



SIMBA CEMENT
NATIONAL CEMENT COMPANY LIMITED

**SUPPLEMENTAL ENVIRONMENTAL IMPACT ASSESSMENT
GREENFIELD CLINKER MANUFACTURE AND LIMESTONE
MINING OPERATIONS, MERRUESHI, KAJIADO COUNTY,
AND CEMENT GRINDING & CABRO MANUFACTURING
OPERATIONS, LUKENYA, MACHAKOS COUNTY KENYA**



Prepared by:

EMC Consultants
Nairobi, Kenya
info@emconsultants.org



ACRONYMS

ADR	Average Daily Traffic
BAT	Best Assessment Technology
CFL	Compact fluorescent bulbs
EMP	Environmental Management Plan
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
HGV	Heavy Goods Vehicles
IBA	Important Bird Areas
IFC	International Finance Corporation
ILO	International Labour Organization
KeNHA	Kenya National Highways Roads Authority
KPLC	Kenya Power and Lighting Company
kV	Kilo Volt
KWS	Kenya Wildlife Service
LGV	Light Good Vehicle (LGV)
MGV	Medium Goods Vehicles (MGV)
MoH	Ministry of Health (MoH)
NCCL	National Cement Company Limited
NEMA	National Environment Management Authority
OHSE	Occupational Health, Safety and Environment
PS	Performance Standard
SPCC	Spill Prevention, Control and Counter
UNESCO	United Nations Educational, Scientific and Cultural
Organization	
WHO	World Health Organization
WRMA	Water Resources Management Authority

Table of Contents

ACRONYMS	II
1.0 PROJECT BACKGROUND	8
1.1 JUSTIFICATION FOR CLINKER MANUFACTURE PLANT	9
Project Objective	10
1.2 MAIN PARTS OF THE DEVELOPMENT	11
2.0 OVERVIEW OF THE PROJECT LOCATION.....	13
2.1 OVERVIEW OF CEMENT PRODUCTION.....	16
2.2 SUPPLEMENTAL STUDIES.....	19
DISCLAIMER	20
3. TRANSPORT PLANNING STUDY	22
3.1 EXISTING TRANSPORT NETWORK	22
3.2 EXISTING ROAD CLASSIFICATION SYSTEM	22
3.3 HIGHWAY NETWORK SYSTEM	23
3.4 EMALI-OLOITOKTOK ROAD.....	23
3.5 EMALI-OLOITOKTOK ROAD QUALITY AND DESIGN.....	24
3.6 EMALI-ATHI RIVER ROAD/MOMBASA ROAD	24
3.7 TRAFFIC STUDY	26
3.8 PLANT SITE TRANSPORT INFRASTRUCTURE.....	28
3.9 LOCAL MOVEMENTS	28
3.10 LONGER DISTANCE PLANT ACCESS / EGRESS NEEDS	29
3.11 IMPACTS TO THE HIGHWAY NETWORK.....	30
Pavement Loading.....	30
3.12 CONCLUSION	31
4. WASTE STUDY	33
4.1 RAW MATERIAL USE AND WASTE PRODUCTION.....	33
4.2 RAW MATERIALS USED IN LIMESTONE MINING ACTIVITIES	34
Limestone.....	34
Bauxite and Laterite	34
Coal	34
Water	34
4.3 MATERIALS USE AND WASTE MANAGEMENT	35
Construction and Operation Phase.....	35
4.4 PROPOSED MITIGATION MEASURES:	36
4.5 WORKERS CAMP WASTE	37
4.6 DUMPSITE.....	37
4.7 MITIGATION MEASURES FOR FUEL SPILLS.....	37
4.8 WASTE IMPACT ASSESSMENT	37
Extent	37
Duration	37

Intensity	38
Probability	38
Impact significance.....	38
4.9 MITIGATION MEASURES	38
4.10 HAZARDOUS WASTE MANAGEMENT	38
Hazardous Materials	38
4.11 HAZARDOUS MATERIALS IMPACT ASSESSMENT	40
Extent	40
Duration	40
Intensity	40
Probability	40
4.12 Impact Significance	40
4.13 Mitigation.....	40
4.14 FUEL SPILL PREVENTION PLAN	41
4.15 WASTE AND AMBIENT AIR QUALITY IMPACT.....	41
Fugitive Dust Emission Impacts.....	41
4.16 MITIGATION.....	42
4.17 ASSESSMENT OF POTENTIAL EFFECTS.....	43
4.18 IMPACTS TO SURFACE WATERS ASSOCIATED WITH OPERATION OF QUARRIES.....	43
4.19 OTHER MEASURES FOR THE PRESERVATION OF SURFACE WATER QUALITY	43
5.0 WATER BALANCE.....	45
5.1 GEOLOGY.....	45
Proterozoic Metamorphic Rocks.....	45
Kilimanjaro Volcanics	45
South Chyulu Hills Volcanics	45
Kimana Formation.....	46
Surficial Deposits.....	46
5.2 GROUNDWATER OCCURRENCE	46
5.3 SUB SURFACE WATER AVAILABILITY IN PROJECT AREA	47
Sub Surface Water Quality.....	48
Surface Water Availability in Project Area.....	48
5.4 QUARRYING ACTIVITIES WATER DEMAND	49
5.5 CLINKER MANUFACTURE WATER DEMAND	49
5.6 ACCOMMODATION WATER USE DEMAND.....	49
5.7 SOURCE OF WATER FOR PROJECT	49
5.8 IMPACT OF TECHNOLOGY AND PROCESS SELECTION ON WATER RESOURCE MANAGEMENT.....	50
5.9 LAND QUALITY AND GROUNDWATER.....	51

6.0 LABOUR AND ACCOMODATION	53
6.1 OVERVIEW OF CONSTRUCTION ACTIVITIES	54
6.2 SOCIO-ECONOMIC ASPECTS.....	55
6.3 TERMS OF EMPLOYMENT	55
6.4 LIVING CONDITIONS AND CAMP FACILITIES	56
Room/dormitory facilities	56
Sanitary and toilet facilities.....	57
Toilet facilities	57
Showers/bathrooms and other sanitary facilities.....	58
Canteen, cooking and laundry facilities	58
Standards for nutrition and food safety	59
Leisure, social and telecommunication facilities	59
Medical facilities	60
6.5 BASIC CAMP INFRASTRUCTURE INCLUDES:.....	60
Wastewater treatment	60
Drainage:	61
Fire Safety Hazards.....	61
Heating and Air conditioning:	61
6.6 OCCUPATIONAL HEALTH AND SAFETY	61
6.7 HEALTH AND SAFETY TRAINING	61
6.8 MANAGING WORKERS' ACCOMMODATION	62
6.9 SECURITY OF WORKERS' ACCOMMODATION	62
6.10 COMMUNICATION AND CODES OF CONDUCT	62
6.11 IMPACTS ON THE LOCAL COMMUNITIES: OPPORTUNITIES FOR EMPLOYMENT AND LOCAL PROCUREMENT ..	63
6.12 IMPACTS ON THE LOCAL COMMUNITIES	64
6.13 COMMUNITY HEALTH AND SAFETY.....	64
6.14 COMMUNITY COHESION	64
6.15 LAND ACQUISITION AND RESETTLEMENT	64
6.16 MANAGEMENT OF COMMUNITY RELATIONS	65
7.0 TERRESTRIAL ECOLOGY ASSESSMENT	67
7.1 BASELINE TERRESTRIAL ECOLOGICAL CONDITIONS.....	67
Fauna.....	68
7.2 AMBOSELI AREA.....	70
Flora	71
Fauna.....	72
7.3 IMPACT ON TERRESTRIAL ECOLOGY	76
Flora and Fauna.....	76
7.4 PROPOSED MITIGATION MEASURES	77
7.5 DUST EMISSION IMPACTS.....	78

8.0 AMBIENT AIR QUALITY	80
8.1 POINT SOURCE EMISSIONS	80
8.2 AREA SOURCE EMISSIONS	81
8.3 DISPERSION MODELLING.....	83
8.4 AMBIENT AIR QUALITY FINDINGS	84
Ambient Air Quality.....	85
8.5 RESULTS OF THE AMBIENT AIR QUALITY MONITORING	86
8.6 ADVERSE IMPACTS	88
Construction Phase	88
Mitigation Measures	88
Effects During Operation	89
8.7 IMPACT OF TECHNOLOGY CHOICES AND PROCESS DESIGN ON ENERGY, WATER EFFICIENCY AND MINIMIZATION OF GHGS	89
Process Technology.....	89
Energy Supply.....	89
Fuel Supply	90
Water Efficiency	90
NOISE EMISSION BASELINE-LUKENYA PLANT	91
OBJECTIVE	91
PROJECT DESCRIPTION	91
PROJECT SITE DESCRIPTION	92
LEGISLATION.....	93
IFC/WORLD BANK ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINES.....	94
KENYA AIR EMISSION REGULATIONS	ERROR! BOOKMARK NOT DEFINED.
Noise and Excessive Vibration Pollution Control Regulations	94
MEASUREMENT METHODOLOGY.....	95
SURVEY LOCATIONS	95
HEALTH AND SAFETY	101
RECOMMENDATIONS	ERROR! BOOKMARK NOT DEFINED.
AIR EMISSIONS BASELINE –LUKENYA PLANT	105
SCOPE OF WORK.....	105
PROJECT DESCRIPTION.....	ERROR! BOOKMARK NOT DEFINED.
LEGISLATION AND GUIDELINES	105
METHODOLOGY	106
RESULTS.....	ERROR! BOOKMARK NOT DEFINED.
CONCLUSION.....	115
RECOMMENDATIONS	115

Chapter 1.0 PROJECT BACKGROUND

The International Finance Corporation (IFC) proposes to invest in National Cement Company Limited (“NCCL” or the “Company”) to support: 1) the completion of the Company’s cement manufacturing plant near Nairobi; and 2) the construction and operation of a greenfield clinker manufacturing unit near Merrueshi in southeastern Kenya. NCCL trades under the brand “Simba Cement” and currently produces 0.60 million tons per annum (mpta) of blended Portland cement at its Lukenya plant using clinker imported from abroad. NCCL has completed two additional cement-manufacturing lines on the same site, which will increase Company’s installed capacity to 1.65 mpta (the “Project”).

The existing cement manufacturing plant located in Lukenya, is a facility comprised of 3 cement mills (lines) with a production capacity of 4,400tonnes per day and is operated by NCCL.

The proposed clinker production facility and associated quarries described in this statement will be owned and operated by NCCL, part of the Devki Group of Companies.

Devki is a large, Kenyan owned company that produces, delivers and trades in cement, aggregate, concrete for mixture and similar products for the construction industry. It is also engaged in the steel and iron industry. Devki has an excellent reputation for upholding the laws of the countries within which it operates and where possible extends its environmental performance beyond the requirements of those laws. Devki wishes to grow its business in Kenya in the cement industry and has created NCCL to operate the proposed facility.

National Cement Company Limited has been duly established and organized according to Kenyan Legislation. The registered address of the company is Ruiru Town.

The existing cement manufacturing plant facility includes;

1. 3 Cement Mills
2. 1 Crushing Plant (gypsum)
3. 1 Crushing Plant (Pozzolana)
4. 3 Packaging Plants
5. A Cabro Manufacturing Plant

The proposed green-field facility and limestone mining in Merrushi includes:

- The opening of a limestone quarry to supply the major raw materials for the production process.
- An integrated 3, 300 tpd clinker production line to be located in Merrueshi Area in Kajiado County
- The clinker will be used for the manufacture of cement, according to Kenyan and international norms;
- Coal will be used as the main fuel in clinker production.

The limestone quarry including the clinker plant site area will cover approximately 2,200 acres. The total land area leased by NCCL from the Imbirikani Group Ranch is 1,600 acres and total area purchased from private land is 600 acres. Thus, the total area available to NCCL for the development of the project is 2,200 acres. The clinker plant will cover approximately 207 acres.

This report is structured in 2 parts that are mutually exclusive and include:

1. Chapter **3 to 8**, which is principally a **supplemental environmental assessment** of the proposed clinker and limestone mining plant in Merrueshi. The supplemental studies include; **Water Balance; Traffic Planning; Waste Management; Terrestrial Ecology Assessment; Workers Accommodation; and Ambient Air Quality Assessment.**
2. Chapter **9 to 10** is a **Baseline Analysis** to establish the **noise** and **air emissions** in and around the plant during the operations phase of the NCCL cement plant at Lukenya and eventual assessment of the impacts emanating from the plant's operation.

1.1 Justification for Cement and Clinker Manufacture Plant

The Kenyan economy is growing and it is predicted that there will be an increase in the national building and infrastructure programme. NCCL wish to expand cement production and develop a new clinker manufacture facility to help meet the expected demand for cement. The preferred plant location is rich in the raw materials necessary for the production of clinker.

