads through lifting of their seeds by turbulence caused by moving vehicles, dispersal by birds that forage on seeds and runoffs that transport the seeds to lower catchments. Thus, the spread of AIPS is envisaged to be very high during the operation phase of the proposed Olkaria Industria Park project.

Extent of Impact: AIPS will potentially spread on the Olkaria Industrial Park. 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 (Table 12).

Magnitude of Impact: Large populations of the AIPS will grow along the road and drainage systems connected to the project area. This will evenly spread to pasture lands especially with the wind dispersed AIPS seeds (Table 13).

Duration of Impact: The spread of AIPS was observed mostly during the operation phase of the project. The spread of AIPS will take place even post project life span (Table 13).

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 (Table 13).

Table 14: Rating of significant impact of introduction of Alien Invasive Species during operation phase of the project

Unmitigated Impacts on the Introduction of Invasive Alien Plant Species during the operational phase	
Extent of impact	4
Magnitude of impact	4
Duration of impact	5
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium high (117)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Since AIPS appears later after soil disturbance, aftermath proliferation of AIPS should be controlled by regularly uprooting reducing their population and recruitment.	
Mitigated impacts on introduction of invasive alien plant species during operation phase	
Extent of impact	1
Magnitude of impact	1
Duration of impact	5
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (42)
Recommendation	Implement and manage the mitigation measures

3.2.3 Accidental Killings of Reptiles and Small Mammals Crossing the Roads

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 and foundation for industries. While crushing or collision with animals is likely to take place during construction phase of the project. Accidental killings will be caused during excavations and movement of vehicles or earthmoving machines within the construction sites and on roads

Extent of impact: Most movements of vehicles and earthmoving machines are rampant near or within the construction site. Accidental killing will occur mostly at the construction site (Table 14).

Magnitude of impact: Incidences of accidental killings will occur in isolated sites where construction is active (Table 14).

Duration of impact: The duration of impact will be confined during the active construction period. It will be intermittent since movements of vehicles will be confined within a particular period of transportation of materials within day time (Table 14).

Likelihood of impact: It is obvious transportation of materials for construction to the site will take place. Excavations of level and foundation pits will be will be performed. Hence,

there is a high likelihood that accidental killings of herpetofauna, low flying birds and rodents will occur (Table 15).

Table 15: Assessment of potential accidental killings of reptiles, rodents and small mammals during the construction phase of the project

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	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-81)
Recommendation	Propose mitigation measures
Comments/mitigation 1. Vehicles should slowly at 40 km/h in to allow for emergency breaking 2. Site should be inspected before excavation begins in order to remove (or chase away) present animals	
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	Very Low (-24)
Recommendation	Implement and manage the mitigation measures

During the operation of the road, herpetofauna and rodents that would be crossing roads will be prone to road kills. Also, the low flying birds are likely to be hit by vehicles moving at speed during operation phase of the project. Road kills would be high in the initial period of operation since due to improved roads vehicles would move faster than usual.

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.

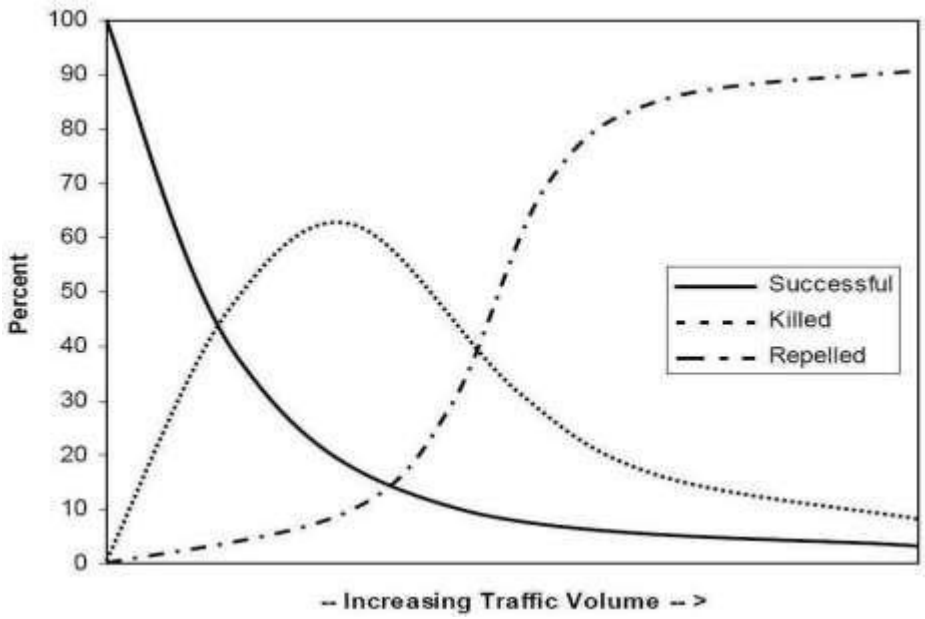

Figure 27: Response of herpetofauna to increase in traffic flow (source: Habitat connectivity, 2022)

Extent of impact: Increase in traffic will potential cause accidental killings in the project site and adjacent areas accessed by vehicles (Table 15).

Magnitude of impact: The population of the species potentially threatened by accidental road kills will be high due to a wider area of operation for vehicles (Table 15).

Duration of impact: The impact will occur during operation phase of the project (Table 15).

Likelihood of impact: These animals have tendency of moving across the landscape in search for forage and water. Herpetofauna, especially, prefers busking on warm surfaces such as roads that might increase chance of road kill (Table 16).

Table 16: Assessment of impact of IP on accidental killings of reptiles and rodents crossing the road during operation phase

Unmitigated accidental killings of reptiles and rodents crossing the road during operation phase	
Magnitude of impact	4
Geographic extent	3
Duration of impact	5
Likelihood of Impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-96)
Recommendation	Propose mitigation measures
Comments/mitigation Vehicles should be driven at a maximum speed of 40 km/h within the IP to allow for an emergence breaking for crossing herpes	
Mitigated accidental killings of reptiles and rodents crossing the road during operation phase	
Magnitude of impact	2
Geographic extent	2
Duration of impact	2
Likelihood of Impact	5
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-30)
Recommendation	Implement and manage the mitigation measures

3.2.4 Potential destruction and increased erosions on steep areas (land degradation)

The construction will involve clearing of vegetation and disturbance of the upper soil layers that will predispose soils on steep areas to landslide (mudflow) and erosion. Timing of excavations during rainy season will cause severe erosion or mudflow during construction period.

Extent of impact: erosion or mudflow incidences will be observed on steep slopes of the establishments

Magnitude of impact: Disturbance will dislodge a lot of soil on the surface which will be eroded by runoffs or flow as mud on steep areas. Landscape for the proposed IP is generally lying on sloppy areas hence erosion or mudflows will be severe.

Duration of impact: Processes of erosion and mudflow will occur during rainy seasons which occur during long rain between April to June and short rains in October to December during the short rains.

Likelihood of impact: Disturbance of surface soil at the onset of rains will definitely cause erosion by runoffs or trigger mudflow

Table 17: Assessment of impacts of erosion on steep areas during construction phase

Unmitigated impacts of erosion on steep areas during construction phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	3
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	Medium High (-81)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Construct sediment settling tanks/ponds for collecting runoff water and reducing runoff erosivity down streams 2. Immobilize loose soil from being carried downstream during rainy season. Alternatively, loose soil can be disposed of outside the project area where they will not be eroded. Inspection of such site should conducted prior to disposal	
Mitigated impacts of erosion on steep areas during construction phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	5
Likelihood of impact	6
Significance = (Extent + Duration + Magnitude) x Likelihood	Low (48)
Recommendation	Implement and manage the mitigation measures

Physically disturbed areas will undergo several rainy seasons that will subsequently experience runoff accumulation increasing erosivity of the drainage of from upstream of the proposed establishments to downstream banks of the drainage. The deep loose soils of Olkaria are very vulnerable when exposed to high runoff accumulations. High runoff water accumulation will cause severe erosion on the slopes of the hills destroying vegetation and cause deep cuts in the gorge.

Extent of impact: The extent will cover from downstream of the road (e.g., culvert) and IP establishments to an outlet point in streams or rivers (Table 17).

Magnitude of impact: A lot of soils will potentially be eroded from the surface. The amount will increase in subsequent years destroying vegetation of the banks of the channels (Table 17).

Duration of impact: Impact will occur throughout the operation phase of the project (Table 17).

Likelihood of impact: High runoff accumulation will be generated from the IP establishments and reinforced surfaces such as roads. This is based on the seasonality of rains and loose nature of the soils (Table 18).

Table 18: Assessment of potential impacts of erosion on steep areas during operation phase

Unmitigated impacts of erosion on steep areas 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	High Medium (-80)
Recommendation	Propose mitigation measures
Comments/mitigation: 1. Construct tanks/ponds for collecting runoff water and reducing their erosive power down streams 2. Reduce high energy water in upstream of the road by designing several crossing channels across the road to puncture the energy. 3. Reinforce channels on the slope to avoid erosion of soils	
Mitigated impacts of erosion on steep areas 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

3.2.5 Barrier to movement of elephants and other animals across the landscape

Activities of Industrial Park construction will likely prevent movement of the wild animals that uses the Olkaria area as their residential habitat or destination ranges. Physical movements and noise from construction and vehicles will prevent and limit wild herbivores from utilizing the landscape. Animal species that would be affected adversely are the Elephants (Critically Endangered), buffaloes (Near Threatened). Buffaloes are residents of the area while elephants use the area as destination ranges. Wild animals especially elephants, Zebras, Buffaloes and Antelopes move freely between Hell's Gate National Park to Longonot NP and to Mt. Suswa Conservancy and to the far south

(Figure 28). During construction, excavations of deep and wide channels will likely affect crossing of elephant calves. These excavations will likely to cause pitfall effects on elephant calves and other mammal species.