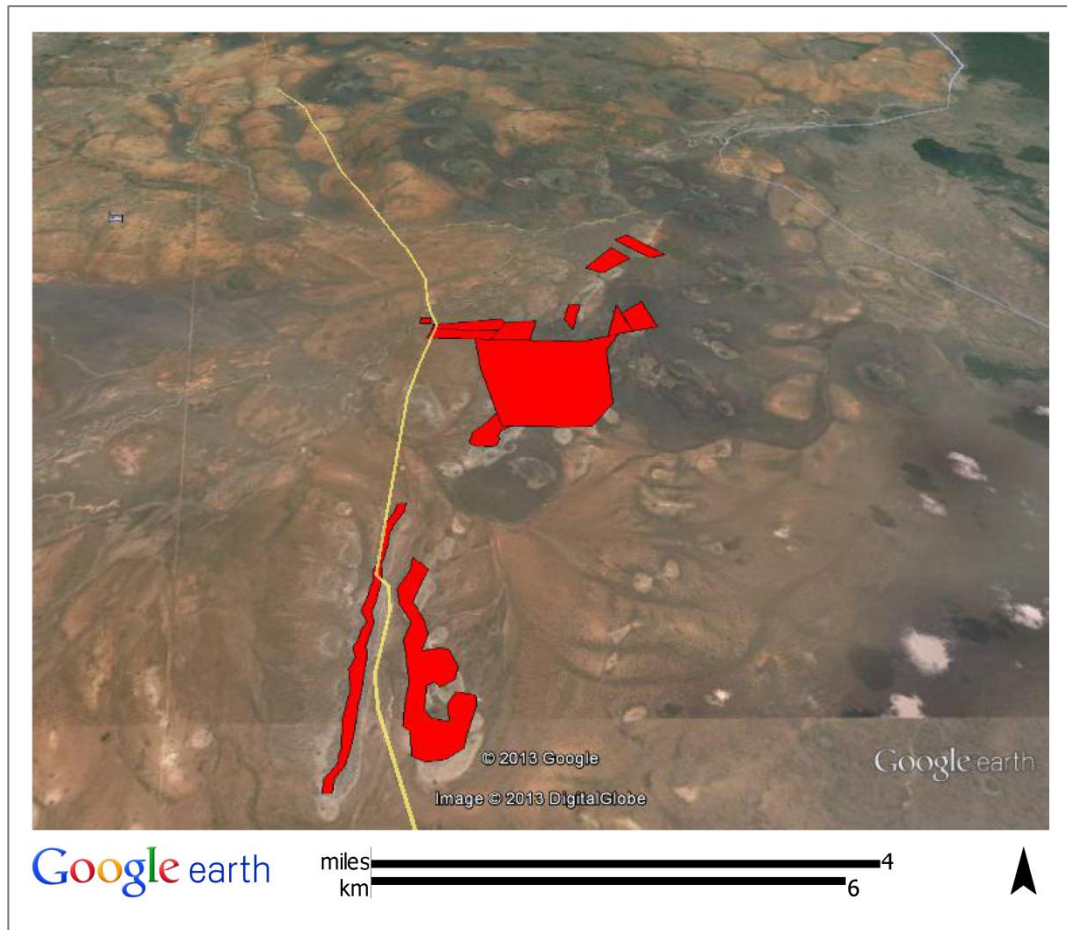


Figure 1. Aerial View of Project Location

Project Objective

The objective of the proposed plant is to produce clinker by using available limestone and clay resources, whilst achieving a balance between impacts on the local environment, community needs and economic viability.

Cement manufacturing consists of raw meal, grinding, blending, calcining to form clinker and cement grinding. In short, limestone and other materials containing calcium, silica, aluminum and iron oxides are crushed and milled into the raw meal.

This raw meal is blended and heated in the pre-heater to initiate the dissociation of carbonate to calcium oxide and carbon dioxide. The meal then proceeds to the kiln for heating and reaction between calcium oxide and other elements to form calcium silicates and aluminates at a temperature up to 1450C. The products leave the kiln as a nodular material called clinker. The clinker is inter-ground with the gypsum and other additives like slag to a fine product called cement.

The main benefits that will be derived from the project are:

Up to 1000 jobs will be generated during the construction and operation phases of the project. Due to the skilled nature of the construction process the majority of the workforce will comprise of non-local Kenyan and expatriate worker. However, construction phase jobs will be created that are anticipated to be filled by the local population. In addition, where possible, supplies will be sourced locally which is likely to benefit local business.

During construction stage all unskilled workers will be employed from the local community (This applies to the contractor's also). During the operation stage, in the mining area as well as production area and other operation area all unskilled workers will be employed from the local community. Training and Development of unskilled workers will be undertaken to upgrade them to semi-skilled and skilled category over a period of time.

All these recruitment and labour related commitments will be kept and contractually secured in the supplier contracts too.

The proposed development will generate employment for the duration of the quarry and plant operations, which is anticipated to be in excess 60 years and will generate approximately 300 permanent jobs within the area.

It is envisaged that majority of the employment opportunities (unskilled) that will be provided will be taken up by local communities who may not necessarily be from the Maasai –the majority community in the project area but who are attached to livestock and pastoral livelihood and may not sign up for wage labour. However, efforts will be made to enlist as many willing Maasai as possible.

Appropriate training and education will be provided to local employees to ensure that they have the ability to undertake both the manual and skilled roles required at both clinker plant and quarry sites.

It is considered that a proportion of the materials required during the operation of the proposed development, including food and materials for the employees, are likely to be sourced from the local area, where feasible, which will enhance the economic conditions of the area through increased spending.

The main benefits that will be derived from the project are thus:

1. A reduction in the necessity for the country to import cement from overseas.
2. A source of raw materials near a suitable site of cement production.
3. The ability to export surplus quantities of cement generating foreign revenue.
4. Improvements in the local infrastructure and contribution to the local economy.

1.2 Main Parts of the Development

The main characteristics of the project are:

- The opening of a limestone quarry to supply the major raw materials for the production

process.

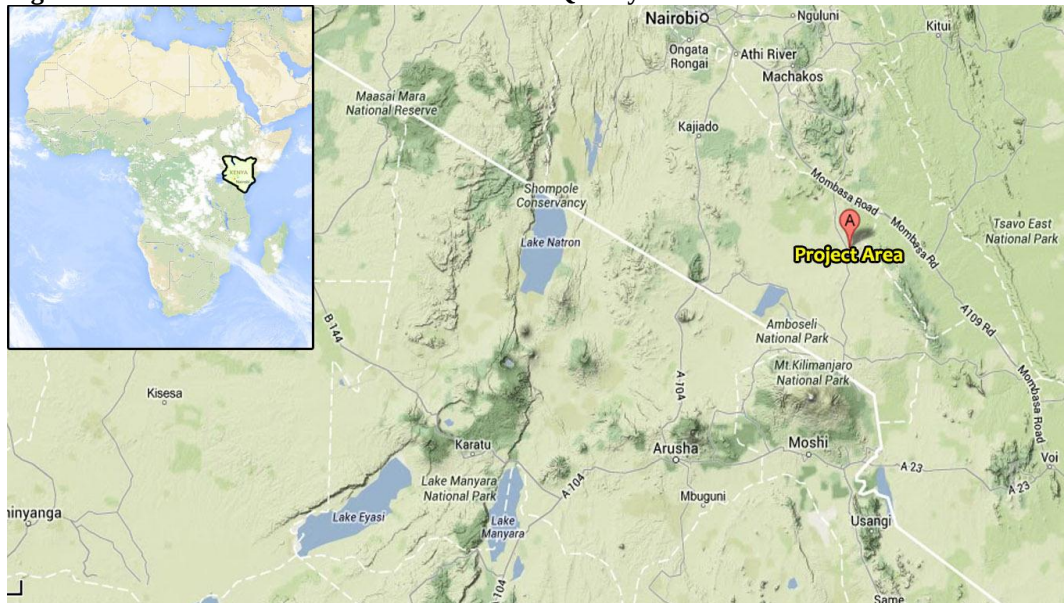
- Transport of large volumes of materials along these routes as well as using the established transport infrastructure. Transport will be along roads, using heavy goods vehicles.
- Associated with the development will be the construction of a power line to connect the quarry site with the main existing power line importing energy into the region. The details of the power line, in particular potential routes are being considered at the time of writing this report. NCCL has proposed to avail power supply for the clinker manufacturing facility and the clinker grinding facility from the Kenya Power and Lighting Company (KPLC) grid through dedicated feeders.
- As regards clinker manufacturing facility, there is an existing 132 kV busbar at Kiboko Sub-station of KPLC situated approximately 32 kms from the proposed site. The dedicated connectivity will be obtained from existing KPLC grid. The application for temporary power of 1 Mega Volt Ampere for construction requirements has already been made to KPLC. For operation of the facility a quote has already been obtained from KPLC for construction of the dedicated line. Based on the progress of the project, application for the total requirement of 12 to 13 MVA will be made to KPLC.

Chapter 2.0 OVERVIEW OF THE PROJECT LOCATION

The site of the proposed clinker manufacture and associated quarries lies within a region comprising fields, the less hilly, and lush savannah vegetation characterized by bushes and shrubs and patches of tufted grass.

The proposed location of the quarries is rural in nature. There are a number of small residential communities including the Orgutum Hills to the very far East, and the expansive Imbirikani Ranch to the South East of the factory site. About 1.5km to the north, using the main road, one crosses the Merrueshi River and gets to the Merrueshi Trading Centre, which is a settled area. The administrative location of the area limestone quarry area (Kajiado County) and project site (Merrueshi) is illustrated in the **Figure 2, 3 and 4 below.**

Figure 2. Administrative Location of Limestone Quarry Site



The clinker manufacturing facility is located in Merrueshi Location, Kajiado Central sub County, Kajiado County. The site is located 35 Kilometres away from the Mombasa-Nairobi highway and is well connected by main road to the highway.

The land for construction of the clinker manufacturing facility along with limestone deposits has also been acquired by the NCCL on long term lease hold basis and measures around 2,200 Acres.

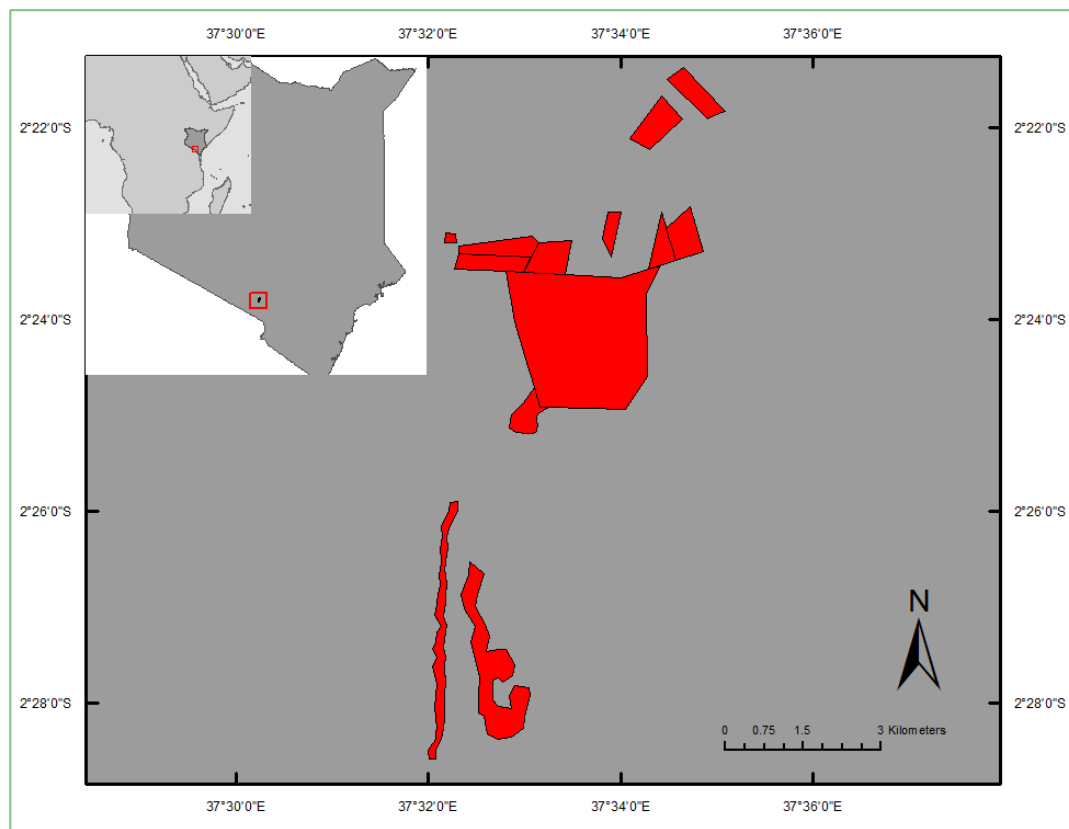


Figure 3. Location Map showing site and quarries



Figure 4. Project Location-site (Merrueshi)

2.1 Overview of Cement Production

The proposed plant will produce clinker from solid raw materials extracted from the adjacent quarries as shown in **figure 3** above. The raw materials are heated to a very high temperature causing the thermal reactions, which produce cement clinker. This clinker is then crushed to produce the cement for sale. A Process Flow Diagram illustrating the process is presented in **Figures 5 and 6**. A brief summary of each stage of the production process is as follows:

- **Raw Material Extraction:** Extraction of the raw materials is from local quarries. The main raw materials are limestone (chalk) and silica-aluminate (a clay-like material also known as “flysch”). There are several quarries in the plots acquired by NCCL and these quarries are where the limestone will be extracted. The quarries are approximately 5-10 kms from the clinker plant.
- During the initial 2-year project phase (upon commencement of extraction of limestone) the extracted materials will be loaded on to transporters/trucks and taken to the clinker plant area. In order to prevent dust emissions during the transport of extracted materials, all raw material preparation will be place in a controlled environment at the clinker plant.
- Emissions during this 2 year period associated with limestone hauling on dust roads within the project area will be a permanent problem and thus, spraying several times a day in the dray season will be the mitigation measure
- Dust emissions do arise at the quarries or during transport of quarried materials to the clinker plant, the quarried materials and roadways will be sprayed with water to prevent wind entrainment of the dust.
- After 2 years, transportation of raw materials to clinker site will be by use of rope technology/conveyor belt which is not only Best Assessment Technology (BAT) but which will minimize electricity as well as dust emission through use of road.
- **Raw Material Preparation:** Once the raw materials have arrived at the clinker manufacture plant they are crushed in separate crushers to produce the correct size of stone for feeding into the cement production process. In order to minimize dust emissions at crusher inlets, water curtains will be used. Crushed materials will be stored in large covered stockpiles. No crushed materials will be stored outdoors. The process of crushing, stacking and reclaiming for the purpose of feeding into the next stage of the process also achieves raw material ‘pre-blending’. The raw materials then fed in to separate feed bins.
- BAT in cement industry dictates that crushing occur at the quarry sites and for that reason after the initial 2 year plant operation, the project will establish crushing at the quarries instead of transporting to clinker site for crushing as will be the case in the first 2 years of plant operation.
- An iron-source and bauxite are also required to make cement and these will be delivered

to site from external sources and stored in silos. These materials will be needed in relatively small quantities.

- The raw materials are fed to the raw mill, where they are ground to a fine powder. Before entering the raw mill, each material is weighed to adjust the chemistry of the raw mix. The ground raw material (raw meal) is transported to the homogenization silo, where it is blended (homogenized), by following a certain extraction sequence as the material leaves the silo.
- At all stages of raw material preparation, appropriate methods will be used to prevent escape of dust, including trucks and on enclosed conveyors when they are established and storage, minimization of material drops, use of bag filters at the raw mill. All bag filters will be designed and operated to ensure particulate emissions below 30 mg/Nm³, in accordance with good international industry practice as standards including IFC standards as described in the Environmental Health and Safety (EHS) guidelines.

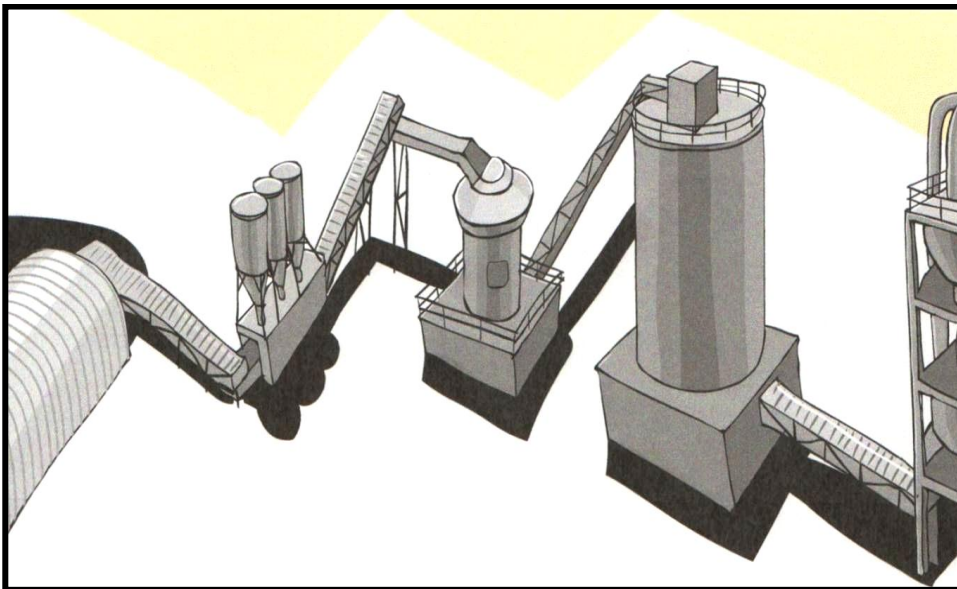


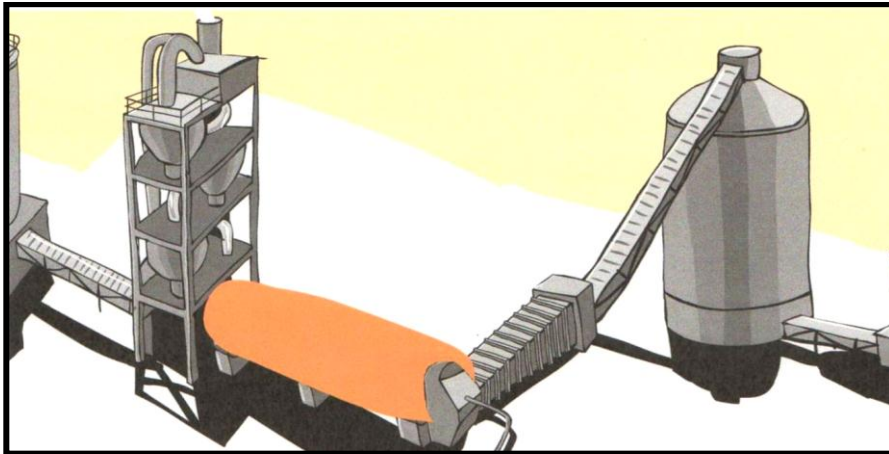
Figure 5. Raw grinding (Source: Devki Group of Companies, 2012)

- **Solid Fuel Preparation:** The production of clinker requires a significant amount of energy. In order to provide this energy, conventional solid fuels are burned, e.g. coal, petroleum coke or lignite. The fuels (coal) will be transported to the plant by trucks from the port of Mombasa. The fuel used in the plant will be extracted overseas. Before being burnt, the fuels, like the raw materials, have to be crushed prior to feeding into the clinker production process.
- **Raw Material Heating:** The raw materials are added and heated to high temperatures; the cement “clinker” being formed as a result of thermal reaction. The plant will use the most modern and efficient design for undertaking this process. The raw materials are first fed into a 5 stage ‘pre-heater’ heated by hot gases from next stages of

the process. The end part of the pre-heater is called the pre-calciner', where more than half the fuel is burnt and the chemical reactions are well underway. The raw material mix enters the large, horizontal kiln where the remaining fuel is burnt and the final high temperature chemical reactions take place. The produced clinker is then cooled before storage.

- Basic chemical reactions are: evaporating all moisture, calcining the limestone to produce free calcium oxide and reacting with the calcium oxide with minor materials. This results in a final grey (different shades), nodular product known as “clinker” which has the desired hydraulic properties.
- In the dry process, kiln feed is fed to a pre-heater tower. Material from the pre-heater tower is discharged to a rotary kiln. The pre-heater tower and rotary kiln are made of steel and lined with refractory materials to protect it from the high process temperatures which can reach up to 1450 Degrees Celsius. Suctions to bag filters will be installed at all material drop/transfer points, as well as raw mills, and process plant. The only place where ESPs are justified is at the cooler section due to its gas temperatures and cement milling.
- The rotary kiln is fired with an intense flame produced by burning coal. Pre-heater towers will be equipped with firing as well. The rotary kiln discharges the red-hot clinker under the intense flame into a clinker cooler. The clinker cooler recovers the heat from the clinker and returns the heat to the pyro-processing system thus reducing fuel consumption and improving energy efficiency. Clinker leaving the clinker cooler is at a temperature conducive to being handled on standard conveying equipment.
- **Cement Grinding and Storage:** The clinker is ground with additives (e.g. gypsum, limestone, fly ash) depending on the quality requirements of the final cement. The cement dust is then stored in large silos. The process of producing cement including grinding and storage will not occur in the clinker site in Merrueshi but will be undertaken in Lukenya area, in Mombasa road where NCCL already has an existing cement production facility.
- **Bagging and Despatch:** Part of the cement will be sold in bulk and will be transported in specialized bulk road transporters. The rest will be bagged on site at a bagging plant, before being despatched to the customer.

Figure 6. Pyroprocessing system (Source: Devki Group of Companies, 2012)



2.2 Supplemental Studies

Chapter 3 to 8 below is the **supplemental environmental studies** for the proposed greenfield clinker plant and quarries which have been prepared in order to build upon the Environmental Impact Assessment study report originally prepared but which required additional studies specifically on **Ambient Air Quality; Waste Management; Labour and Accommodation; Water Balance; Transport Planning; and Terrestrial Ecology**. These specialist studies were lacking in the original **Environmental and Social Impact Assessment** report and in order to satisfy the IFC standards, the studies were necessitated.

DISCLAIMER

This document has been produced by EMC Consultants Limited for National Cement Company Limited (NCCL).

It may not be used by any person for any other purpose other than that specified without the express written permission of EMC Consultants Limited. Any liability arising out of use by a third party of this document for purposes not wholly connected with the above shall be the responsibility of that party who shall indemnify EMC Consultants against all claims costs damages and losses arising out of such use.

Note that these development permissions and permits have already been granted by the local and national regulatory bodies including National Environment Management Authority (NEMA), and Water Resources Management Authority (WRMA) among other institutions, based on the earlier submissions

If you have to print, we suggest you use, for economical and ecological reasons, double- sided print- outs as much as possible.

EMC Consultants Ltd, Shelter Afrique Centre, Upper Hill, Wing 3A, Kenya Tel. +254
020- 2102222 | Cell. +254 (0) 722 579 272 | Email. info@emconsultants.org
Website. www.emconsultants.org

Consultant Team:
Tito Kodiaga (Team Leader)

Chapter 3. TRANSPORT PLANNING STUDY

This chapter presents the findings, conclusions and recommendations arising from a Transport/Traffic Planning of the proposed clinker production facility and associated quarries (“the Project”).

3.1 Existing Transport Network

This section covers the existing conditions on the available relevant transport networks both on the infrastructure and the operation side as well as any relative plans for improvement that may have an effect on the transport generated by the plant. The related plant transport needs comprise internal movements of quarry materials, staff traffic and external movements to bring in raw materials and ship out clinker and other products as well as staff in and out for the factory operation.

3.2 Existing Road Classification System

The current road classification system in Kenya was developed over 30 years ago and has six road classes named from Classes A to E and a Special Purpose Road class. Each class is defined by the functional criteria related to administrative level of centres the roads connect. The system covers only 61,936km of the entire road network of 160,886km while the rest 98,950km are not classified.

Table 1. Road Classification in Kenya

Class	Description	Function
A	International Trunk Roads	Link centres of international importance and cross international boundaries or terminate at international ports or airports (e.g. Mombasa.)
B	National Trunk Roads	Link nationally important centres (e.g. County headquarters)
C	Primary Roads	Link provincially important centres to each other or to higher class
D	Secondary Roads	Link locally important centres to each other, or to more important centres or to a higher class road (e.g. divisional headquarters)
E	Minor Roads	Any link to a minor centre
SPR	G L R S T W	Government Roads Settlement Roads Rural Access Roads Sugar Roads Tea Roads Wheat Roads
U	Unclassified	All other public roads and streets

Source: Kenya Roads Board (KRB).

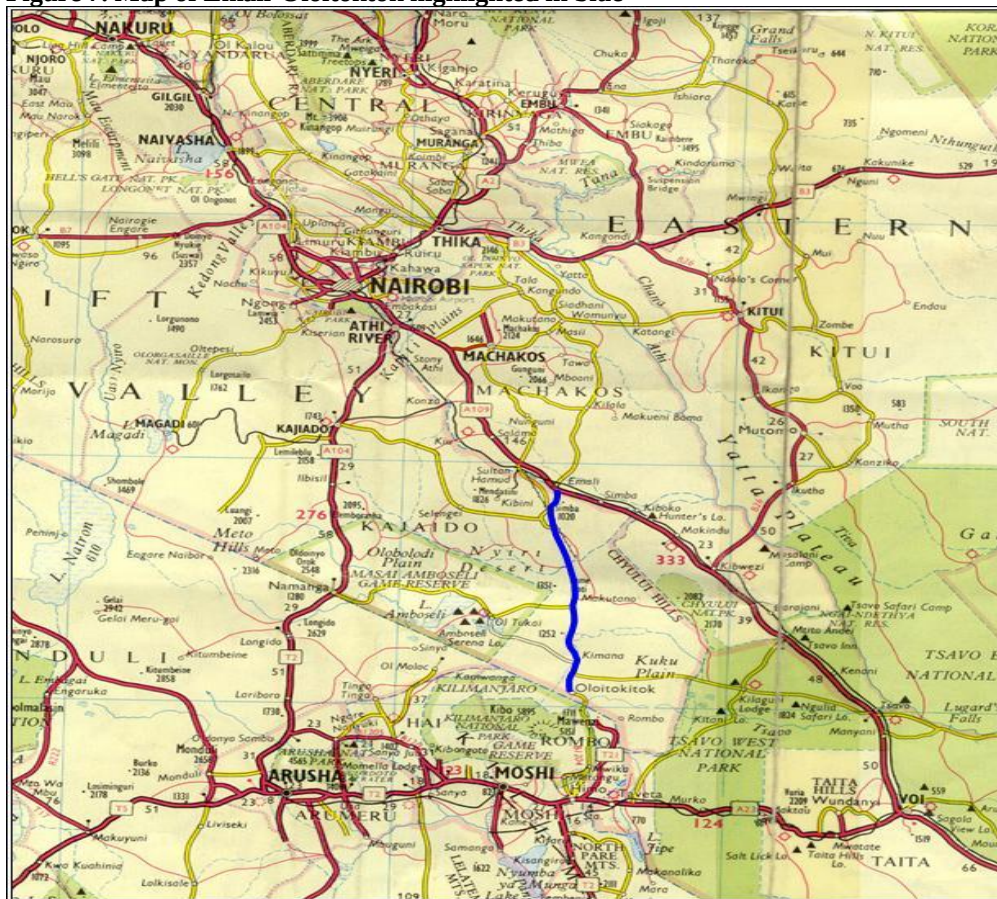
3.3 Highway Network System

The wider area highway network providing access to the clinker manufacturing and quarry sites appears in the following **Figure 7**. It comprises the highway sections of the Emali-Oloitoktok road respectively. The transportation of clinker to the cement plant for crushing and final production of cement will be via the Emali-Athi River Road where the cement production plant is located.

3.4 Emali-Oloitoktok Road

The proposed site is 36Km to the south of Emali Town and lies on the new Emali-Oloitoktok road, which is a single carriage way and not busy and connects the site to the busy Mombasa-Nairobi road at Emali Town. It connects the site further to the neighboring Republic of Tanzania via the Rongai and Lasset border crossings. The Emali-Oloitoktok road is a class C102 road according to the road classification in Kenya.

Figure 7. Map of Emali-Oloitoktok highlighted in blue



3.5 Emali-Oloitoktok Road Quality and Design

The existing road starts at Emali at the junction with the Nairobi-Mombasa Road, traversing an area of semi-arid bush country with low rainfall southwards to the town of Oloitokitok at the Kenya/Tanzania border. The road is a single carriageway, two-lane 6.5 m wide, bitumen surfaced road between Emali and Oloitoktok with 1.5 m shoulders on each side.

Four bridges, 31 box culverts varying in size from 2.0 m x 1.5 m to twin 4.0 m x 2.5 m, and several pipe culverts are part of the road infrastructure. The road is fairly new and was commissioned in 2011 thus only 2 years in age and has a lifeline of 20 years. The riding quality and physical characteristics of the highway network have been assessed through a relevant survey, which took place between 22nd-30th August 2013 and which indicate that the pavements are good and capable of accommodating truck weights of 30 tonnes.