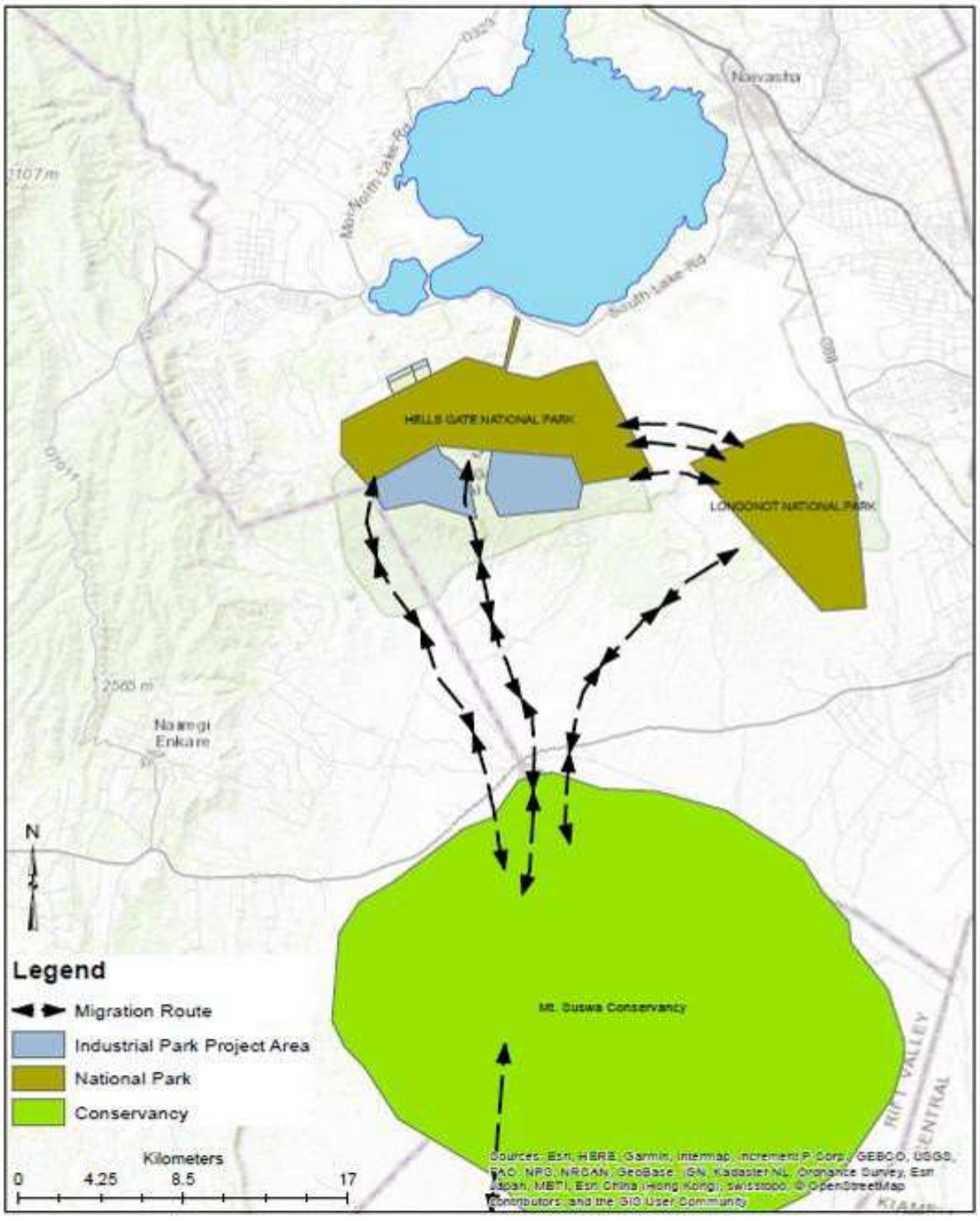

Figure 28: Migration Routes

Extent of Impact: Wild animals including elephant will avoid areas with physical movements and noise. Thus, sites with active construction will be avoided by the animals, especially at day time (Table 18).

Magnitude of Impact: The establishment of IP on the proposed area covers a large area that would displace animals utilizing the area. Buffaloes and giraffes are residential species that will be displaced. While elephants which are regular visitors will be limited in the upper ranging areas (Table 18).

Duration of impact: Impact will occur mostly during the construction phase of the project which might affect movements in a particular season (Table 18)

Likelihood of impact: Wild animals always avoid noisy places and areas with human activities. Thus, movements will definitely be caused by construction activities (Table 18).

Table 19: Assessment of impacts of barrier to movement of elephants and other animals across the landscape during construction phase

Unmitigated impacts of barrier movement of elephants and other animals across the landscape during construction phase	
Extent of impact	4
Magnitude of impact	4
Duration of impact	3
Likelihood of impact	12
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (132)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Crossing ramps should be put in place across trenches to allow movement of animals 2. Vehicle movement should be restricted to the current 40 km/h during construction 3. Construction activities should begin by 8.30am and stop by 5pm to avoid disturbance of movements at early morning and in the evenings	
Mitigated impacts of barrier movement of elephants and other animals across the landscape 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

The completion of the establishment will reduce noise and high traffic of vehicles that transport materials. However, it shall reduce the area for ranging for wild herbivores such as giraffes that uses the area for foraging on the *Acacia drepanolobium* distributed within the *Tarchonanthus camphoratus*. The area is dominated by *T. camphoratus* that is not foraged on by most wild herbivores.

Extent of Impact: The extent will be within area of establishment and neighbouring area (Table 19)

Magnitude of Impact: A large area will be under IP and this will deprive wild herbivores foraging ground in their upper ranges (Table 19)

Duration of impact: Impact will occur mostly during the operation phase of the project (Table 19)

Likelihood of impact: The proposed site is an area that is used by the wild annimals hence; their ranging areas for foraging are likely to be reduced (Table 20)

Table 20: Unmitigated impacts of barrier movement of elephants and other animals across the landscape during construction phase

Unmitigated impacts of barrier movement of elephants and other animals across the landscape during operation phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	4
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-100)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Vehicle movement should be restricted to the current 40 km/h during construction 2. Any fencing should provide allowance for animal movement around the establishments 3. Avoid using bright lights on establishment that might scare away wild animals moving within the location	
Mitigated impacts of barrier movement of elephants and other animals across the landscape during construction phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (56)
Recommendation	Implement and manage the mitigation measures

3.2,6 Potential Increase in Human – Wildlife Conflicts around the Project Area

Project construction activities will likely cause diversion of movements of wild animals and prevent them from accessing some areas. Movements of animals will be directed to human settlement around the proposed Industrial Park which will affect the village residents. The wild animals are likely to cause damage to crops that resident grow. Some animal will be in physical confrontation with residents that will likely cause injuries or death to the residents or the animals.

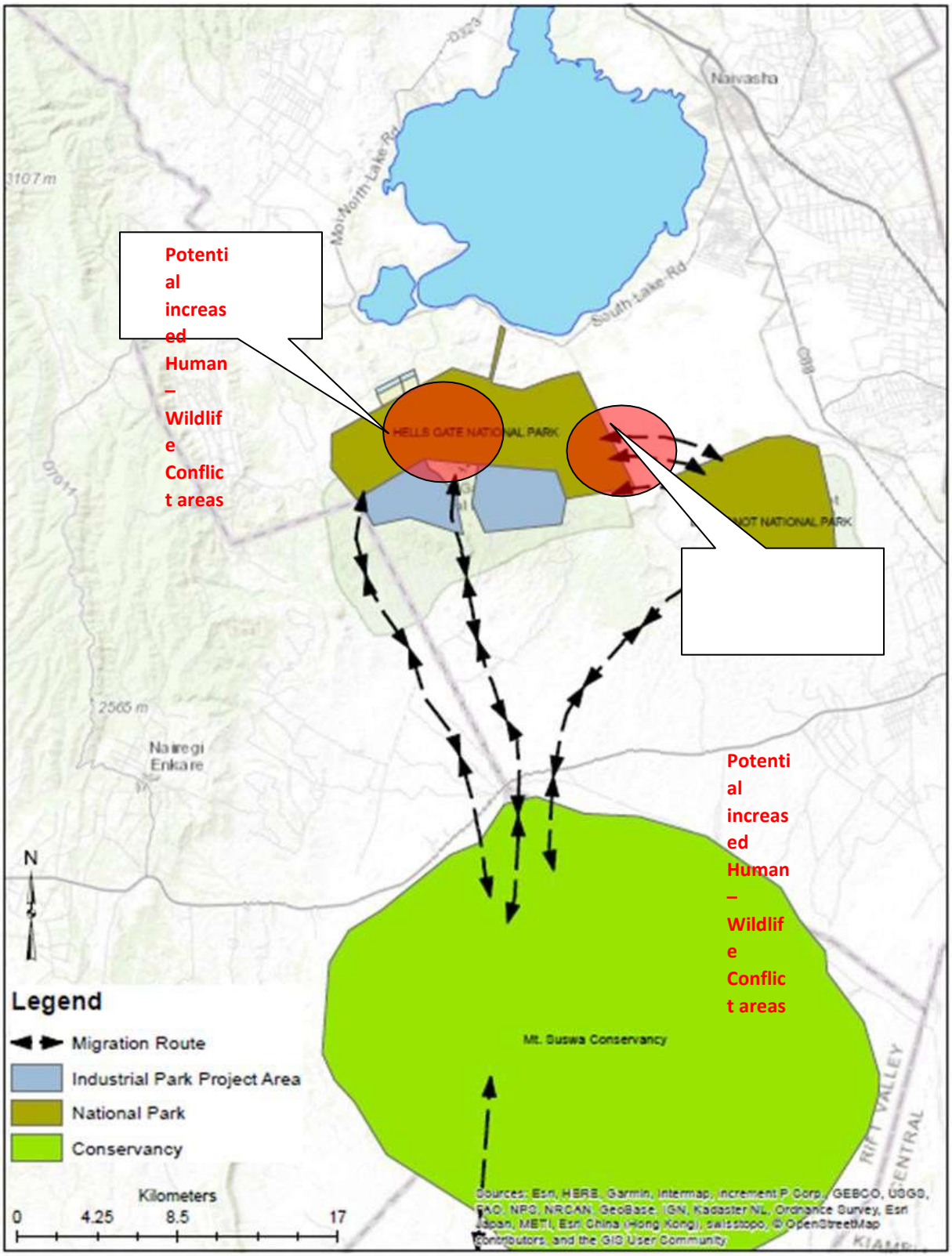

Figure 29: Potential Increased Human-Wildlife Conflict Areas

Extent of Impact: Conflict will occur within and outside project area in the neighbouring areas (Table 20).

Magnitude of Impact: Crop damage by wild herbivores will be high in the villages as a result, killing of wildlife will increase (Table 20).

Duration of Impact: Impact will occur mostly during the operation phase of the project (Table 20).