Figure 8. Domestic Animals Crossing on Emali-Oloitoktok Road



Figure 9. Emali-Oloitoktok Road

3.6 Emali-Athi River Road/Mombasa Road

The A109 international trunk road (Mombasa Road) links the portal city of Mombasa to Nairobi, the Kenyan hinterland and neighboring countries like the Democratic Republic of Congo, Uganda, Rwanda and Burundi. Traffic volumes passing through the highway were obtained

from the Ministry of Transport and Infrastructure.

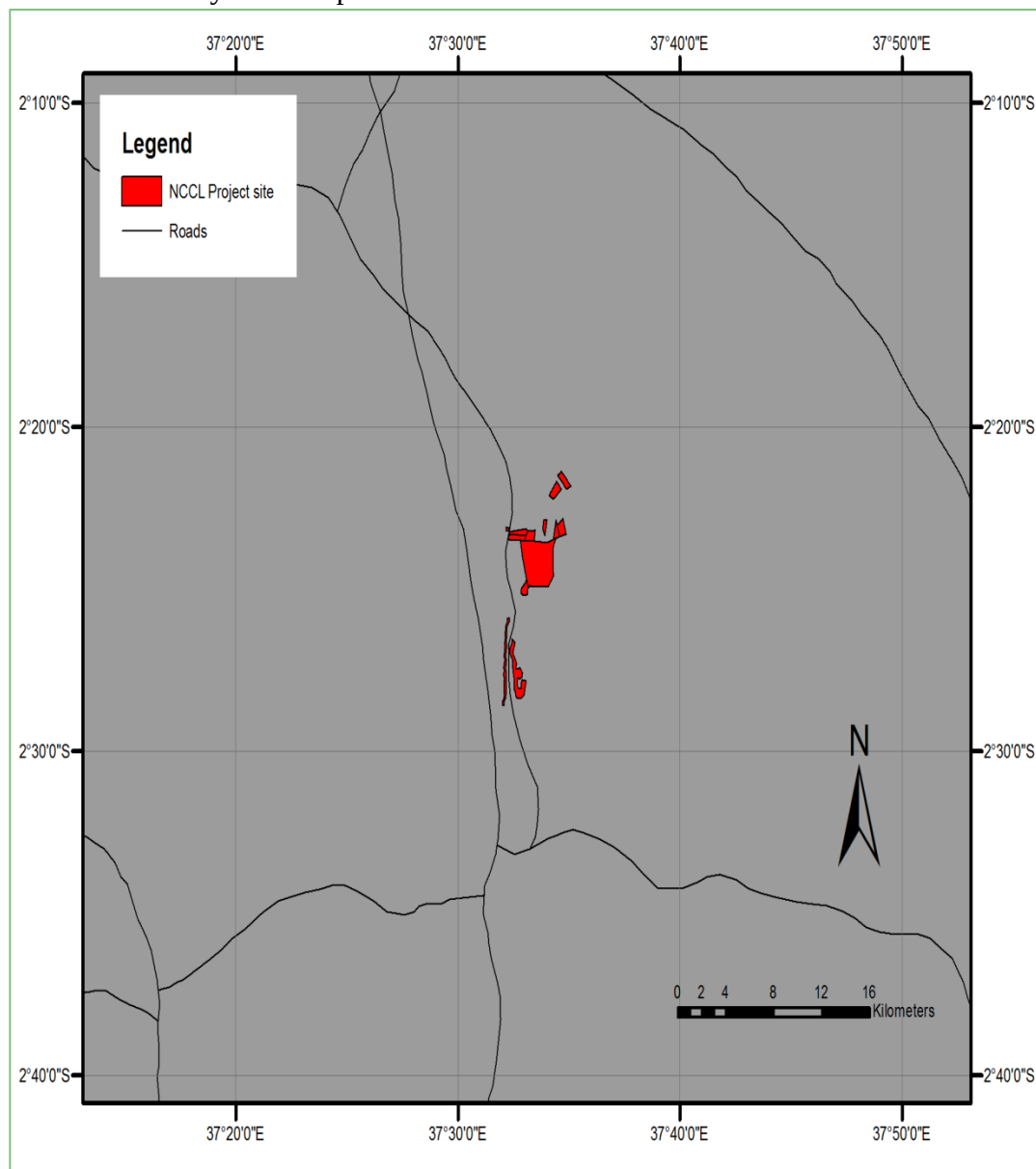


Figure 10. Map of road networks in the project site

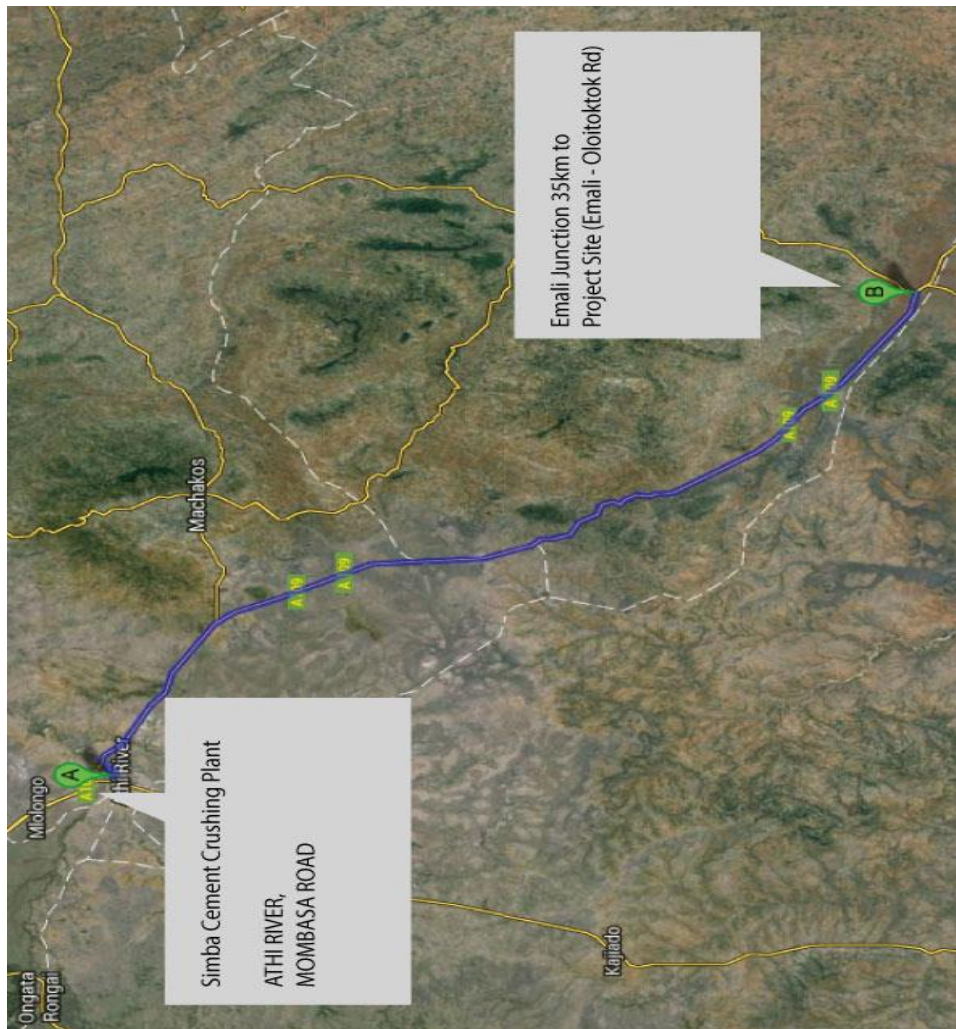


Figure 11. Mombasa Road (Class A) to Emali Junction (Class C)

3.7 Traffic Study

Traffic on the Emali-Athi River Road (A109) and Emali-Oloitoktok Road (C102) was studied on the basis of historical traffic data obtained from the Ministry of Transport and Infrastructure. The latest road traffic on the A109 traffic counts that could be obtained were 24hour (06:00am to 7:00am) and included traffic volume composition information to (among other parameters) establish the heavy vehicle traffic share participation. Seven consecutive day counts were carried out to ensure better accuracy in the calculation of Average Daily Traffic (ADT).

Throughout the study, vehicle classes contained in **Table 2** below are recognized. While they are based upon the Ministry's system of classification for road counts, an extra category of vehicles has been added in the Light Good Vehicle (LGV) class, namely *matatus*. This class has become broader over the years as *matatus* have come to include the 3-ton light trucks that are built with a bus body. The class is usually combined with LGV into a heterogeneous mix of vehicles from 0.75 – 3 metric ton carrying capacity. These are often counted separately in view of their crucial role in public transport.

Table 2. Description of vehicle classes

Vehicle Class	Description
Cars	Sedans, 4x4, and station wagons with up to 9 passenger seats.
Light Goods Vehicle (LGV)	Pick-ups, vans, and other goods vehicles of up to 1.5 tons carrying capacity (goods vehicles of less than 1,524 kg unladen weight).
Matatus	Passenger service vehicles of 9 – 25 passengers.
Medium Goods Vehicles (MGV)	Two-axle trucks, including some light tankers (over 1,524 kg unladen weight)
Heavy Goods Vehicles (HGV)	Multi-axle trucks and truck-trailer combinations. This is also a heterogeneous category as there is a multiplicity of configurations. In some studies oil tankers are counted separately in view of the notorious problem of exceeding axle weights and in order to determine competition from the oil pipeline (see later). A separate sub-category was adopted for oil tankers, which are all HGV carrying bulk liquids.
Bus	Vehicles with seating capacity exceeding 25 seats.

The traffic volumes counted reach up to an average of 309 vehicles (Emali-Oloitoktok) per day and 6,224 (Emali-Athi River) as shown in table 3 and 4 below. The percentage of truck traffic has been measured and does not even constitute 1% of traffic flows by vehicle type and indication that this route is not busy in terms of truck traffic or any other form of vehicles for that matter.

Table 3. Average Daily Traffic Flow by Vehicle Type along Emali-Oloitoktok Road

Car	L. Goods	Matatu	M. Goods	M. Goods-Tanker	H. Goods	H. Goods-Tanker	Bus	Total
24	152	69	39	2	7	0	16	309

Table 4. Average Daily Traffic Flow by Vehicle Type along Emali-Athi River Road

Car	L. Goods	Matatu	M. Goods	M. Goods-Tanker	H. Goods	H. Goods-Tanker	Bus	Total
1277	1215	1224	521	14	1544	101	328	6224

The results indicate that the composition of vehicles on all census sites for through traffic varied in Emali-Oloitoktok road but the general pattern is that the predominant traffic class for the road is the LGV followed by matatus. When the Light Goods Vehicles are combined (LGV = V + M + LGO), this category becomes the predominant traffic class.

From the table above, it can be seen that the percentage for the Heavy Goods Vehicles category is less than 5%.

On the Emali-Athi River road, the results indicate that the composition of vehicles on all census sites for through traffic varied and the predominant traffic class for the road is the Heavy Goods Vehicle followed by cars. From the above Table, it can be seen that the percentage for the Heavy Goods Vehicles category is less than 25%.

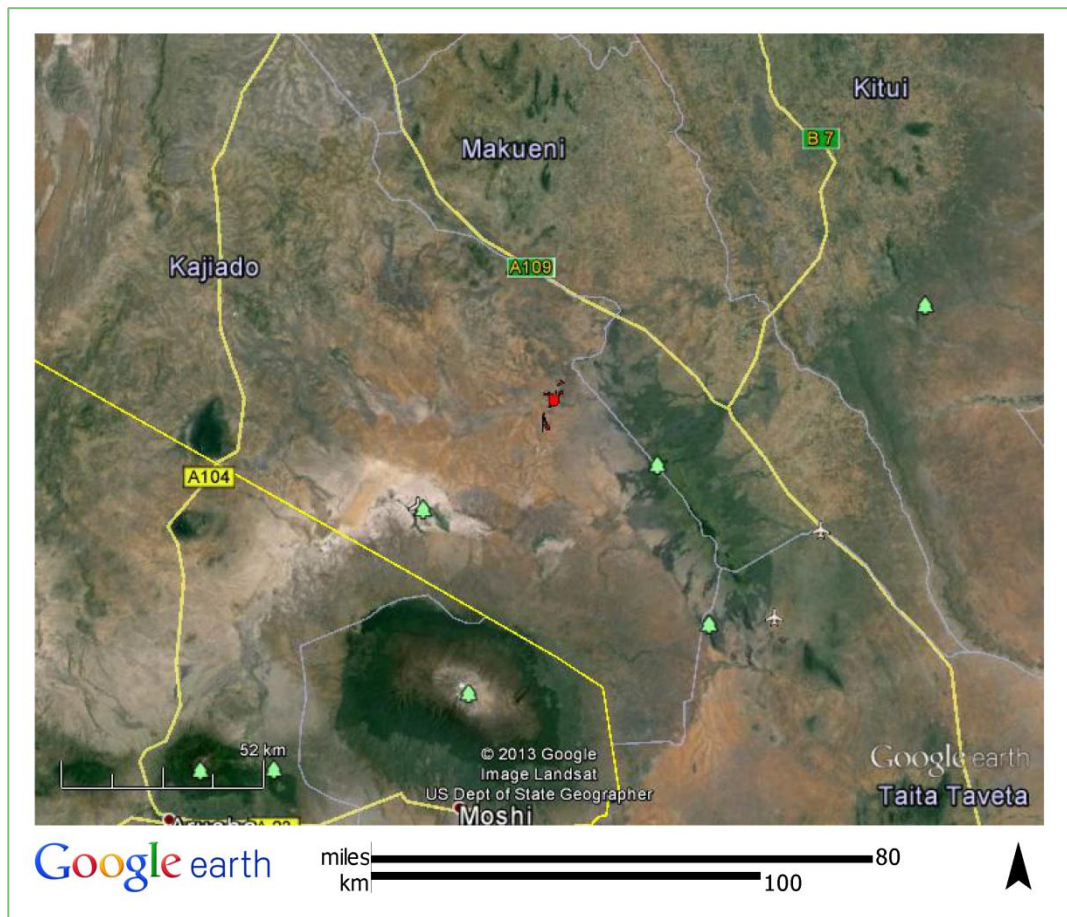


Figure 12. Road network aerial view

3.8 Plant Site Transport Infrastructure

Currently access to the plant area is achieved through the main road (Emali-Oloitoktok) via a left turn and does not go through any village hence there is clearly no difficult connection for heavy vehicles both from the geometric and road safety point of view.