Likelihood of Impact: restriction to movement from the upper ranges will definitely push the animals to villages causing conflicts (Table 20).

Table 21: Assessment of impact of the project on human – wildlife conflicts during construction phase of the project.

Unmitigated impacts of human – wildlife conflicts during construction phase	
Extent of impact	4
Magnitude of impact	4
Duration of impact	4
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-120)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Vehicle movement should be restricted to the current 40 km/h during construction 2. Construction activities should begin by 8.30am and stop by 5pm to avoid disturbance of movements at early morning and in the evenings	
Mitigated impacts of human – wildlife conflicts during construction phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	4
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (56)
Recommendation	Implement and manage the mitigation measures

During the operation of the project wild herbivore movement will be restricted to the lower part of the hills by presence of Industrial Park establishments, movement of vehicle, roaring of plant engines, extreme lights at nights and fences. Due to this restriction, potential diversion of wildlife will likely to occur causing wildlife invasion of crops in the villages, accidental attacks to local communities by

wild animals

Extent of Impact: The extent will be within the neighbouring areas

Magnitude of Impact: Incidences of conflicts will increase

Duration of Impact: Impact will occur mostly during the construction phase of the project

Likelihood of Impact: Barrier to movement will definitely be caused by construction activities

Table 22: Assessment of impact of potential increase in human – wildlife conflicts

Unmitigated impacts of human – wildlife conflicts during operation phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	4
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	High (-100)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Any fencing should provide allowance for animal movement around the establishments 2. Avoid using bright lights on establishment that might scare away wild animals moving within the location	
Mitigated impacts of human – wildlife conflicts during operation phase	
Extent of impact	2
Magnitude of impact	1
Duration of impact	4
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (56)
Recommendation	Implement and manage the mitigation measures

3.2.7 Increased poaching for bushmeat in the surrounding

Establishment of Industrial Park in the proposed location in Olkaria will attract a huge population from direct and indirect jobs. Influx of population in the surrounding areas will be eminent in the adjacent villages by people who will be looking for cheaper rentals and shorter distance they can walk to work. Villages that will see influx of population include the Olomayian, Rap Land, and Narasha. These villages record considerable wildlife visiting the areas and are in the larger migratory

routes of wildlife which might make wildlife vulnerable to bushmeat. The construction phase of the project will have generally lower population compared to operation phase. Hence, increased poaching will be significantly high during operation than construction phase of the project.

Extent of Impact: The extent will be within the neighbouring areas

Magnitude of Impact: Incidences of poaching will definitely increase

Duration of Impact: Impact will occur mostly during the construction and operation phase of the project

Likelihood of Impact: There have been incidences of poaching for bushmeat around Naivasha. Increase in demand for meat will definitely cause increase in poaching incidences

Table 23: Assessment of impact of increased poaching for bushmeat in the surrounding during construction phase of the project

Unmitigated impacts of increased poaching for bushmeat in the surrounding during construction phase	
Extent of impact	4
Magnitude of impact	4
Duration of impact	4
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-120)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. KWS should screen contractor personnel working in the project area. 2. Contractor should work within the construction space of the road and designated construction camp. 3. KWS should screen contractor's construction plant, equipment, containers, etc. 4. Improve surveillance on wild animals by KWS 5. Increase inspection of butcheries	
Mitigated impacts of increased poaching for bushmeat in the surrounding during construction phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	4
Likelihood of impact	7

Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (56)
Recommendation	Implement and manage the mitigation measures

Table 24: Assessment of impact of increased poaching for bushmeat in the surrounding during operation phase of the project

Unmitigated impacts of increased poaching for bushmeat in the surrounding during construction phase	
Extent of impact	4
Magnitude of impact	4
Duration of impact	4
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-120)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Personnel should be educated on wildlife conservation and protection 2. Security in the region should enhance surveillance on vehicles 3. Vehicles should be inspected on entrance and exit	
Mitigated impacts of increased poaching for bushmeat in the surrounding during operation phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	4
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (56)
Recommendation	Implement and manage the mitigation measures

3.2.8 Disruption of dispersal of seeds for sustainable enrichment

Movement of wild herbivores across landscape increases chances of seed dispersal. Enrichment of plant population of grasses, shrubs and trees on the landscape are maintained by seed dispersal by wild animals (including birds) and livestocks. Interference of movements of the wild herbivores will upset the natural replenishment of seeds on the landscape. Restriction of movement will be high on wild herbivores during the operation than construction phase of the project. Construction phase is normally shorter than the operation hence the number of seasons that correlate with movement of wild herbivores are few. Besides dispersal of seeds through wild herbivores and livestock, seeds and propagules are dispersed by runoffs and drainage system that plays important role in distributing upstream seed resources to downstream. Clearing of vegetation in the proposed only contribute in reducing seed banks and resilience of the down streams vegetation.

Extent of Impact: The extent of this impact is potentially on a wider landscape which forms the catchment

Magnitude of Impact: Disruption of seed dispersal will be small during construction phase but imperceptibly more during the operation phase

Duration of Impact: Impact will occur mostly during the construction and operation phase of the project

Likelihood of Impact: The contribution of barrier to movement of wild herbivores and destruction of upstream seed banks will occur though its impact will be imperceptible

Table 25: Assessment of impact on the disruption of dispersal of seeds for sustainable enrichment during construction phase of the project

Unmitigated impacts on the disruption of dispersal of seeds for sustainable enrichment during construction phase	
Extent of impact	4
Magnitude of impact	3
Duration of impact	3
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-70)
Recommendation	Maintain current management
Comments/Mitigation: N/A	
Mitigated impacts on the disruption of dispersal of seeds for sustainable enrichment **during construction 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	N/A
Recommendation	Maintain current management

Table 26: Assessment of impact on the disruption of dispersal of seeds for sustainable enrichment during operation phase of the project

Unmitigated impacts on the disruption of dispersal of seeds for sustainable enrichment during operation phase	
Extent of impact	4
Magnitude of impact	3
Duration of impact	5
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-120)
Recommendation	Propose mitigation measures

Comments/Mitigation: 1. Avoid fencing the lower slopes of the hills to allow movements of wild herbivores to allow for seed dispersal 2. The lower slopes should not be cleared or any project located on the area in order to preserve the seed reservoirs on the landscape. 3. Engage community in collection of seeds for pasture species for strategic reseeding on pasture areas	
Mitigated impacts on the disruption of dispersal of seeds for sustainable enrichment during operation phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	4
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-54)
Recommendation	Implement and manage the mitigation measures

3.2.9 Visual intrusion and distraction

The industrial establishment will be associated with huge structures that will cause visual intrusion to animals and tourist in the area. Introducing of huge structures on the landscape interferes with scenic beauty that is attractive and appreciated by tourist. Besides this, visual intrusion would be caused by distribution of the AIPS and scattered solid wastes. All these affect the nature beauty of the landscape. Modification of physical appearance of landscape and introduction of flood lights severely affects animals that uses the landscape feature for navigation. Features that causes visual intrusions are normally introduced during construction phase of the project. Production of industrial plumes and flood lights takes place during the operation phase which also causes visual impact.

- **Extent of impact:** Industrial establishment will be constructed in the proposed IP areas
- **Magnitude of impact:** Huge structures will cover the landscape in form of buildings, roads and pipelines
- **Duration of impact:** Visual intrusion will begin during construction phase but becomes more distractive during the operation phase of the project **Likelihood of impact:** Implementation of the industrial establishments is

Table 27: – Assessment of impact on visual intrusion and distraction during construction phase of the project

Unmitigated impacts on visual intrusion and distraction during construction phase	
Extent of impact	3
Magnitude of impact	2
Duration of impact	3

Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-64)
Recommendation	Maintain current management
Comments/Mitigation: N/A	
Mitigated impacts on visual intrusion and distraction during construction 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	N/A
Recommendation	Maintain current management

Table 28: Assessment of impact on visual intrusion and distraction during operation phase of the project

Unmitigated impacts on visual intrusion and distraction during operation phase	
Extent of impact	4
Magnitude of impact	5
Duration of impact	5
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-140)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Minimize clearing of vegetation around the industrial establishment 2. Plant trees around the industrial establishments to provide a curtain for the industries 3. Avoid noisy colours on structures that will cause distraction from far distance 4. Avoid use of flood lights at night to enable wild animals access areas adjacent to the establishment	
Mitigated impacts on visual intrusion and distraction during operation phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	3
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-63)
Recommendation	Implement and manage the mitigation measures

3.2.10 Generation of solid wastes and dumps

Management of solid waste pollution is being a challenge along our roads. Generation of solid wastes emerge from illegal dumping and careless throwing of solid wastes from contractor personnel and population influx attracted by the project. 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. The industrial processing's are associated with generation solid wastes that would affect the landscape if not properly managed. This together with the large number of workers expected to operate in the area and the influx of population around the proposed area will potentially cause uncontrollable generation of solid wastes.

- ***Extent of impact*:** The area to be affected during construction phase will be within the proposed IP and surrounding areas
- ***Magnitude of impact:*** Littering will always occur on sites where personnel take lunches or break from work. Solid waste pollution will adversely affect aesthetic values of the areas and will also attract vermins such as rats to sites
- ***Duration of impact*:** Time of exposure of solid waste depends on duration of construction on site ***Likelihood of impact*:** Engagements of contractor personnel on the landscape will be site based, which is based on particular project within the IP

Table 29: Assessment of impact on generation of solid wastes and dumps during construction phase of the project

Unmitigated impacts on generation of solid wastes and dumps during construction phase	
Extent of impact	3
Magnitude of impact	4
Duration of impact	2
Likelihood of impact	8
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-72)
Recommendation	Maintain current management
Comments/Mitigation: N/A	
Mitigated impacts on generation of solid wastes and dumps during construction 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	N/A
Recommendation	Maintain current management

Table 30: Assessment of impact on generation of solid wastes and dumps during operation phase of the project.

Unmitigated impacts on generation of solid wastes and dumps during operation phase	
Extent of impact	4
Magnitude of impact	5
Duration of impact	5
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-140)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Roll out waste management plan for the surrounding areas where population influx is envisaged 2. Provide dustbins on locations within the establishment for dumping waste litters 3. Provide environmental education and awareness on waste management to industry personnel	
Mitigated impacts on generation of solid wastes and dumps during operation phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	3
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-63)
Recommendation	Implement and manage the mitigation measures

3.2.11 Generation of liquid industrial wastes

The proposed Industrial Park will have industries that range from small to large size industries that will generate liquid wastes from the industrial processing's. These liquid wastes consist Wastewaters with inorganic and organic wastes, hazardous waste, with heavy metals, , Oil and water mixtures, and with PCB waste. Industrial liquid wastes will be generated during the operation phase of the project. Drainage of these liquid wastes into the drainage system will expose wildlife to poisonous waters with acute or chronic impacts on the life and reproduction.

- ***Extent of impact:*** areas that will potentially be affected will include the upper and the lower catchments of the proposed project area
- ***Magnitude of impact:*** Large number of wastewaters will be discharged from different

industries drained through the natural drainage system

- ***Duration of impact:*** discharge of liquid industrial wastewaters will take place throughout the life operation of the projects ***Likelihood of impact*****:** Any operating industry normally generate wastewaters from their operation. It is, therefore, definite that these industries will discharge wastewaters will occur

Table 31: Assessment of impact on generation of liquid industrial wastes during construction phase of the project.

Unmitigated impacts on generation of liquid industrial wastes during construction phase	
Extent of impact	1
Magnitude of impact	2
Duration of impact	2
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-64)
Recommendation	Maintain current management
Comments/Mitigation: N/A	
Mitigated impacts on generation of liquid industrial wastes during construction 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	N/A
Recommendation	Maintain current management

Table 32: Assessment of impact on generation of liquid industrial wastes during operation phase of the project

Unmitigated impacts on generation of liquid industrial wastes during operation phase	
Extent of impact	4
Magnitude of impact	5
Duration of impact	4
Likelihood of impact	10
Risk = (Extent + Duration + Magnitude) x Likelihood	Very High (-130)
Recommendation	Propose mitigation measures

Comments/Mitigation: 1. Use appropriate technology to reduce or minimize generation of the liquid industrial wastes 2. Construct retention tanks for the liquid industrial wastes 3. construct and fence off series of lagoons for treatment of the liquid wastes 4. release treated liquid wastes during rainy seasons from lagoons for dilution of discharge from lagoons	
Mitigated impacts on generation of liquid industrial wastes during operation phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	4
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-70)
Recommendation	Implement and manage the mitigation measures

3.2.12 Interreference with communication signs for wildlife

Wildlife communication through calls and release of chemicals known as pheromones. These communications are likely to be affected severely by elevated levels of noise and air pollution. Communication by calls and chemicals are used by animals for attracting mates. Noise pollution will likely affect wild animal communication during construction phase; while noise and pollution will adversely affect communication during operation phase of the projects. Interference of these communications will affect movements, increase vulnerability to predation by wild herbivores, affect mating patterns within the proposed project area. Comparatively, noise pollution coverage is less widespread compared to air pollution and each affect different dimensions of communications.

3.2.13 Impact of noise pollution

Table 33: Assessment of impact on communication signs for wildlife by noise pollution during construction phase of the project.

Unmitigated impacts on communication signs for wildlife by noise pollution during construction phase	
Extent of impact	2
Magnitude of impact	3
Duration of impact	3
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-56)
Recommendation	Maintain current management

Comments/Mitigation: N/A	
Mitigated impacts on communication signs for wildlife by noise pollution during construction 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	N/A
Recommendation	Maintain current management

Table 34: Assessment of impact on communication signs for wildlife by noise pollution during operation phase of the project

Unmitigated impacts on communication signs for wildlife by noise pollution 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	High (-108)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Use of noise mufflers is highly recommended to reduce on levels of noise 2. Plant machines should be well maintained for smooth running of the engines which reduces levels of noise	
Mitigated impacts on communication signs for wildlife by noise pollution during operation phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	4
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-49)
Recommendation	Implement and manage the mitigation measures

3.2.14 Impact of air pollution

Table 35: Assessment of impact on communication signs for wildlife by air pollution during construction phase of the project.

Unmitigated impacts on communication signs for wildlife by noise pollution during construction phase

Extent of impact	2
Magnitude of impact	2
Duration of impact	2
Likelihood of impact	6
Risk = (Extent + Duration + Magnitude) x Likelihood	Low (-36)
Recommendation	Maintain current management
Comments/Mitigation: N/A	
Mitigated impacts on communication signs for wildlife by air pollution during construction 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	N/A
Recommendation	Maintain current management

Table 36: Assessment of impact on communication signs for wildlife by air pollution during operation phase of the project.

Unmitigated impacts on communication signs for wildlife by air pollution during operation phase	
Extent of impact	4
Magnitude of impact	5
Duration of impact	4
Likelihood of impact	9
Risk = (Extent + Duration + Magnitude) x Likelihood	High (-117)
Recommendation	Propose mitigation measures
Comments/Mitigation: 1. Use appropriate technology to reduce emission levels of the plant engines and other processes 2. Use high stacks for emissions of exhaustion gases and particulates to enhance mixing of the emissions to reduce exposure levels in the environment	
Mitigated impacts on communication signs for wildlife by air pollution during operation phase	
Extent of impact	3
Magnitude of impact	3
Duration of impact	4
Likelihood of impact	7
Risk = (Extent + Duration + Magnitude) x Likelihood	Low Medium (-70)

Recommendation	Implement and manage the mitigation measures

4. ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

4.1 Environmental and Social Management Plan

The role of the environmental and social management and monitoring plan is to effectively manage the social and environmental issues identified during the impact assessment process, and the implementation of the environmental and social management plan (ESMP) will be implemented. The ESMP is comprised of a set of plans developed with the mitigation and management measures to be implemented during construction and operation of the Industrial Park in Olkaria. The management plan assigns responsibilities, policies, procedures, monitoring and reporting systems.

Objectives of the ESMP are to:

- Filter out the potentially significant impacts that were identified for different phases of the project
- Develop costs for implementing the proposed mitigation measures to be achieved during the project cycle;
- Assigns responsibilities and institutional arrangement to ensure that the mitigation measures are implemented
- Integrating environmental considerations fully into the various activities of the proposed project
- Providing mechanisms for follow up to ensure the effectiveness of the mitigation measures in meeting standards;
- Provide targets to achieve, timeframe and monitorial indicators.

Table 37: Environmental and social management plan during construction phase

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Environmental Impact Assessment					
Potential Collection of Live Specimens		• 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	Prevent illegal collection of species and specimens	Contractor, KWS	1,000,000
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	KenGen / Contractor, KWS/KFS	500,000
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. - Conducting road patrol to monitor road kills	Reduces incidence of road kills	KenGen / Contractor, KWS	1,000,000
Potential destruction and increased erosions on steep areas (land degradation)	Medium high	- Construct sediment settling tanks/ponds for collecting runoff water and reducing runoff erosivity downstreams - Immobilize loose soil from being carried downstream during rainy season. Alternatively, loose soil can be disposed of outside the project area where they will not be eroded. Inspection of such site should be conducted prior to disposal	Control of soil erosion	KenGen / Contractor, KWS	30,000,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Potential increased in 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 - Engage KWS on strategic response to conflict incidences	Minimise incidences of damages to properties, injuries and deaths	KenGen / Contractor, KWS	2,000,000
Increased poaching for bushmeat in the surrounding	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	Contractor, KWS	2,500,000
Barrier to movement of elephants and other animals across the landscape	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	Enhance movement of wildlife for access to resources across the landscape	Contractor, KWS	2,400,000
Solid waste pollution	Medium High	-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	KenGen / Contractor, KWS/KFS	2,500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Pollution of streams, rivers and reservoirs	Medium High	-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	Prevention of pollution of streams and wetland	KenGen / Contractor, KWS	
Pitfalls resulting from excavation of trenches	Medium high	-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	Contractor	2,100,000

Table 38: Environmental and social management plan during operation phase

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Potential collection of live specimens	Medium high	- Vehicles getting into and out of the IP area should be inspected by KWS - All vehicles to sign for where they are going and host should also countersign to confirm their intention - The vehicles should not allow carrying of wild animals or specimen or part of the species in the vehicle.	Prevent illegal collection of species and specimens	KenGen / Project proponent	1,000,000
Potential Human-Wildlife conflict	High	- Any fencing should provide allowance for animal movement around the establishments - Avoid using bright lights on establishment that might scare away wild animals moving within the location - Patrol by KWS	Minimise incidences of damages to properties, injuries and deaths	KenGen/Project proponent	1,500,000
Wildlife Poaching	Very High	- Personnel should be educated on wildlife conservation and protection - Security in the region should enhance surveillance on vehicles - Vehicles should be inspected on entrance and exit	Prevent trade on wildlife	KenGen/Project proponent	2,500,000
Barrier to movement of elephants and Rhinos to the river and dispersal foraging grounds	Medium High	- Vehicle movement should be restricted to the current 40 km/h during construction - Any fencing should provide allowance for animal movement around the establishments - Avoid using bright lights on establishment that might scare away wild animals moving within the location - Engage KWS on patrol among the villages	Enhance movement of wildlife for access to resources across the landscape	KenGen/Project proponent	1,500,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Potential impact	**Level of Impact**	**Mitigation measures**	**Goals/Targets**	**Responsibility**	**Estimated Cost (Ksh)**
Visual intrusion and distraction	Very High	- Minimize clearing of vegetation around the industrial establishment - Plant trees around the industrial establishments to provide a curtain for the industries - Avoid noisy colours on structures that will cause distraction from far distance - Avoid use of flood lights at night to enable wild animals access areas adjacent to the establishment	Enable wildlife utilize landscape effectively	KenGen / Project proponent	1,200,000
Solid waste pollution	Very High	- Roll out waste management plan for the surrounding areas where population influx is envisaged - Provide dustbins on locations within the establishment for dumping waste litters - Provide environmental education and awareness on waste management to industry personnel	Enhance environmental sanitation and manage visual expectation	KenGen / Project proponent	5,000,000
Introduction of Alien Invasive Plant Species	High	- Physical uprooting of AIPS recruitments before they develop seeds	Control the spread of AIPS in protected areas and grazing areas	KenGen / Project proponent	2,000,000

Potential impact	Level of Impact	Mitigation measures	Goals/Targets	Responsibility	Estimated Cost (Ksh)
Generation of liquid industrial wastes	Very High	- Use appropriate technology to reduce or minimize generation of the liquid industrial wastes - Construct retention tanks for the liquid industrial wastes - construct and fence off series of lagoons for treatment of the liquid wastes - release treated liquid wastes during rainy seasons from lagoons for dilution of discharge from lagoons	Control discharge of liquid industrial waste and prevent harm to wildlife	KenGen / Project proponent	25,000,000
Potential impact	**Level of Impact**	**Mitigation measures**	**Goals/Targets**	**Responsibility**	**Estimated Cost (Ksh)**
Interference with communication signs for wildlife by noise pollution	High	- Use of noise mufflers is highly recommended to reduce levels of noise - Plant machines should be well maintained for smooth running of the engines which reduces levels of noise	Enable effective communication between wild animals	KenGen/Project proponent	2,500,000
Interference with communication signs for wildlife by air pollution	High	- Use appropriate technology to reduce emission levels of the plant engines and other processes - Use high stacks for emissions of exhaustion gases and particulates to enhance mixing of the emissions to reduce exposure levels in the environment	Enable effective communication between wild animals		2,500,000
Accidental killings of reptiles and rodents crossing the roads	Medium High	Vehicles should be driven at a maximum speed of 40 km/h within the IP to allow for an emergence breaking for crossing herpes	Reduces incidence of road kills	KenGen / Contractor	500,000

5. 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 the proposed Olkaria Industrial Park. 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.