Access to the area between limestone quarry locations and the clinker manufacture plant will be via paved cabro routes that will be constructed by NCCL. The limestone quarries are within the same location as the clinker manufacture and in effect, hence no need for any auxiliary connection. Movement will be limited within the project site hence minimizing impacts related to traffic movement over long distances.

Truck traffic inside the plant will vary according to production requirements but the internal road network should be designed as to be able to accommodate demand without any problems. Truck parking spaces will be provided according to relevant needs, which will be established during the plant design phase.

3.9 Local Movements

It is estimated that approximately 500 (contract employees) will be working at the plant during construction phase, another 400 during equipment installation phase and approximately 300

during the project operation phase. The construction and installation phase will take a period of **28 months** in total. Local workers recruited from the surrounding community will use public transportation to access the plant while resident workers will not need transport because the workers accommodation camp is opposite (across the main road) the clinker production and quarry sites.

3.10 Longer Distance Plant Access / Egress Needs

The production of 3,300 tons of clinker per day at the proposed site will necessitate movements of 25-30 ton trucks. In order to supply the factory with raw materials it is estimated that 750 tons of freight will be entering the plant per day – the equivalent of approximately 30 truck movements per day (30 one-way trips will be 60 round trips per day). This will be specifically for the trucks bringing in coal from the port of Mombasa.

From the quarry/mine to the crusher, 250 trips per day will be made by a 25-ton truck but this is within the quarry site where the client will construct paved cabro roads to facilitate easy movement of trucks and keep down dust emission related impacts.

From the quarry site (Merrueshi) to Lukenya, clinker will be transported by approximately one hundred -30 ton trucks, which will make a total of approximately 150 trips from the clinker plant to the cement production plant, which is approximately 138kms making a total of 300 round trips.

Other materials like iron ore, bauxite, sand among others will necessitate the use of fifteen, 25 ton trucks per day (one way trip) which will be 30 round trips.

Thus along the Emali-Oloitoktok road there will be: 60 round trips for coal supply; 300 round trips to the cement plant in Athi River; and 30 round trips for bauxite supply hence 390 round trips per day or one truck every 3.7 mins.

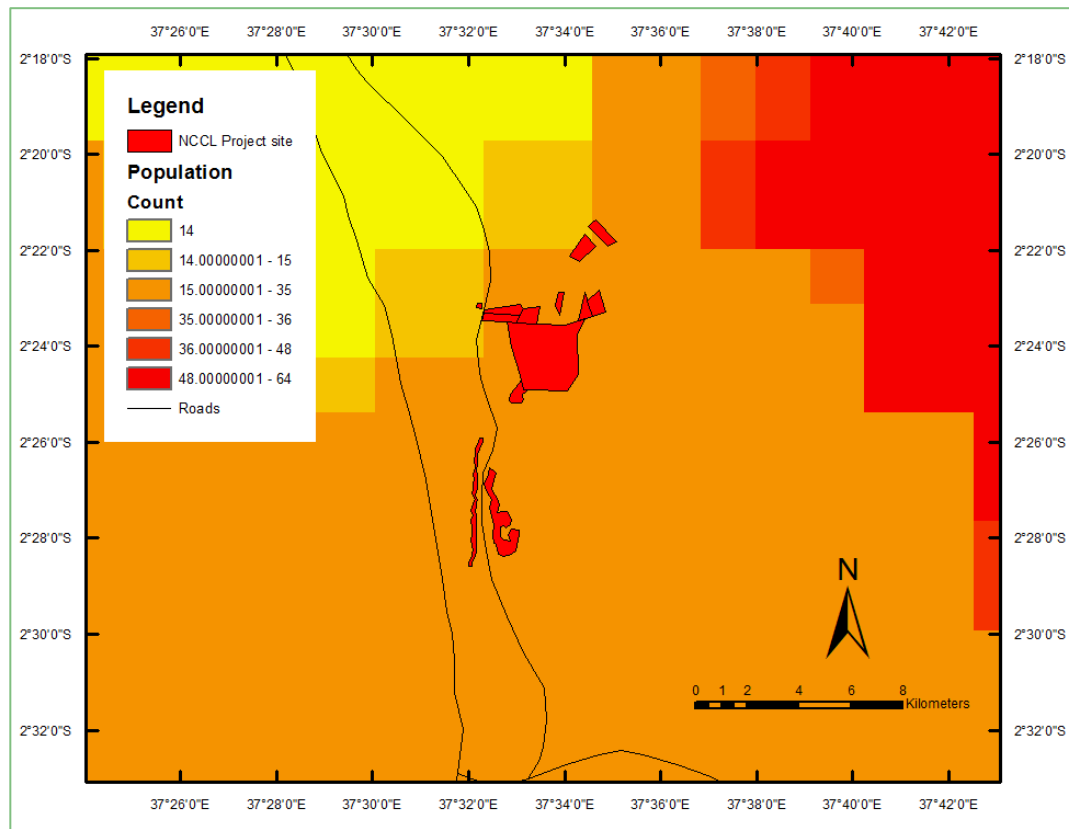


Figure 13. Population Density

3.11 Impacts to the Highway Network

Pavement Loading

The impact on pavement loading to the roads may, however, be more significant. Assuming the truckloads per day as calculated, which are fully loaded, inbound per day along Road A109 and C102.

This represents a percentage proportion. The accumulative additional axle loading over a sustained operational period is relatively significant. The overall impact of the construction traffic during the construction period translates to advancing the need for pavement rehabilitation and improvement. This situation is the worst-case at point of turning to the proposed plant from the main road.

The effect on pavement loading and subsequent advance of any rehabilitation programme should be mitigated after completion of construction. Such mitigation and associated costs would need to be discussed between management and the Kenya National Highways Roads Authority (KeNHA).

The present national highway road (C102) to Emali/Oloitoktok passes a few meters away from the plant site. The road (C102) would have to be realigned and redesigned to accommodate the vehicles, which shall be turning to and from the plant with more emphasis on heavy traffic

during construction and operation. The KeNHA would have to be consulted to realign the road and provide the design for access junction to the proposed clinker manufacture site.

The construction traffic impact is moderately severe, the extent is localized, the duration is long term, it will definitely occur, its significance is moderate, and the degree of certainty is probable.

The impacts of the additional traffic generated by the plant on the highway network will be moderately significant especially on the Emali-Oloitoktok road which is less busy and experiences very little traffic. Further, the Emali-Oloitoktok road is sparsely populated as shown in **(figure 13)** with settlements away from the main road hence the nuisance factor of increased heavy vehicle traffic on this road is not acutely significant.

The Emali-Athi River Road is part of the Nairobi-Mombasa Road and classified as an international road (Class A1) and is capable of accommodating all forms of traffic because it is built to international standards. This is a busy road section since it serves as the gateway to Uganda, Rwanda and Burundi.

It appears that the impacts are negligible on all highway sections. Of course this is partly due to the fact that no traffic is going to use local roads.

3.12 Conclusion

It is recommended that the effect on pavement loading and subsequent advance of any road rehabilitation program should be mitigated after completion of construction. Such mitigation and associated costs would need to be discussed between NCCL and KeNHA.

Agreement would need to be reached regarding mandates and responsibility for the roads rehabilitation programme for the point of turnoff to the proposed clinker site.

It is recognized that traffic supplying raw materials to the plant is envisaged to branch off C102; there shall be need for design approvals for adequate deceleration lane for traffic towards the site off Oloitoktok bound lane and acceleration lane to accommodate the Lorries that have off loaded raw materials.

Provide adequate parking space within the plant to avoid trucks parking along the highway an issue that could lead to road accidents.

Accommodation, ablution and toilet facilities will have to be provided for truck drivers and their mates.

Drivers and mates may be idle while waiting to unload or pick-up materials thus attracting prostitution and contributing to the spread of HIV/AIDS and other communicable diseases. The area may become a hot spot for prostitution, as is the case with Mlolongo area another truck transit stop over along Mombasa road. Hence awareness creation on behavior change on spread of HIV/AIDS and communicable diseases spread will be initiated by the project in collaboration with the Ministry of Health (MoH) and local Non Governmental Organizations (NGOs).

Chapter 4. WASTE STUDY

This chapter presents the findings, conclusions and recommendations arising from an assessment of waste management of the proposed clinker manufacture facility and associated quarries (“the Project”).

4.1 Raw Material Use and Waste Production

1. The bulk of the raw materials used in the cement manufacturing process will be provided directly from the limestone quarries within the project site acquired by NCCL under a 100 year long lease.
2. Available information indicates that the company has thoroughly investigated the nature of the raw material reserves and that there should be no issues associated with the use of in appropriate raw materials leading to significant emissions to air from the process.
3. Further, on line testing in the production process will ensure that no unsuitable materials will enter the process. The process produces very little waste and that which is produced will be recycled back into the process.
4. Secondary raw materials will be received from elsewhere, brought to the site by bulk road container. The sources of these raw materials will be from both within and outside the country, necessitating the use of the Mombasa port.
5. Other materials will also be used in the process as consumables, mainly for the maintenance of the installation. These will not be used in bulk and therefore are not expected to have a significant impact on the environment during normal operation.
6. The use of consumables will involve the use of a relatively small volume of hazardous materials, including oils, particularly for maintenance. As a backup, diesel will be used in order to generate electricity. This will be stored in fuel tanks on site on standby.
7. There is no potential impact during normal operations from any of these materials; however, there is a potential for releases during accidents and emergencies. Appropriate response to preventing and minimizing impacts of these substances is described in the Environmental Management Plan (EMP).

4.2 Raw Materials Used in Limestone Mining Activities

Limestone

NCCL has acquired land with limestone deposits on long-term leasehold basis in Kajiado. The total area of land measures around 2,200 Acres. As the clinker manufacturing facility is being constructed on this area, the availability of limestone will be alongside the facility.

The geological appraisal of the limestone prospect undertaken with core drilling in about one third of the total area has revealed that the prevalent grade of limestone is of high quality. The area has about 90 million Tonnes of limestone reserve to sustain rising of 1.5 million MT of limestone to produce 1 million Tonnes of clinker for about 60 years.

The limestone found in the area is essentially white crystal in colour. The grade of limestone prevalent in the area is of high CaO (*Calcium Oxide*) content - 40% to 53% and low SiO₂ (*Silica*) – 3% to 14 %, as well as low MgO (*Magnesia*) – 0.12% to 2.5% which is well suited for manufacture of cement. Due to lower iron and aluminium content, blending of bauxite and laterite has to be done. The proximity of the source of limestone shall enable NCCL to minimize expenses on transportation of limestone to the manufacturing facility.

Bauxite and Laterite

Approximately 9,900 MT of Bauxite and laterite will be required for the plant operation and will be sourced at a distance of 100 kilometres from the site.

Coal

The coal will be imported from South Africa. The requirement of coal for production of 990,000 MT of clinker will be around 148,500 MT per annum. Based on the progress of the project necessary contractual arrangements will be made with prime suppliers of coal from South Africa.

Water

At the clinker manufacturing facility, water is required for construction purposes and during the operation stage for cooling and general purposes. Two boreholes with capacity of 16 Cubic Metres per hour and 20 Cubic Metres per hour respectively have been drilled at the site and one of the boreholes has been made operational and the other will be made operational at the appropriate time as required.

Table 5- Raw Materials Used (Tonne/year)

Material	Quantity per annum
Coal	148,500 MT per annum
Bauxite and Laterite	9,900 MT per annum
Water	400 cub metres per day

4.3 Materials Use And Waste Management

Construction and Operation Phase

The majority of the waste generated during the construction phases generally arises from the demolition of existing structures (above ground and sub-surface), site levelling and excavations. Since there are no previous structures at the proposed site, this will not be a source of waste.

The most significant waste type that is generated by the quarry operations is overburden and waste rock. These waste types will be temporarily stockpiled before being returned to the pits as part of the reclamation process. Overburden and topsoils will be kept separately for further use during reclamation activities.

Waste generation will arise from earth moving and construction activities. Construction waste generated will include inert fill and waste building materials, steel, metals, wood, cardboard, paper, oils, hazardous wastes and general wastes.

Soil from site levelling and excavations will be reused for final landscaping in the final phase of construction works.

Waste produced when operating or maintaining the equipment and vehicles will be segregated, stored in designated places and removed off site by appropriate waste contractors.

There are several measures recommended to minimize waste handling problems:

- Topsoil should be stored separately and covered to enable its reuse for landscaping;
- Waste storage and control procedures should be introduced to ensure that wastes are identified and stored correctly, in order to prevent the escape of polluting materials;
- Areas of ground become exposed and disturbed during construction. This increases the potential for soil erosion and could potentially result in an increase in the sediment load of waters leaving the construction site. Even though the plant site is level and thus, the potential for water flowing across the site to cause significant soil erosion is low, to prevent impacts from runoff during land preparation and gradual plant construction the following measures are foreseen:
- Excavations' face will be kept minimal to avoid the exposure of expanded surfaces to natural conditions; (b) surface runoff collection will be implemented through temporary drainage grooves and sedimentation ponds to avoid their direct discharge to the natural receptor (i.e. River Merrueshi).

- Appropriate measures will be employed at the construction site to reduce the risk of potentially polluting materials leakage. In particular, polluting materials such as oils, fuels and chemicals will be stored in dedicated storage areas, complete with spillage protection and working procedures, which ensure that these materials are handled correctly. Further, any hazardous materials will be stored in areas with secondary containment.
- The waste production per year is low. The largest volume of the waste, the waste refractories, will be sold to recycling companies in Kenya and will not be recycled back into the process. Therefore, there will be no need to dispose of this waste off site. All other wastes are incidental and are produced as a result of the operation and maintenance of the process and are not 'process wastes'.
- The project will not need a bleed in the process to enhance limestone or additive qualities hence bleed waste and disposal is not expected to be an issue.

4.4 Proposed Mitigation Measures:

Construction activities have the potential to release pollutants to the ground (topsoil, subsoil and natural strata) and groundwater. Potential sources of pollution include: importation of pollutants already present within the materials to be used for filling and site levelling operations.

- Pollutants could be introduced onto the site and then leach from the imported material into the groundwater; accidental release of fuels, oils, chemicals, hazardous materials etc., to the ground, especially in the construction lay-down area, during delivery, storage, handling and use, for example, re-fuelling, maintenance activities, etc. with subsequent leaching to groundwater; accidental release of liquid wastes during storage, handling and removal, with subsequent leaching to groundwater; accidental discharge of sanitary wastewater to ground and groundwater from the workers camp and effluent treatment plant; and discharge of pollutants in water used for plant, equipment and vehicle washing to ground and subsequent leaching to the groundwater.
- Measures will be employed to reduce the risk posed by the potential sources of pollutants listed above. All possible steps will be taken to prevent materials being imported onto the site, which are already polluted.
- Potentially polluting materials, such as fuels, oils, chemicals and associated liquid waste materials, etc. will be stored in dedicated, segregated storage areas, with spillage protection and appropriate environmental security measures to prevent accidental release to ground during storage. In addition, appropriate working procedures will be adopted to minimize the risk of accidental release during delivery to and removal from the storage areas.
- Working procedures will ensure that these materials (raw and waste) are handled correctly. Working procedures will seek to prevent accidental release during the use of

these materials, for example, vehicle re-fuelling and plant maintenance, especially with regard to waste oil. Procedures will be adopted to minimize the potential for accidental discharge of pollutants during the washing down of plant, equipment and vehicles. Sanitary wastewater will not be discharged to either ground or groundwater.

- Filter dust disposal is also an important issue because of possible large quantities. Establishment of filter dust handling procedures is included in the EMP.
- Hazardous materials management and disposal techniques should be established. At present the routes of management and disposal of hazardous materials has not yet been decided.
- Identification of waste minimization and recycling options of all incidental wastes should be undertaken. It will not be enough to ensure appropriate disposal only.

4.5 Workers Camp Waste

Domestic type wastewater from the workers camp will be collected through septic sewage system, which will be in all the accommodation units and the canteen as well as administration block. Design details of this plant were being discussed at the time of writing and will comply with the standards for design of effluent disposal in Kenya.

4.6 Dumpsite

Solid waste generated from the plant site, including ancillary buildings, will primarily be domestic and industrial non-hazardous waste, but will include hazardous waste. All domestic waste will be disposed via a private domestic waste collection company. A comprehensive Waste Management Plan (WMP) will be developed for the project that will detail more accurate quantities of waste generated, how it will be disposed, waste tracking and monitoring.

NCCL has committed to the principle of the waste reduction at source, followed by recycling and ultimately safe disposal, where no options for prevention or recycling exist.

4.7 Mitigation Measures for Fuel Spills

Above ground fuel storage facilities will be installed to maintain a minimum of 4 weeks fuel supply – equivalent to 3Ml of diesel line. The storage facilities will be bunded, with hard surfaces and re-fuelling taps protected against accidental collision. Facilities will also be established to ensure that any spillage during tank refilling can be captured and prevented from being discharged to the environment.

4.8 Waste Impact Assessment

Extent

Possible impacts associated with the proposed waste handling associated with the plant will be local in extent and limited to the progressive use of airspace in the project area. No significant impacts are associated with the temporary storage of overburden and waste rock, and the planned implementation of a robust reclamation programme, will reduce the threat of impact further still.

Duration

The duration of the impact will be long term and follow the life of the plant. The domestic waste

landfill within the quarry will be permanent but impacts associated with the landfill will be limited, if at all.

Intensity

The intensity of the impacts associated with waste management is likely to be low.

Probability

The manifestation of significant impacts as a result of waste generated during expanded operations is considered improbable.

Impact significance

Given the above impact significance is considered to be low.

4.9 Mitigation Measures

A waste management plan will be developed for the plant operation and mitigation will take the form of the implementation of that waste management plan. The waste management plan will satisfy Kenyan regulatory and IFC requirements (specifically the IFC Framework directive on waste). The waste management plan will specify procedures for:

1. Minimizing waste at source
2. Segregation and temporary storage
3. Re-use and recycling
4. Final disposal

4.10 Hazardous Waste Management

Hazardous Materials

As with other materials, there will be a relatively small volume of hazardous waste materials produced. The company will be required to as part of the Waste Management Plan include specific measures for managing hazardous wastes generated with clear commitments on the same. The same mitigation measures for other hazardous materials apply. In addition, the company must ensure that all waste contractors have the appropriate licences and that all waste are disposed of appropriately.

Materials spillages, especially oils and petroleum products, pose a risk to surface and ground water quality. In general terms, this is an area of concern and a spill control/prevention facilities at the specific fuel storage facilities will be required prior to commencement of construction and operation activities.

Re-fuelling, lubrication and topping up of oil including maintenance of machinery will happen within the dedicated maintenance and refueling areas.

Further, there will be need for establishment of proper refuelling facilities at the plant with the necessary hard surfaces, bund walling and spill drains and capture sumps will significantly reduce the threat of such spillages, despite the fact that significantly larger volumes of fuels and lubricants will need to be stored at the mine to provide for the increased vehicle fleet and equipment.

As part of the Environmental and Social Action Plan (ESAP) it is recommended that a full spill management plan be implemented at the plant. This spillage plan is to include the identification of all activities that have the potential to result in spillages of hazardous materials, and the development and implementation of operational procedures and facilities to:

1. Prevent spills
2. Ensure that when spills do occur that they are rapidly and effectively ameliorated
3. Reduce the potential for spilled material to enter the environment These facilities include bunding for storage tanks, filler connections and loading/unloading areas, consolidation of outdoor maintenance areas, sealing the floors of maintenance areas and the establishment of oily water separators at points of discharge of surface water runoff into the external environment. The implementation of these requirements will reduce the potential for spills to result in an impact on ground and/or surface water quality.

In terms of hazardous waste the dominant waste type in terms of quantity is used oil and oil-contaminated materials. These wastes will either be recycled (in the case of the used oil) or used as a fuel in the boiler. The disposal of used oil by using it as fuel is directly prescribed by the Kenyan regulatory authorities, but will be investigated for possible conflict with IFC requirements. In the event that there is a conflict the plant will discuss an alternative disposal strategy with the regulators, and implement that disposal option.

Fused mercury lamps constitute the most hazardous waste type but these are generated only in relatively small quantities and there is provision for the recycling of the lamps so that they do not need to be disposed.

Several options exist for the disposal of tyres and, a safe disposal option for tyres will be implemented including shredding and using the tyres as fuel. However, Kenya through NEMA has developed guidelines and regulations for management of waste tyres (Environmental Management and Coordination (Waste Management Tyre) Regulations, 2013 and the NCCL will ensure that waste tyres are disposed in accordance with these regulations.

Mercury containing lamps (mainly incandescent bulbs) will be minimized in terms of use and instead the project will use Compact Fluorescent Lamps (CFL), which do not contain mercury but are expensive.

Used batteries will be collected by recycling companies in Nairobi that have the capacity and are registered by NEMA to recycle used batteries.

Batteries that have become unserviceable are temporarily stored at the plant and will be recycled in future. Again, given that the plant will be relatively new, there are no transformers with PCB containing transformer oil.

4.11 Hazardous Materials Impact Assessment

Extent

The extent of impacts associated with possible spillages of hazardous materials is considered to be highly localized given that there will be effective controls at points of possible spillage as well as mechanisms for the rapid and effective rehabilitation of spillage should these occur.

Duration

The duration of such impacts would be short term in nature. Again, this is a function of measures to remediate rapidly in the event of a spill before the hazardous materials can impact on ground or surface water.

Intensity

Given the environmental sensitivity of surrounding watercourses the intensity of the impact were hazardous materials to be released into the environment would be severe. By ensuring that even in the event of a spill, that hazardous materials are not released into the environment the impact intensity would be low.

Probability

The manifestation of a significant impact on the environment in the event of a hazardous material spill is considered to be improbable.

4.12 Impact Significance

Given the above, the significance of potential impacts on the environment is considered to be low. However, it must be emphasized that this rating is contingent on the full implementation of the various spill control measures defined in the plant plan and supported by the implementation of the Oil Spill Prevention, Control and Counter Measures Plan that is included in the ESAP presented as part of this document.

4.13 Mitigation

To ensure that impact significance remains low a fuel spill prevention, control, and counter measures plan (SPCC) will be developed and implemented. The SPCC will include information and management interventions in respect of: The SPCC plan will need to be developed before restart of construction as it was clearly missing in the previous construction phase.

- Materials, properties, quantities, and containers;
- Safe practice in transporting materials;
- Spill responsibility;
- Readiness;
- Accidental release notifications, and protocols;
- Spill prevention;
- Spill control and countermeasures; and,
- Employee training.

4.14 Fuel Spill Prevention Plan

A Fuel Spill Prevention, Control, and Countermeasures Plan (SPCC) will have to be developed for the plant operation. The plan details procedures for ensuring that the potential for, and risk resulting from, accidental releases of potentially hazardous materials is minimized or prevented.

4.15 Waste and Ambient Air Quality Impact

Fugitive Dust Emission Impacts

- Quarry activities in general have a potential to create dust. Dust emissions may be mechanically generated, or windblown from surfaces. When in proximity to residential properties or other sensitive properties, dust emissions have the potential to cause higher than normal levels of dust deposition on surfaces. Over a period of time the cumulative deposition may result in a loss of amenity or, in more extreme circumstances, be a nuisance to residents.
- Although dust may include particles up to 75 µm in diameter, it is the larger particles of above 30 µm in diameter, which tend to deposit within a hundred metres of the source. In general it is these particles that have the most potential to affect local residents where properties are within range. The larger particles most capable of giving rise to a nuisance would be deposited relatively close to their source, whilst smaller particles travel further before settling to the ground. Due to these differences in dispersion across the range of particle sizes released, dust deposition rates fall markedly with increasing distance from the boundary.
- Often mechanical disturbance of ground surfaces within a site is a primary source of dust, for example as a result of vehicles travelling on unpaved areas. Wind blown dust may also arise from dusty hard surfaces or from disturbed ground. Materials handling such as loading and unloading operations may also release smaller amounts of dust. Dust emissions from blasting, although resulting in localised visible emissions, are infrequent and hence are generally negligible contributions to overall quarry emissions.
- Limestone will be extracted from the quarries and in each quarry there will be stockpiles of materials ready to feed to the clinker plant. These will be limited quantities of safety stocks of the blasted limestone/carbonate materials and excavated flysch/silica-aluminates material. These will be stored at the respective quarry benches and operating plateaus, ready for loading. The stockpiles serve the purpose of supplying the cement plant with all necessary quantity and appropriate quality of the raw materials, under sufficient quality control and safe operating conditions.
- Stockpiles at the quarries will be in the order of approximately 1 month reserves for the limestone and approximately 2 weeks reserves for flysch.
- All quarried materials will be transferred to the clinker plant for crushing under controlled conditions. This will prevent escape of dust emissions from the operations.

Materials will be transported from quarries by bulk road transporters. Since the materials will not have been crushed, the potential for dust emissions during transport will be limited. While it is right that the material itself will not be very dusty the transport on dirt roads will be a major dust suppression issue. However, dust emissions, damping down of materials will be undertaken.

- At the clinker site/plant the materials will undergo their initial stage of preparation of crushing and storage. In order to minimise dust emissions at crusher inlets, water curtains will be used. The raw materials are crushed and mixed (separately) so that their quality is constant. This is important to maintain control of the process and the cement produced from it. Crushing will take place in dedicated buildings where dust will be extracted to bag filters and noise reduced by enclosure of the crushing equipment within the building.
- All stockpiles will be stored undercover. No crushed materials will be stored outdoors.
- An iron source and bauxite are also required to make cement and these will be delivered to site from external sources and stored in silos. These materials will be needed in relatively small quantities.
- The Raw Material Preparation department will be equipped with all the necessary data logging (belt scales between reclaimers and hoppers, running times, availability of equipment, electrical consumption, etc.) required for plant operation.
- From the stockpiles the materials are transported to separate feed bins. The combined action of stacking and reclaiming achieves raw material pre-blending.

4.16 Mitigation

- The most frequently used dust mitigation measure is the use of water bowsers or sprays on haul routes and on minerals during loading operations. In particularly sensitive situations chemical dust suppressants or wetting agents may be added to improve dust control on haul routes or stockpiles where surfaces are likely to remain largely undisturbed.
- Maintenance and regular grading and compaction of un-surfaced roads will further reduce the potential for dust emissions, particularly in combination with periodic dampening.
- The hard-surfacing of semi-permanent sections of frequently trafficked haul routes will reduce dust emissions provided that the road surface is not allowed to become soiled.
- The sheeting of lorries, and wheel and vehicle washing can assist in the control of dust from site traffic leaving the site and are widely used to prevent environmental nuisance on local roads.

4.17 Assessment of Potential Effects

The limestone quarry permits include numerous measures to mitigate environmental effects including the following:

- The rocky area should be wetted before explosions and during drilling for crushing the massive rock, and
- Clean trucks should transport the inert materials with special care to clean the mud (the tires should be cleaned before the truck exits into asphalted roads; during transportation the trucks should be covered with covers that prevent material falling on the street and emission of dust.