This ESMoP is a dynamic document that will be updated as necessary as the Olkaria Industrial Park 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 below).
- Sampling and analysis of effluents and drainage discharged from construction sites and camps (see Table below).
- Air quality monitoring at active construction sites.
- Noise monitoring at active construction sites near to settlements or noise sensitive receptors.

Table 39: Environmental and social monitoring plan during construction phase

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Potential Human-Wildlife conflict	Construction phase	Safety of local residents, constructors and animals Safety of properties	• Incidences of conflicts • Records of injuries, deaths • Records of damages to properties	Olmayian, Rapland and Narasha	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.	Contractor/KWS
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	Within and environs of the project area	Daily monitoring during construction and operation phase of the project	Contractor/KWS
Barrier to movement of elephants and other wildlife	Construction phase	Migration and local movements	• Stranded movement of elephant • Diverted movements of animals	Within the project location	Monitoring should be conducted daily on active sites of construction activities	Contractor/KWS
Visual intrusion and distraction	Construction phase	Visual appreciation	• Complaints from tourists and local residence	Within the projection location	Quarterly inspection on project area for solid waste and trees and grass planted.	KenGen / Contractor/KWS

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Solid waste pollution	Construction phase	Visual appreciation	• Presence of scattered solid wastes on road side	Within project location and areas around (in villages)	Weekly inspection of solid waste management	KenGen / Contractor/KWS
Pollution of streams, rivers and reservoirs	Construction	Water Quality	No stock piles along the road Piles covered with a waterproof material	Gorge and drainage channels emerging from the project area	Daily visual inspection	KenGen / Contractor
Introduction of Alien Invasive Plant Species	Construction phase	Species displacement/destruction	Emergence of new species (i.e. AIPS)	Within the project location and area around it	Monitoring should be conducted every 3 months for the first two years	KenGen / Contractor/KWS
Pitfalls resulting from excavation of trenches	Construction	Movement of animals	Fallen amphibians and reptiles in trenches and rescuing them	Within project location	Daily monitoring of trenches on specific sites of active construction	Contractor/KWS
Potential collection of live specimens of chameleon	Construction phase	Occurrence of species	Incidences of specimen collections	Within the project location and area around it	Performance of random checks on personnel bags	KenGen / Contractor/KWS
Accidental killings of reptiles and rodents crossing the roads	Construction	Local movement for foraging and breeding	Incidences of kills	Within project location	Reporting system should be established for daily construction activities. Weekly monitoring should be undertaken.	KenGen / Contractor/KWS

Table 40: Environmental and social monitoring plan during 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 properties	Within and outside project 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.	Contractor/KWS
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	Within and outside project area	Daily monitoring during construction and operation phase of the project	Contractor/KWS
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	Within and outside project area	Monitoring should be conducted daily on active sites of construction activities	Contractor/KWS
Visual intrusion and distraction	Operation phase	Visual appreciation	• Complains from tourists and local residents	Within and outside project area	Quarterly inspection on project area for solid waste and trees and grass planted.	KenGen / Contractor/KWS

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Solid waste pollution	Operation phase	Visual appreciation	• Presence of scattered solid wastes within IP, around IP and on road side	Within and outside project area	Weekly inspection of solid waste management	KenGen / Contractor/KWS
Introduction of Alien Invasive Plant Species	Operation phase	Species displacement/destruction	Emergence of new species (i.e., AIPS)	Within and outside project area	Monitoring should be conducted every 3 months for the first two years	KenGen / Contractor/KWS
Potential stormwaters and flooding	Operation phase	Flow of water	Increased incidences of flooding on farms	Gorge and downstream of project area	Performing of checks for stagnant waters on farms Reporting system at community level to report on incidences of flooding	KenGen / Contractor
Accidental killings of reptiles and rodents crossing the roads	Operation phase	Local movement for foraging and breeding	Incidences of kills	Within project area	Reporting system should be established for daily construction activities. Weekly monitoring should be undertaken.	KenGen / Contractor/KWS

Monitoring Item	Monitoring Phase	Parameter	Monitoring Indicators	Location	Management Frequency	Responsibility
Interference with communication signs for wildlife	Operation phase	Connection by individual or groups	Pairing frequency	Within project area	Seasonal (6 months)	KWS

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APPENDICES

Appendix I: Plant Species

Item No.	Species Name	IUCN Red List Status
1.	*Tarchonanthus comphoratus*	LC
2.	*Acacia drepanolobium*	LC
3.	*Nicotiana glauca*	LC
4.	*Plectranthus barbatus (Fence)*	LC
5.	*Sida sp.*	LC
6.	*Psiadia punctulate*	LC
7.	*Vernonia auriculifera*	LC
8.	*Vernonia brachycalyx*	LC
9.	*Typha domingensis*	LC
10.	*Grewia sp.*	
11.	*Rumex usambarensis*	LC
12.	*Hypoestes*	LC
13.	*Ocimum forskolei*	LC
14.	*Ocimum gratissimum*	LC
15.	*Commelina bangalensis*	LC
16.	*Achyranthes aspera*	LC
17.	*Dodonea viscosa*	LC
18.	*Datura stramonium*	LC
19.	*Cirsium vulgare*	LC
20.	*Acacia xanthophloea*	LC
21.	*Olea europaea subsp. africana*	
22.	*Carissa edulis*	LC
23.	*Salvadora persica*	LC
24.	*Lippia sp.*	-
25.	*Euphobia candelabrum*	LC
26.	*Maerua decumbens*	
27.	*Solanum incanum*	LC
28.	*Solanum mauritianum*	LC

Item No.	Species Name	IUCN Red List Status
29.	*Sesbania sesban*	LC
30.	*Lemon Grass*	LC
31.	*Pavona*	
32.	*Vigna parkeri*	LC
33.	*Sphaeranthus sp.*	-
34.	*Senna didymobotrya*	LC
35.	*Cyphostema maranguense*	LC
36.	*Gomphocarpus semilunatus*	LC

Appendix II: Bird Diversity within 10 km buffer distance

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Order: Accipitriformes								
Accipitridae	Accipiter minullus	Little sparrowhawk	LC	√	√	√		
Accipitridae	Accipiter tachiro	African goshawk	LC		√			√
Accipitridae	Aquila nipalensis	Steppe eagle	EN				√	√
Accipitridae	Aquila rapax	Tawny eagle	LC		√	√		√
Accipitridae	Aquila spilogaster	African hawk-eagle	LC		√			
Accipitridae	Aquila verreauxii	Verreaux's eagle	LC		√			
Accipitridae	Buteo augur	Augur buzzard	LC		√	√	√	√
Accipitridae	Buteo buteo	Common buzzard	LC	√	√	√	√	√
Accipitridae	Chelictinia riocourii	Scissor-tailed kite	VU		√			
Accipitridae	Circaetus cinereus	Brown snake eagle	LC		√			
Accipitridae	Circaetus pectoralis	Black-chested snake eagle	LC		√			
Accipitridae	Circus aeruginosus	Western marsh harrier			√			√
Accipitridae	Circus macrourus	Pallid harrier	NT					√
Accipitridae	Circus pygargus	Montagu's harrier	LC		√	√	√	
Accipitridae	Clanga pomarina	Lesser spotted eagle	LC		√	√		
Accipitridae	Elanus caeruleus	Black-winged kite	LC		√	√		√
Accipitridae	Gypaetus barbatus	Bearded vulture	NT		√	√		
Accipitridae	Gyps africanus	White-backed vulture	EN		√	√	√	
Accipitridae	Gyps rueppellii	Rüppell's vulture			√	√		√
Accipitridae	Haliaeetus	African fish eagle	LC		√			√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
	vocifer							
Accipitridae	Lophaetus occipitalis	Long-crested eagle			√			√
Accipitridae	Micronisus gabar	Gabar goshawk	LC		√	√		√
Accipitridae	Milvus migrans	Black kite	LC		√	√	√	√
Accipitridae	Necrosyrtes monachus	Hooded vulture			√	√		
Accipitridae	Neophron percnopterus	Egyptian vulture	EN	√		√		
Accipitridae	Polyboroides typus	African harrier-hawk	LC		√			√
Sagittariidae	Sagittarius serpentarius						√	√
Accipitridae	Terathopius ecaudatus	Bateleur			√			
Accipitridae	Torgos tracheliotos	Lappet-faced vulture	VU		√			
Order: Anseriformes								
Anatidae	Alopochen aegyptiaca	Egyptian goose	LC		√			√
Anatidae	Anas capensis	Cape teal	LC		√			√
Anatidae	Anas erythrorhyncha	Red-billed teal	LC					√
Anatidae	Anas undulata	Yellow-billed duck	LC					√
Anatidae	Netta erythrophthalma				√			√
Anatidae	Sarkidiornis melanotos							√
Anatidae	Spatula hottentota							√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Anatidae	Spatula querquedula							√
Order: Apodiformes								
Apodidae	Apus aequatorialis	Mottled swift	LC			√	√	√
Apodidae	Apus affinis	Little swift	LC		√	√		√
Apodidae	Apus apus	Common swift	LC		√			
Apodidae	Apus barbatus	African black swift	LC		√	√		
Apodidae	Apus caffer	White-rumped swift	LC		√	√		√
Apodidae	Apus horus	Horus swift	LC		√	√	√	
Apodidae	Apus niansae	Nyanza swift	LC		√	√	√	√
Apodidae	Tachymarptis aequatorialis			√	√	√		
Order: Bucerotiformes								
Bucorvidae	Bucorvus leadbeateri	Southern ground hornbill	VU			√		
Bucerotidae	Lophoceros alboterminatus							
Bucerotidae	Lophoceros nasutus				√	√		√
Phoeniculidae	Phoeniculus purpureus				√			√
Phoeniculidae	Rhinopomastus cyanomelas				√			√
Phoeniculidae	Rhinopomastus minor							
Bucerotidae	Tockus erythrorhynchus				√	√	√	
Upupidae	Upupa epops				√	√	√	√
Order: Charadriiformes								