Winds capable of transporting dust from the limestone quarry towards Merrueshi Trading Centre (the closest settlement) are limited to those from the north-northeast to east sector. With reference to the meteorological data it is evident that winds from this quadrant are relatively infrequent, occurring for only 25.5% of the time. However, given the distance of over 2kms to the nearest housing in Merrueshi Trading Centre, no discernible effect due to dust from the quarry is anticipated.

The prevailing northerly wind will carry dust to the south of the quarry towards Imbirikani Group Ranch. However, there are no properties in this direction for well over 60 kilometers, well beyond the range at which any effects would be observed.

4.18 Impacts to Surface Waters Associated with Operation of Quarries

1. Increase of sediment content in surface waters due to fugitive dust dispersion from the plant and quarries sites, as well as storm water direct discharge to River Merrueshi without prior processing.
2. Degradation of surface water quality due to process water direct disposal.
3. Degradation of surface water quality due to leakage of polluting materials.

Storm water direct disposal to River Merrueshi is not considered an option. Instead, storm water management in the plant will be undertaken through a network of ditches and/or internal road gutters (piping is usually avoided due to clogging), which will end up into the natural environment using natural contours.

Similarly, process water direct disposal to River Merrueshi is not considered an option. Water used for cooling of equipment will circulate in closed circuit and recycled and re-used back to the cooling system.

4.19 Other measures for the preservation of surface water quality

Storage of fuels used during the process of production in an enclosed building to minimize and/or avoid particulates and other polluting materials dispersion.

Tidying of the plant in order to minimize fugitive dust emissions. In particular, mechanical sweepers will be used to remove collected dust from the internal road network and respective gutters.

Incidents of polluting materials leakage during the operation phase (for example spillage of oils or spent lubricants during their transportation) will be immediately addressed to avoid migration to surface water. Polluted surfaces will be thoroughly washed and washings will be collected and disposed off as special waste.

With regard to quarries' operation, fugitive particulates consist an unusual impact of materials extraction procedure. However, in the case of the examined limestone, existing know how and mode of operation will ensure the minimization of particulates content migrating to surface waters. In particular, the following mitigation measures are foreseen:

- Quarrying face will be kept as minimal as possible.
- Gradual rehabilitation (through landscaping and planting) of the locations where extraction works have been completed.
- Storm water direct disposal to River Merrueshi is not considered an option during the operation of the quarries. Instead, storm water management will be undertaken through a peripheral ditch of adequate dimensions. Effluent will next be discharged to a natural receptor by means of an open ditch.
- Appropriate collection and transportation of potential polluting materials (e.g. spent oils, lubricants, etc.).
- Explosives will be used and water arising in the quarry area will, if any explosives are needed, contain significant amounts of ammonium components and can therefore not be discharged to any surface water(s), oil skimming will not remove the ammonium components.

Chapter 5.0 WATER BALANCE

This chapter identifies the adverse environmental impacts that may be caused by the construction; operation and decommissioning of the clinker manufacture and quarry on water (surface and sub surface), and, where possible, assesses the likely severity of these impacts based on current information. Measures to reduce the severity of the impacts identified are also proposed (termed “mitigation measures”). This chapter presents the findings; conclusions and recommendations arising from the impacts associated with water utilization by the proposed clinker manufacture and associated quarries (“the Project”).

IFC Performance Standard 1 (PS1) promotes need for (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client’s management of environmental and social performance throughout the life of the project. Performance Standard 6 (PS6) specifically addresses the need for biodiversity conservation and sustainable management of living natural resources

This section describes the baseline water situation (hydrogeology) in the project area including the surface water and sub surface hydrology as well as the impact of technology and processes on the water availability. This section also reviews the implication of water provision by the project to the local communities as part of overall social responsibility.

5.1 Geology

The geology of the area is composed of metamorphic rocks, volcanics and surficial deposits.

Proterozoic Metamorphic Rocks

The oldest rocks recognised in the area are of Proterozoic age and form part of the Mozambique Belt. They include both para and orthogneisses, including crystalline limestones, granulites, schists and pegmatites.

Kilimanjaro Volcanics

Onto the metamorphic rocks are the early eruptions of Kilimanjaro probably produced a broad basaltic shield which rapidly built up into the volcanic centres of Shira and Mawenzi, followed by the spectacular central volcano (Kibo) which formed from the more evolved lavas, including phonolites and nephelinites. The building of this large volcanic edifice affected the rainfall patterns. Eruptive products coupled with glacial material and reworked debris covered the surrounding plains, blocking or latering the drainage patterns and producing large lakes, later filled with Quaternary lacustrine and fluvial deposits.

South Chyulu Hills Volcanics

At some time in the late Pleistocene a sequence of mainly basaltic lavas erupted through a major NNW-SSE fissure system (extending from Mzima to Simba) producing an elongate shield, the Chyulu shield. Early eruptions included flooded tholeiites, and later basalts are typically alkali olivine basalts. The shield is capped with a spectacular ridge of relatively unconsolidated lava, spatter and cinder cones together with thick spreads of pumiceous pyroclastic deposits.

Kimana Formation

This volcano-sedimentary sequence overlies the Kilimanjaro volcanic. It comprises lower unit of clays, and unsorted coarse clastic fluvial deposits, many of lapilli size (probably reworked pyroclastics). The upper deposits are coarse, with angular vesicular basalts and pumice clasts supported in a matrix, indicating a debris flow origin.

Surficial Deposits

Much of the Chyulu-Oloitokitok area is mantled with a variety of pleistocene and recent superficial deposits. These are very varied and include reworked debris flows, lacustrine and fluvial deposits, together with residual sandy soils derived principally from the metamorphic rocks. Blocking and damming of drainage system established before the Pleistocene control the distribution of these deposits.

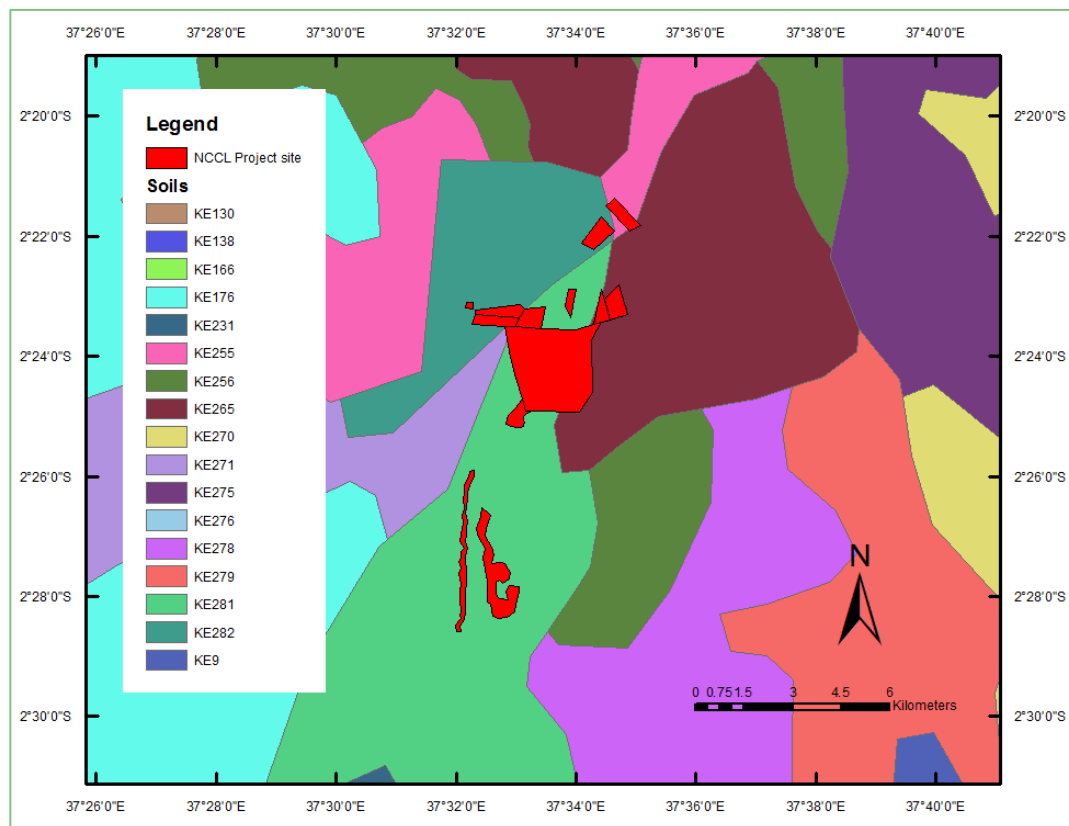


Figure 14. Soil Map of project area

5.2 Groundwater Occurrence

The mountain uplands serve as the primarily recharge areas with the valley bottoms as groundwater discharge areas. The hydrogeological environment of the area can be described as alluvial deposits, or an abandoned river valley and fractured metamorphic rock.

The alluvial deposits are derived from the deposition of sand and gravel from the nearest watercourse on a flood plain. Wells located in these highly permeable strata bordering streams

produce large quantities of water, as infiltration from the streams augments groundwater supplies.

Abandoned valleys are valleys no longer occupied by streams that flowed in them. Although they may resemble watercourses in permeability and quantity of groundwater storage, their recharge and perennial yield (that is the rate at which water can be withdrawn perennially under specified operating conditions without producing an undesired results) are usually less. Wells drilled in such formations may yield a good quantity of water, in other places they are relatively thin and have limited productivity.

Solid metamorphic rocks are relatively impermeable and hence serve as poor aquifers. In order for groundwater to occur, there must be secondary openings developed through weathering, fracturing or faulting. In general, the amount of fracturing in crystalline rocks decreases with depth. Saprolite overlying the altered metamorphic rock acts as a reservoir, storing infiltrated water and releasing it to wells intersecting fractures in the underlying crystalline rock.

The probability of obtaining a high-yield well in crystalline rock areas can be maximized if drilling takes place in an area where fractures are localized. The degree of alteration decreases progressively downwards until fresh, unweathered rock is reached. The underlying unweathered bedrock is rarely a significant aquifer.

Even where fracturing may produce somewhat higher localized permeability the available storage in the fresh rock is negligible, and a borehole drilled into fresh bedrock will draw on the storage of the overlying weathered zone aquifer.

Well yields in some areas of crystalline rock are greater when the wells are located on valley bottoms. Many of the valley bottoms probably developed along fracture traces.

Groundwater occurrence and distribution in volcanic terrain is influenced by primary and secondary porosity. Primary porosity is formed by pore spaces in the grains during volcanic eruptions. Secondary porosity is formed by cracks and fractured after the rocks have been formed. Groundwater occurrence could also be encountered on the old land surfaces, where new volcanic episodes lay the lava over an older surface.

Boreholes drilled within these terrains have variable yield depending on the location and intersection of weathered surfaces with respect to volcanic episodes. The aquifer is replenished from two possible sources. One is the direct precipitation infiltrating through the regolith, and the second is the lateral recharge from the confined aquifer stretching from higher ground away.

5.3 Sub Surface Water Availability in Project Area

Table 6 below shows the ground water potential in the project area including the census of existing sub surface water points based on an analysis and reference documents prepared by the Water Resources Management Authority (WRMA).

Table 7 further shows the preliminary inferred hydrogeological environment within the project area.

The boreholes in the area yield a range of 4.2 to 9.9 cubic metres per hour. For a recommended 10 hour pumping regime, this gives a yield of 42-99 cubic metres.

Table 6. Potential of the groundwater in the area-Existing boreholes in project site

BH No.	Owner	Location	Map No.	Sheet	Comp. Date	Total depth (M)	Water Struck Level (M)	Water Rest Level	Yield M ³ /h
C 11413	Mbirikani Ranch	Mbirikani	174/2		13/6/1996	100	69	70	9
C 5053	Fr J.M.Davies	Merrueshi	174/3		3/4/1982	100	84	6	9.9
C 3	D.W.D	Emali	173/2		1/7/1938				
C8520	RDF	Itital	182/4		1990	62	14,22	8.58	4.2
C1044 8	KWS	Mbirikani/A mboseli	181/1		1993	96	17,32	16.40	7.2

Table 7. Preliminary inferred hydrogeological environment

Owner	Total depth (M)	Water Struck Level (M)	Water Rest Level	Yield M ³	Inferred geological environment
Mbirikani Ranch	100	69	70	9	Recharge zone, volcanics
Fr J.M.Davies	100	84	6	9.9	Recharge zone, volcanics
RDF	62	14,22	8.58	4.2	Discharge zone, Basement
KWS	96	17,32	16.40	7.2	Discharge zone, Basement

Sub Surface Water Quality

The boreholes that have been drilled by NCCL for use in the clinker manufacture process and for domestic use have been tested to ensure that it is safe for drinking and meets the WHO standards for the same. **Annex 1 and 2** shows the water quality analysis of the 2 boreholes conducted and principally the findings indicate that the water is hard and saline, has a high fluoride content more than 1.5mg/l which is the recommended as well as the sulphate content. The water is thus not satisfactory for human consumption without treatment. NCCL will have to treat all water from the boreholes prior to using for domestic consumption to ensure safety and reduce the content of sulphate and fluoride to recommended levels.

Surface Water Availability in Project Area

The project site and it environs has different sources of surface water bodies and include the Merrueshi River and a number of man made dams and pans of different capacities. The Merrueshi River also known as Eslenkei or Kiboko depending on where it is crossing is the only natural surface water body and is located about 1 kms from the project site. To the west the river is called Eselenkei, near the site, it is Merrueshi and to the far East it is Kiboko River. This is a seasonal river that only flows during the rainy season.

The table 8 below also shows the quantity of exploitable water in dams and pans and capacity in the project area.

Table 8. Quantity of surface water Availability

Division Name	Name of Dam/Pan	Dam Location	Capacity
Imbirikani	Olng'osua	Imbirikani	15000m ³
	Alngarama 1	Imbirikani	25000m ³
	Alngarama 2	Imbirikani	25000m ³
	Ndaraja/Emulgoi	Imbirikani	25000m ³
	Oltiasika	Imbirikani	25000m ³
	Olpiri	Olbili	20000m ³

5.4 Quarrying Activities Water Demand

The clinker manufacture process as well as limestone quarrying activities will require water for different purposes. During the quarrying activities, water will be required principally for the purpose of minimizing dust emissions emanating from the quarry works this will also be a requirement when the trucks are moving limestone from the quarries to the clinker manufacture plant area. NCCL will further lay paved cabro type of bricks on all access roads (paved roads) within the quarry site used by trucks as a mechanism to reduce fugitive dust generated by truck movement hence reducing water demand.