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Scolopacidae	Actitis hypoleucos	Common sandpiper	LC					√
Jacanidae	Actophilornis africanus	African jacana	LC	√				√
Scolopacidae	Calidris ferruginea	Curlew sandpiper	LC					√
Scolopacidae	Calidris minuta	Little stint	LC					√
Scolopacidae	Calidris pugnax	Ruff	LC					√
Charadriidae	Charadrius dubius	Little ringed plover	LC		√			√
Charadriidae	Charadrius hiaticula	Common ringed plover	LC					√
Charadriidae	Charadrius tricollaris	Three-banded plover	LC					
Laridae	Chlidonias hybrida	Whiskered tern	LC					√
Laridae	Chlidonias leucopterus	White-winged tern	LC					√
Laridae	Chroicocephalus cirrocephalus	Grey-headed gull	LC		√			√
Laridae	Chroicocephalus ridibundus	Black-headed gull	LC					√
Laridae	Gelochelidon nilotica							√
Recurvirostridae	Himantopus himantopus							√
Laridae	Larus cirrocephalus							√
Laridae	Larus fuscus							√
Jacanidae	Microparra							√
	capensis							
Scolopacidae	Tringa erythropus							√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Scolopacidae	Tringa glareola							√
Scolopacidae	Tringa nebularia							√
Scolopacidae	Tringa ochropus							√
Scolopacidae	Tringa stagnatilis				√			√
Scolopacidae	Tringa totanus							√
Charadriidae	Vanellus armatus				√			√
Charadriidae	Vanellus coronatus					√		√
Charadriidae	Vanellus coronatus coronatus							
Charadriidae	Vanellus crassirostris				√			√
Order: Ciconiiformes								
Ciconiidae	Ciconia ciconia	White stork	LC					√
Ciconiidae	Leptoptilos crumenifer				√			√
Ciconiidae	Mycteria ibis				√			√
Order: Coliiformes								
Coliidae	Colius striatus	Speckled mousebird	LC			√	√	√
Coliidae	Urocolius macrourus				√			√
Order: Columbiformes								
Columbidae	Columba guinea	Speckled pigeon	LC			√		√
Columbidae	Columba livia	Rock dove	LC		√	√		√
Columbidae	Oena capensis				√			
Columbidae	Spilopelia senegalensis				√			√
Columbidae	Streptopelia capicola					√	√	√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Columbidae	Streptopelia decipiens				√			√
Columbidae	Streptopelia lugens				√	√		
Columbidae	Streptopelia semitorquata				√	√		√
Columbidae	Streptopelia senegalensis				√	√	√	√
Columbidae	Treron calvus				√			√
Columbidae	Turtur afer							√
Columbidae	Turtur chalcospilos							
Columbidae	Turtur tympanistria				√			√
Order: Coraciiformes								
Alcedinidae	Ceryle rudis	Pied kingfisher	LC					√
Coraciidae	Coracias caudatus	Lilac-breasted roller	LC					√
Coraciidae	Coracias garrulus	European roller	NT		√			√
Coraciidae	Coracias naevius	Purple roller	LC		√			
Alcedinidae	Corythornis cristatus	Malachite kingfisher	LC		√			√
Alcedinidae	Megaceryle maxima							√
Meropidae	Merops albicollis							√
Meropidae	Merops apiaster				√	√		
Meropidae	Merops bullockoides				√	√	√	√
Meropidae	Merops				√			
	oreobates							
Meropidae	Merops pusillus				√	√		
Order: Cuculiformes								

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Cuculidae	Centropus superciliosus	White-browed coucal	LC					√
Cuculidae	Chrysococcyx cupreus	African emerald cuckoo	LC		√			
Cuculidae	Chrysococcyx klaas	Klaas's cuckoo	LC		√			√
Cuculidae	Clamator glandarius	Great spotted cuckoo	LC		√			√
Cuculidae	Clamator jacobinus	Jacobin cuckoo	LC					√
Cuculidae	Cuculus clamosus							
Cuculidae	Cuculus gularis				√	√		
Cuculidae	Cuculus solitarius							√
Order: Falconiformes								
Falconidae	Falco biarmicus				√			√
Falconidae	Falco naumanni				√	√		√
Falconidae	Falco peregrinus				√	√		
Falconidae	Falco rupicoloides			√	√		√	
Falconidae	Falco subbuteo				√	√		√
Falconidae	Falco tinnunculus				√			
Order: Galliformes								
Phasianidae	Coturnix delegorguei	Harlequin quail	LC					
Numididae	Numida meleagris				√	√	√	√
Phasianidae	Peliperdix coqui				√			
Phasianidae	Pternistis hildebrandti				√	√	√	√
Phasianidae	Pternistis squamatus			√	√			√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Order: Gruiformes								
Rallidae	Amaurornis flavirostra	Black crake	LC		√			√
Rallidae	Amaurornis marginalis	Striped Crake	LC					√
Gruidae	Balearica regulorum	Grey crowned crane	EN					√
Rallidae	Crecopsis egregia	African crake	LC					√
Rallidae	Fulica cristata							√
Rallidae	Gallinula chloropus							√
Rallidae	Rallus caerulescens							√
Rallidae	Zapornia flavirostra							√
Order: Otidiformes								
Otididae	Ardeotis kori	Kori bustard	NT		√	√		
Order: Passeriformes								
Acrocephalidae	Acrocephalus baeticatus	Common reed warbler	LC					√
Acrocephalidae	Acrocephalus gracilirostris	Lesser swamp warbler	LC					√
Acrocephalidae	Acrocephalus schoenobaenus	Sedge warbler	LC					√
Muscicapidae	Agricola pallidus	Pale flycatcher	LC			√		
Ploceidae	Anaplectes	Red-headed	LC		√	√		√
	rubriceps	weaver						
Motacillidae	Anthus cinnamomeus	African pipit	LC		√	√		√
Motacillidae	Anthus similis	Long-billed pipit	LC		√	√	√	√
Motacillidae	Anthus trivialis	Tree pipit	LC		√			

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Motacillidae	Anthus vaalensis	Buffy pipit	LC		√			
Cisticolidae	Apalis flavida	Yellow-breasted apalis	LC		√	√	√	√
Platysteiridae	Batis molitor	Chinspot batis	LC		√	√		√
Muscicapidae	Bradornis microrhynchus	African grey flycatcher	LC				√	√
Locustellidae	Bradypterus baboecala	Little rush warbler	LC		√			√
Locustellidae	Bradypterus cinnamomeus	Cinnamon bracken warbler	LC					
Buphagidae	Buphagus africanus	Yellow-billed oxpecker	LC		√			
Buphagidae	Buphagus erythrorhynchus	Red-billed oxpecker	LC		√			
Cisticolidae	Camaroptera brachyura	Green-backed camaroptera	LC		√			√
Campephagidae	Campephaga flava	Black cuckooshrike	LC		√			√
Hirundinidae	Cecropis abyssinica	Lesser striped swallow	LC					√
Hirundinidae	Cecropis daurica	Red-rumped swallow	LC			√		√
Hirundinidae	Cecropis senegalensis	Mosque swallow	LC		√			
Nectariniidae	Chalcomitra amethystina	Amethyst sunbird	LC					√
Nectariniidae	Chalcomitra senegalensis	Scarlet-chested sunbird	LC		√			√
Sturnidae	Cinnyricinclus leucogaster	Violet-backed starling	LC					√
Nectariniidae	Cinnyris pulchellus	Beautiful sunbird	LC		√			

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Nectariniidae	Cinnyris venustus	Variable sunbird	LC		√	√		√
Cisticolidae	Cisticola aridulus	Desert Cisticola	LC		√		√	
Cisticolidae	Cisticola brunnescens	Pectoral-patch cisticola	LC		√		√	
Cisticolidae	Cisticola cantans	Singing cisticola	LC		√			
Cisticolidae	Cisticola chiniana	Rattling cisticola	LC		√	√		√
Cisticolidae	Cisticola galactotes	Rufous-winged cisticola	LC		√			√
Cisticolidae	Cisticola hunteri	Hunter's cisticola	LC		√	√	√	√
Cisticolidae	Cisticola lais	Wailing cisticola	LC		√		√	
Cisticolidae	Cisticola robustus	Stout cisticola	LC		√			
Estrildidae	Coccopygia quartinia	Yellow-bellied waxbill	LC		√			
Corvidae	Corvus albicollis	White-necked raven	LC		√			
Corvidae	Corvus albus	Pied crow	LC	√	√	√	√	√
Corvidae	Corvus capensis	Cape crow	LC	√	√		√	√
Muscicapidae	Cossypha caffra	Cape robin-chat	LC		√	√		√
Muscicapidae	Cossypha heuglini	White-browed robin-chat	LC	√	√	√		√
Sturnidae	Creatophora cinerea	Wattled starling	LC					√
Fringillidae	Crithagra citrinelloides	African citril	LC					√
Fringillidae	Crithagra				√			
	dorsostriata							
Fringillidae	Crithagra reichenowi				√	√	√	√
Fringillidae	Crithagra striolata				√	√	√	√
Fringillidae	Crithagra sulphurata				√	√	√	√
Hirundinidae	Delichon urbicum				√			√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Dicruridae	Dicrurus adsimilis				√	√	√	√
Nectariniidae	Drepanorhynchus reichenowi				√			√
Malaconotidae	Dryoscopus cubla				√			√
Emberizidae	Emberiza flaviventris			√	√			
Emberizidae	Emberiza tahapisi				√		√	
Cisticolidae	Eminia lepida				√			√
Cisticolidae	Eremomela icteropygialis				√			
Estrildidae	Estrilda astrild				√			
Estrildidae	Estrilda rhodopyga				√	√		
Ploceidae	Euplectes capensis				√		√	√
Estrildidae	Granatina ianthinogaster					√	√	√
Nectariniidae	Hedydipna collaris				√	√		√
Hirundinidae	Hirundo angolensis				√			
Hirundinidae	Hirundo rustica				√	√	√	√
Hirundinidae	Hirundo smithii				√			√
Estrildidae	Lagonosticta rubricata				√			
Estrildidae	Lagonosticta senegala				√	√		√
Sturnidae	Lamprotornis chalybaeus				√	√		√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Sturnidae	Lamprotornis hildebrandti				√			√
Sturnidae	Lamprotornis purpuroptera				√			√
Sturnidae	Lamprotornis superbus					√	√	√
Malaconotidae	Laniarius aethiopicus				√	√		√
Malaconotidae	Laniarius funebris							√
Malaconotidae	Laniarius major				√			√
Laniidae	Lanius cabanisi						√	√
Laniidae	Lanius collaris				√	√		
Laniidae	Lanius collurio				√			√
Laniidae	Lanius excubitoroides					√		√
Laniidae	Lanius humeralis				√	√	√	√
Motacillidae	Macronyx croceus				√		√	
Muscicapidae	Melaenornis fischeri				√			√
Paridae	Melaniparus albiventris				√			√
Paridae	Melaniparus fringillinus	Red-throated tit	LC	√	√	√	√	√
Alaudidae	Mirafra africana					√		
Alaudidae	Mirafra rufocinnamomea				√		√	
Muscicapidae	Monticola rufocinereus				√	√	√	√
Motacillidae	Motacilla aguimp				√			√
Motacillidae	Motacilla cinerea				√			
Motacillidae	Motacilla clara				√	√		

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Motacillidae	Motacilla flava				√	√		√
Muscicapidae	Muscicapa adusta				√	√	√	
Parulidae	Muscicapa striata				√	√		
Muscicapidae	Myrmecocichla aethiops				√	√	√	√
Nectariniidae	Nectarinia famosa				√			
Nectariniidae	Nectarinia kilimensis				√		√	√
Nectariniidae	Nectarinia tacazze				√	√		√
Malaconotidae	Nilaus afer				√	√		√
Muscicapidae	Oenanthe isabellina				√			√
Muscicapidae	Oenanthe lugubris				√	√	√	√
Muscicapidae	Oenanthe lugubris schalowi				√			
Muscicapidae	Oenanthe oenanthe				√	√		√
Muscicapidae	Oenanthe pileata				√	√		
Muscicapidae	Oenanthe				√	√	√	√
	pleschanka							
Sturnidae	Onychognathus morio				√	√	√	√
Oriolidae	Oriolus auratus							√
Oriolidae	Oriolus larvatus					√		√
Oriolidae	Oriolus oriolus				√			√
Estrildidae	Ortygospiza fuscocrissa				√			

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Passeridae	Passer domesticus				√		√	
Passeridae	Passer eminibey					√		√
Passeridae	Passer gongonensis				√			
Passeridae	Passer rufocinctus	Kenya sparrow	LC	√	√	√	√	√
Passeridae	Passer suahelicus				√			√
Passeridae	Petronia pyrgita						√	
Cisticolidae	Phyllolais pulchella				√			√
Phylloscopidae	Phylloscopus trochilus					√		√
Passeridae	Plocepasser mahali				√			√
Ploceidae	Ploceus baglafecht				√	√		√
Ploceidae	Ploceus cucullatus				√			√
Ploceidae	Ploceus intermedius							
Ploceidae	Ploceus ocularis				√			√
Ploceidae	Ploceus rubiginosus				√			√
Ploceidae	Ploceus spekei				√	√		√
Ploceidae	Ploceus vitellinus				√			
Ploceidae	Ploceus xanthops				√			√
Cisticolidae	Prinia subflava				√	√	√	√
Prionopidae	Prionops poliolophus							

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Hirundinidae	Psalidoprocne albiceps				√			
Hirundinidae	Psalidoprocne pristoptera				√			
Hirundinidae	Pseudhirundo griseopyga				√			√
Hirundinidae	Ptyonoprogne fuligula				√	√		√
Pycnonotidae	Pycnonotus barbatus				√	√	√	√
Ploceidae	Quelea quelea					√		
Hirundinidae	Riparia cincta			√	√			
Hirundinidae	Riparia paludicola				√	√	√	√
Hirundinidae	Riparia riparia			√	√			√
Muscicapidae	Saxicola torquatus				√			
Fringillidae	Serinus flavivertex				√	√		
Fringillidae	Serinus sulphuratus				√	√		
Sylviidae	Sylvia borin				√			√
Sylviidae	Sylvia lugens							√
Macrosphenidae	Sylvietta whytii				√	√		√
Malaconotidae	Tchagra australis							√
Malaconotidae	Tchagra senegalus			√	√	√		
Malaconotidae	Telophorus sulfureopectus				√		√	√
Monarchidae	Terpsiphone viridis				√	√		√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Muscicapidae	Thamnolaea cinnamomeiventris				√	√		
Leiothrichidae	Turdoides jardineii							√
Leiothrichidae	Turdoides sharpei				√		√	√
Muscicapidae	Turdus abyssinicus			√	√			√
Muscicapidae	Turdus olivaceus				√			√
Estrildidae	Uraeginthus bengalus				√		√	
Viduidae	Vidua macroura				√	√	√	
Zosteropidae	Zosterops senegalensis				√			
Order: Pelecaniformes								
Ardeidae	Ardea alba	Great egret	LC		√			√
Ardeidae	Ardea cinerea	Grey heron	LC					√
Ardeidae	Ardea goliath	Goliath heron	LC					√
Ardeidae	Ardea intermedia	Intermediate egret	LC					√
Ardeidae	Ardea melanocephala	Black-headed heron	LC			√		√
Ardeidae	Ardea purpurea	Purple heron	LC		√			√
Ardeidae	Ardeola ralloides	Squacco heron	LC					√
Threskiornithidae	Bostrychia hagedash	Hadada ibis	LC		√		√	√
Ardeidae	Bubulcus ibis	Cattle egret	LC			√	√	√
Ardeidae	Egretta ardesiaca				√			√
Ardeidae	Egretta garzetta							√
Ardeidae	Ixobrychus minutus				√			√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Ardeidae	Nycticorax nycticorax							√
Pelecanidae	Pelecanus onocrotalus							√
Pelecanidae	Pelecanus rufescens				√			√
Threskiornithidae	Platalea alba				√			√
Threskiornithidae	Plegadis falcinellus				√			√
Scopidae	Scopus umbretta					√		√
Threskiornithidae	Threskiornis aethiopicus							√
Order: Phoenicopteriformes								
Phoenicopteridae	Phoeniconaias minor				√			√
Order: Piciformes								
Picidae	Campethera nubica	Nubian woodpecker	LC		√			√
Picidae	Dendropicos fuscescens				√			√
Picidae	Dendropicos goertae				√			√
Picidae	Dendropicos namaquus							√
Picidae	Dendropicos obsoletus				√			
Picidae	Dendropicos spodocephalus				√			√
Indicatoridae	Indicator indicator						√	
Indicatoridae	Indicator meliphilus				√			
Indicatoridae	Indicator minor				√	√		√

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Indicatoridae	Indicator variegatus				√			√
Ramphastidae	Lybius leucocephalus				√			√
Ramphastidae	Pogoniulus pusillus				√			
Indicatoridae	Prodotiscus regulus				√			
Ramphastidae	Tricholaema diademata				√			√
Order: Podicipediformes								
Podicipedidae	Podiceps cristatus				√			√
Podicipedidae	Tachybaptus ruficollis							√
Order: Psittaciformes								
Psittacidae	Agapornis personatus	Yellow-collared lovebird	LC					√
Order: Strigiformes								
Strigidae	Bubo africanus	Spotted eagle-owl	LC				√	
Strigidae	Bubo capensis	Cape eagle-owl	LC					
Strigidae	Bubo lacteus	Verreaux's eagle-owl	LC		√		√	√
Strigidae	Glaucidium perlatum				√			√
Strigidae	Glaucidium perlatum licua							√
Tytonidae	Tyto alba				√			
Order: Struthioniformes								
Struthionidae	Struthio camelus				√	√	√	

Family	Species Scientific Name	Common Name	IUCN Status	Distance (km)				
				2	4	6	8	10
Struthionidae	Struthio camelus massaicus				√	√		
Order: Suliformes								
Anhingidae	Anhinga rufa	African darter	LC					√
Phalacrocoracidae	Microcarbo africanus							√
Phalacrocoracidae	Phalacrocorax carbo							√

Appendix III: Consultations on Ecosystem Services

The general objectives of the consultations on ecosystem services are, namely:

- Define the role of habitats in the well-being of communities and understand what resources and services, arising from these habitats, are present in the project area;
- Identify the natural resources and services resulting from the habitats present in the project area for which the populations have the most concerns (e.g. reduced accessibility to certain areas for collecting plants or animals, punctual deterioration of water quality);
- Identify the components of the environment (specific habitats (wetlands, rivers, lakes, forests, savanas, etc.), seasons, types of soil, topography, etc.) that influence the availability of the resources used and the services that benefit local populations;
- Make a list of plants or animals consumed or harvested and identify their use;
- Identify and locate the habitats that are most important for the well-being of local populations; and
- Provide insight on how the use of these resources could be affected by the Industrial Park (barrier to access, induced access, land conversion) to compensate for the impacts of the loss of natural habitats on populations.

In general, the stakeholders we want to invite and discuss with are:

- Women;
- Elders;
- Pastoralists;
- Fishermen;
- Farmers; and
- Natural Resource Traders (wood, charcoal, water, other?).

These was invited to the Meeting with Sub-Counties/Wards, Community Members and Chiefs and questioned on ecosystem services during the Map Session.

Detailed Question List:

The following detailed question lists is meant to guide the consultations, not to go systematically through all the questions. The priority questions are highlighted in bold. The questions asked were adapted to the stakeholders in the small groups during the mapping session, and when

meeting other specific groups or associations. Most likely, some resources/themes won't be relevant for some groups and questions will need to be prioritized.

General Questions	
What are the ecosystem services in the project area considered most important by people? What are the habitats most targeted or valued by the population for supply? Who are the different beneficiaries of ecosystem services in the study area? What are the different environmental parameters that influence the availability of ecosystem services? **What distances do they travel to have access to the resources present? Do they use or cross the road to access them?** Deepen the history of resource use in the RSA and the perspective over time. What ecosystem services in the study area are you most concerned about?	
Provisioning Services	
Agricultural Potential and Production	<u>Location</u> **Location of agricultural areas (rain-fed, irrigated, market gardening)** **Location of off-season crops** Location of areas with greater agricultural potential (what environmental factors have an influence on these areas). Location of certain crops according to environmental parameters. Location of women's cultivation areas. <u>Description</u> **Assessment of the contribution of agriculture to household food** **Most consumed species** Types of production (rain-fed, irrigated, market gardening, etc.). Type of crops grown (indigenous and/or exotics), the seasons each crop are grown and productions lifespan. Contribution of agriculture to farmers income (should be considered). Are any amendments necessary (types of amendments (synthetic or

General Questions	
	natural), location of areas where amendments are applied, crops targeted (higher yield crop?). Fallow period (length of fallow, cropping decision factors). Acreage of farms: including proportion of area for major type of crops (also, proportion for livestock grazing on farms). Locations of fragmented farmlands (especially across the road): locations, sizes, land tenure system of farmlands. Agricultural dynamics and sequence: Selection of agricultural areas to cultivate, amendment, tillage, production (influencing factors along the productive / vegetative season), harvest. Sharing of agricultural activities (are crops reserved exclusively for women, area of plots dedicated only to women, what crops, why they cultivate them). Agricultural issues in the area (reduced fertility, erosion, undesirable / invasive species, etc.). What economic activities outside the agricultural period?
Livestock and Forage Resources	<u>Location</u> **Location of forage areas** **Location of areas with better forage potential** **Location of travel corridors** <u>Description</u> **Main type of livestock in the study area** Differences between pastoral resources according to the type of livestock (cattle, pig, poultry, goat, sheep; natural fodder / supplement). Proportion of use of herbaceous and woody species. Seasonal differences. Apiculture developments? **Pattern of use of forage areas in the study area (permanent, seasonal area)** Seasonal pattern of resource use (forage species on the ground, lopping,

General Questions	
	crop residues). Interannual pattern, what influences the quality and availability of foraged resources between years. State of pastures and factors of degradation. Fodder resources development in the area. Location of the best pastures (link with habitat types), location in relation to other environmental factors, link with water resources. Bee Keeping: sources of pastures (forage sources), productivity (yields), traditional or modern bee keeping? Impact of production on household income. Specific pastoral species whose use is linked to a specific use (medicinal plant, anti-parasitic, higher protein value). Most valued fodder plants for livestock. Fragmented pasture areas: location, sizes, land tenure system of pastoral areas. **Daily movement of herds, distance traveled daily, factors influencing movements. How do they decide its time to move, decision-making elements for seasonal migration?** **Percentage of livestock sold (selling price, factors influencing the selling price), percentage consumed, period of consumption**
Fishery Resources	Location **Fishing areas** **Spawning areas** Description **Description of the types of fisheries in the area (subsistence, pleasure or commercial fishing) and associated beneficiaries** Fishing period, fishing vessels and gears. Fish and fishery species. State of fish stocks (growth or decline, factors underlying changes).

General Questions	
	Most favorable fishing areas / habitats most frequented by fish. Seasonality of fish stocks (most productive periods, slack periods, movement of fish, etc. environmental factors influencing the availability of the resource) including fishing seasons. Restricted areas and seasons for fishing? Aquaculture developments in the area? Productivity and income? Use of fishing products or by-products. These products are processed or sold as is. **Different activities related to fishing and fish processing. Person / group in charge of the different activities** Habitats used for the landing stage, boats, fish processing (drying or other). Fisheries and gears. Are there any fishermen's organizations (BMUs)? What vocations do these organizations have? Marketing channel. Fisheries value chains? **Importance in terms of food security (% of protein intake covered by fishing)** What are the baits? Are ichthyotoxic substances used?
Hunting and Bushmeat	<u>Location</u> **Hunting areas** **Seasonal movement of game** <u>Description</u> **Objectives of hunting: subsistence or sale** **Hunting practices: What groups do the hunting (man, woman, adult)? What types of hunting do each group do and what tools do they use?** Game commercialisation, commercialisation network, meat processing. Species used for bushmeat (hunted or caught by snares)?

General Questions	
	Issues of snares or traps for catching games? % of meat consumed from nature (how often bushmeat is used by household?). Hunting season, difference in stocks between seasons. Evolution of hunting over time (increase / reduction of resources, hunters, the importance of hunting, factors that have influenced these transformations). Use of toxic products for hunting and of natural bait.
Natural food products	<u>Location</u> **Preferential picking/gathering areas** <u>Description</u> **What species of natural food products?** Where can we find the collected species? What are the environmental factors that guide their presence? **In what natural habitat are they found?** Are insects eaten? Is there a seasonal variation in the supply (herbaceous vs woody)? Wild collection or harvested as adopted plant on farms? Preservation or conservation of indigenous food plants or animals (including sustainable adoption of growing of the plants into agriculture i.e. farm propagations). Are there times when these plants play a major role in the diet? Are they consumed daily? **What are the priority gathering periods?** Are some species stored? Do they lose a large proportion of the products gathered? Is the gathering considered sustainable?

General Questions	
	What proportion is sold? Do they buy these plants at the market or are they always gathered in the bush? How do they harvest honey or harvest it, who collects it? What is honey used for in food, medicine, sale etc.?
Traditional Medicine	Location **Preferential gathering areas** Description **What (mineral, plants, animals) do local populations treat themselves with?** Where can we find the collected species? What are the environmental factors that guide their presence? **In what natural habitat are they found?** Are particular habitats / areas recognized to support higher value / medically effective species? Is there a seasonal variation in the supply (fauna / herbaceous vs woody)? Is there priority hunting / gathering periods that influence the availability of target species or their effectiveness? Are some species stored? Is the gathering considered sustainable? Preserved plants (trees) on farm for medicinal? Farm propagation: nurseries/seedbeds. What proportion of the collected species are sold? Plant species: parts of plant and efficacy (treatments) or supplements. Do they buy these plants at the market or are they always gathered in the bush? Are these plants dedicated to the care of children, women or men? Availability and access to health care for populations. **Prioritization of treatments by the populations (traditional medicine vs**

General Questions	
	itinerant medicines vs health center and pharmacy)
Construction Materials	Location **Preferred timber harvesting zones** **Preferred areas for harvesting organic materials** **Preferred areas for harvesting mineral materials** Description How are the houses, buildings and furniture constructed, with the different stages of manufacture? **What materials are used and how are they retrieved?** **What species are mainly used?** What is the abundance of these species in the study area? Sources of construction materials/species: on farms, forest, market. Structures on farms: materials and sources of materials. Are these species used for other purposes as well (firewood, pruning) or are they only intended for timber or construction? Development of construction resources (renewable) in the area?
Lumber and Crafts	Location **Collection areas for lumber** **Collection areas for craft materials** Description How do you select the trees to cut (size, shape, etc.)? Are there any factors that influence the presence of higher value trees? **What trees are used or resources?** Where do they get lumber or construction and other materials, which habitats provide materials? Do we sell processed wood products and crafts and where? On farm preservation of indigenous trees or development of other trees? Size of area for trees, species.

General Questions	
	What are the marketing networks for wood and craft products? Licensing for extraction?
Biofuels	Location **Firewood collection areas** Description **What energy sources are used (wood, charcoal, dung, other organic matter)?** How is the wood collected? Wood selection criteria. Are species being targeted for their energy potential (if so, what are these species)? Random collection depending on the availability of dead wood? What are the methods of transforming wood into charcoal? Which group collects (Men, women, children)? Who sells the firewood / charcoal? Are there dedicated firewood plantations nearby? Which species are preferentially used?
Water Resources	Location **Preferred surface water supply areas** Are any areas recognized for the properties of the water drawn from them? Description What water resources are we using? Type of water resources. Water resources development efforts and opportunities. Drainage systems in the area. Including springs. Seasonality of water resources. **Where and when do they use surface water?** **What are the uses of water?** What are the environmental factors that they think influence the quality and quantity of water?

General Questions	
Regulation Services	
Air Quality Control	Description Breathing of dusts, exhaust fumes, smokes? Where does this occur (absence)? What are the environmental components that influence air quality?
Climate Regulation Regional and Local	Description What are the environmental factors that affect temperature, precipitation, droughts, winds and their impacts? What locals think contribute to moderation of temperature and precipitation in the area. Are there benefits or lost of benefits over time with the change of the factor?
Water Regulation	Description **What environmental factors do they think influence the amount of water?** What locals think contribute to availability of natural water. Is there benefits or lost benefits over time with the change of the factor? Seasonality aspect of water availability.
Water Purification and Treatment	Description What environmental factors do they think influence water quality? Wetlands/springs, riverine conservation and water quality.
Control of Erosion and Soil Quality	Description What are the factors that influence erosion dynamics? Land use and land covers: degradation associated with the LULC.
Disease and Pest Control	Description What are the most problematic vector-borne diseases in the area? What are the most problematic pests in the area? What are the environmental factors that influence the proliferation of

General Questions	
	diseases and pests?
Pollination	Description What is the role of insects, birds and small fauna in the profitability of crops? Is there an increase or decrease in pollinators? Which crops are pollinated; by which pollinator species? Are pollinators available. Have they experienced crop production failure due to lack of pollinators? What are threats to pollinators?
Control of Natural Disasters (or Regulation of the Effects of Natural Hazards)	Description What natural risks are populations exposed to? Flood risks? Severe droughts? Dry period grazing areas (e.g. wetlands). What are the repercussions? On livestocks and human being? What is the periodicity of the phenomena? What are the effects of fluctuating water levels on crops and other resources?
Cultural Services	
Sacred Elements	Location **Location of sacred sites within the study area** Description **Are there sacred sites within the study area?** **Are there sacred trees/plants or animals revered by people?** Have practices changed over time given the depletion of certain species or other factors? Do certain species enter into certain rituals or ceremonies practiced by the communities? (Traditional ceremonies and use of species). Are certain species known to protect populations? Traditional artefacts based on plants or animals?

General Questions	
Recreation and Tourism	**What activities?** **Sites** **Type of recreations?** **Charges/payment for service** **Who benefits from them?** **Income from these activities?**