5.5 Clinker Manufacture Water Demand

During the process of clinker manufacture, different type of equipment will require water ostensibly for cooling the machines. These include water for clinker cooling; water for cooling vertical mill exchangers, kiln bearings, compression heat exchangers, and lubricant heat exchangers among others.

The water demand for the clinker production including the sprinkling to manage fugitive dust is estimated at 200 cubic metres per day. The water used for cooling during clinker manufacture will be recycled and re-used in cooling the machines hence minimising water demand.

5.6 Accommodation Water Use Demand

The workers accommodation, canteen and administration block will also require water for different purposes including; cooking and washing, washrooms and toilets, general cleaning, drinking among others. The water demand for the workers accommodation camp including the canteen and administration block is estimated at 200 cubic metres per day.

5.7 Source of Water for Project

NCCL has already drilled 2 boreholes in the project site for use during the construction and operation of the project. The Water Resources Management Authority (WRAMA) has approved these boreholes and certified them thus giving NCCL permission to extract the water for use in the site. The boreholes have a capacity of 16.3 and 17 cubic metres per hour.

Bearing in mind that the clinker manufacture plant and workers accommodation camp will require 400 cubic metres per day (200 cubic metres each) against the potential of the boreholes to generate over 300 cubic metres per day, there is sufficient water for this project without adversely affecting the sub surfaces water resources.

5.8 Impact of Technology and Process Selection on Water Resource Management

Quarry activities in general have a potential to create dust. Dust emissions may be mechanically generated, or windblown from surfaces. When in proximity to residential properties or other sensitive properties, dust emissions have the potential to cause higher than normal levels of dust deposition on surfaces. Over a period of time the cumulative deposition may result in a loss of amenity or, in more extreme circumstances, be a nuisance to residents.

Impacts to surface waters associated with the operation of the clinker plant and quarries refer to:

- Increase of sediment content in surface waters due to fugitive dust dispersion from the plant and quarries sites, as well as storm water direct discharge to River Merrueshi without prior processing.
- Degradation of surface water quality due to process water direct disposal.
- Degradation of surface water quality due to leakage of polluting materials.
- Storm water direct disposal to River Merrueshi is not considered an option. Instead, storm water management in the plant will be undertaken through a network of ditches and/or internal road gutters (piping is usually avoided due to clogging).

Similarly, process water direct disposal to River Merrueshi is not considered an option. Water used for cooling of equipment will circulate in closed circuit passing through a settlement tank of 200 m³ capacity and treated effluent will be recycled, by gravity or by pressure, back to the cooling system.

Further, other measures for the preservation of surface water quality will include:

- Storage of fuels used during the process of cement production in an enclosed building to minimise and/or avoid particulates and other polluting materials dispersion.
- Tidying of the plant in order to minimize fugitive dust emissions. In particular, mechanical sweepers will be used to remove collected dust from the internal road network and respective gutters.
- Incidents of polluting materials leakage during the operation phase (for example spillage of oils or spent lubricants during their transportation) will be immediately addressed to avoid migration to surface water. Polluted surfaces will be thoroughly washed and washings will be collected and disposed off as special waste.
- With regard to quarries' operation, fugitive particulates consist an unusual impact of materials extraction procedure. However, in the case of the examined limestone and quarries, existing know how and mode of operation will ensure the minimisation of particulates content migrating to surface waters. In particular, the following mitigation measures are foreseen:

- Quarrying face will be kept as minimal as possible.
- Gradual rehabilitation (through landscaping and planting) of the locations where extraction works have been completed.
- Storm water direct disposal to River Merrueshi is not considered an option during the operation of the quarries. Instead, storm water management will be undertaken through a peripheral ditch of adequate dimensions, which will direct collected water to a settlement pond for further processing. Effluent will next be discharged to a natural receptor by means of an open ditch.
- Appropriate collection and transportation of potential polluting materials (e.g. spent oils, lubricants, etc.).

5.9 Land Quality and Groundwater

The proposed limestone quarries present a very low potential for accidental releases to ground and ground and groundwater contamination. The limestone quarries and supporting, ancillary activities present a low potential for accidental release to ground and ground and groundwater contamination.

- The operational activities, which have the potential to release pollutants to the ground, are listed below, together with the mitigating measures, which will be adopted.
- Accidental release of fuels, oils, chemicals, hazardous materials, etc, to the ground, during delivery, storage, handling and use, for example, re-fuelling, maintenance activities, etc. with subsequent leaching to groundwater;
- Accidental release of liquid wastes during storage, handling and removal, with subsequent leaching to groundwater;
- Accidental discharge of sanitary and other wastewater to ground and groundwater; and
- Discharge of pollutants in water used for plant, equipment and vehicle washing to ground and subsequent leaching to the groundwater.
- Measures will be employed to reduce the risk posed by the potential sources of pollutants listed above.
- Potentially polluting materials, such as fuels, oils, chemicals and associated liquid waste materials, etc. will be stored in dedicated, segregated storage areas, with spillage protection and appropriate environmental security measures to prevent accidental release to ground during storage. In addition, appropriate working procedures will be adopted to minimise the risk of accidental release during delivery to and removal from the storage areas.
- Working procedures will ensure that these materials (raw and waste) are handled correctly. Working procedures will seek to prevent accidental release during the use of these materials, for example, vehicle re-fuelling and plant maintenance, especially with

regard to waste oil. Procedures will be adopted to minimise the potential for accidental discharge of pollutants during the washing down of plant, equipment and vehicles.

- Sanitary wastewater will not be discharged to either ground or groundwater but will be channelled to septic tanks.
- No hazardous effluent will be released into the septic tanks.
- Groundwater depletion due to continuous water abstraction, which is necessary for the daily production activities of the plant, is not anticipated in the examined area.
- Surface water abstraction is not considered an option due to the significant seasonal flow variations of River Merrueshi and the likelihood of negative effects to the local ecosystem.
- Therefore, the necessary water quantities will result from two or more water abstraction boreholes, which have already been drilled within the plant site boundaries.
- However, based on the initial findings of the aforementioned survey and the analysis in relation to groundwater availability, significant groundwater quantities are present at the examined area below a depth reaching 150 m.
- The assertion that existing groundwater quantities are sufficient to meet water demand for the operation of the plant and further, that water abstraction will not cause groundwater depletion.
- The NCCL has already sunk a borehole in the project site, which is solely for the community to use as part of its Corporate Social Responsibility. The borehole provides water for the local communities for domestic and livestock use.
- This is a beneficial impact and aimed at supporting the area which is a water scarce area and where local communities have to trek long distances in search of water for livestock and home usage. To avoid conflict over use of the borehole water by the community which is likely especially during the dry season, a committee has been set up (community water management committee) to oversee the management of the borehole and ensure that there are no conflicts arising from use of the borehole.

Chapter 6.0 LABOUR AND ACCOMODATION

This chapter identifies the environmental impacts that may be caused by the construction phase of the project specifically workers camp related construction and operation, and, where possible, assesses the likely severity of these impacts based on current information. Measures to reduce the severity of the impacts identified are also proposed (termed “mitigation measures”). This report presents the findings, conclusions and recommendations arising from a Supplementary Study of the impacts associated with **Workers’ and Accommodation** of a proposed cement production facility and associated quarries (“the Project”).

IFC *Performance Standard 2* (PS2) aims to promote “safe and healthy working conditions, and to protect and promote the health of workers.” Arguably this covers living conditions as well when these are the responsibility of employers. *IFC Guidance Note 2 on Labour and Working Conditions* specifically mentions the potential danger of forced labour when housing is provided to workers in lieu of payment or where inappropriate charges for housing are levied.

At the initial scoping phase of this project, it was important to consider whether workers’ accommodation is needed at all. In this respect, the consulting team undertook an analysis of the project’s workforce requirements including skills and likely numbers over the project cycle and to assess the capacity of the local population to meet those workforce requirements either from its current base or as a result of training. This analysis was undertaken through detailed discussion with the client (NCCL).

The analysis indicated that the project would require a mix of local labour preferably sourced from the local communities as this has many advantages; not only in terms of reducing the need for workers’ accommodation but also as it will increase the direct and indirect benefits to the community arising from the project.

An assessment of the skills and competencies of the local workforce and how those skills and competencies fit the project needs was conducted and it was determined that the local population can provide critical labour force in areas including; casual labourers, drivers, cleaners, builders among others.

However, the construction and operation of the plant will require foreign and external skilled and resident labour sourced from within and beyond the country hence presenting a need for workers accommodation and camp facilities.

6.1 Overview of Construction Activities

A specialist contractor will construct the proposed clinker manufacture and quarry for NCCL. A building programme has been established and the logistics of the construction process were being produced at the time of the Assessment. Although full details of the construction activities were not available (e.g. the details of the main equipment enclosures, methods of construction including the final balance of onsite and off-site fabrication)

To date minimal preparatory works have been undertaken for construction in the site including construction of temporary workers camp and office block but construction is programmed to begin in October 2013. Construction of workers camp will be completed by 2015 covering a period of 24 months in total.

Most of the plant and equipment that will be installed at the site is highly specialized, purpose built and will be supplied as vendor packages that have been manufactured off-site and delivered to site by road. All plant items will be enclosed in steel-framed buildings clad in insulated profiled steel, constructed on concrete footings.

Construction activities related to the workers camp accommodation and other facilities will include:

- Demolition and site clearance;
- Fill importing/exporting and site levelling;
- Utilities and services connections to site;
- Foundation excavations and concrete footings pours;
- Erection of building steel frames and cladding;
- Installation of equipment;
- Ancillary facilities erection;
- Services, gas and utilities connections;
- Building fitting-out; and
- Commissioning.

It is expected that there will be 3 areas of operation in the plant site: Main contractor will require a number of on-site facilities to support the;

- Administrative and storage area with warehouses and storage areas for equipment and materials.
- Workers camp.
- Clinker manufacture area/Quarry plant area

The main contractor will provide the majority of the construction workers. It is expected that approximately 1,000 workers will work on site at different times of the project (500 during construction; 400 during installation and 300 during operation phase of the project). It is expected that they will live on-site in a specially constructed camp especially the workers employed during the operation phase. During the construction and installation phase of the project, approximately 50% of the workers will reside in the camp while the rest being local labourers from the community will commute on a daily basis.

The workers camp will be located adjacent to the clinker manufacturer site and will consist of several pre-fabricated buildings and necessary infrastructure.

The camp will be equipped in all the necessary utilities including heat, water, wastewater and electricity. Electricity will be supplied to the camp via the national grid and alternative electricity will be produced on site through diesel generators.

6.2 Socio-Economic Aspects

The introduction of a migrant/external workforce during the construction and operation period has the potential for significant impact on the local communities and economy. In addition, to the impact on the local communities consideration has to be given to the working (and living) conditions of the workers themselves. The socio economic impact assessment of the work camp has considered:

- Terms of employment for workers including foreign /external workers if necessary;
- Living conditions for workers;
- Camp facilities for workers (including health care and leisure);
- Local employment and procurement opportunities and
- Other impacts on the local community.

6.3 Terms of Employment

All foreign workers require work permits to work in Kenya. The main contractor and NCCL will arrange these work permits. In order to obtain a work permit the company employing the foreign worker and the worker themselves must agree to certain conditions with regard to employment conditions and local taxation. These conditions are summarized below:

- National requirements on the working week will also be met; these set a 40 hour working week.
- The contractor's terms and conditions of employment must meet minimum Kenyan wage requirements.
- A maximum of 4 hours overtime can be worked per week. Overtime will be paid and workers are entitled to 30 days paid annual leave and an annual return flight paid by the contractor.
- Kenyan tax on salaries and payments for social insurance and health contributions will be calculated in accordance with the tax regulations in Kenya. Tax and contributions for qualified and unqualified employees and personnel in the private sector are calculated according to the classification of the economic activity performed.
- Health and medical costs/insurance will be paid by the contractor

The foreign workers (expatriates) will contribute to the economy through the appropriate payment of tax and insurance contributions (as well as through local expenditure).

Kenya recognizes the International Labour Organization (ILO) convention on Migrant Workers (Supplementary Provisions) Convention, 1975 (No. 143); including the equality of opportunity

and treatment.

The supply contract between NCCL and the contractor must specify the terms and conditions of workers employment and payment. Clauses including requirements identified under the International Labour Organization (ILO) conventions for forced labour, child labour and discrimination and other aspects such as the minimum wage requirements and deductions, grievance mechanism, codes of conduct in camp and outside camp will have to be incorporated in the contract. Foreign workers will keep their own passports.

It can therefore be assured that (inter alia) the workforce will be in Kenya of their own free will, they will be provided with a fair wage and their working conditions will be satisfactory.

6.4 Living Conditions and Camp Facilities

Room/dormitory facilities

The standards of rooms' are important to allow workers to rest properly and to maintain good standards of hygiene. Overcrowding will be avoided particularly. Rooms will be kept clean and in a good condition.

Exposure to noise and odour will be minimized and in addition, room design and equipment will strive to offer workers a maximum of privacy. There will be no dormitories and the rooms will be single or double and self contained.

Information has been provided by NCCL regarding the workers camp. The facilities will all be largely self-contained. Workers will be accommodated in a three persons/room or two person/room or single person/room with adequate spacing.

1. Rooms will kept in good condition and cleaned by local cleaners who will be hired by NCCL for this purpose.
2. Rooms/dormitories will be aired and cleaned at regular intervals.
3. Sanitary facilities will be located within the same room i.e. each room will be self contained with in built sanitary facilities
4. All doors and windows will be lockable, and provided with mosquito screens where conditions warrant.
5. Every resident will be provided with adequate furniture such as a table, a chair, a mirror and a bedside light.
6. Separate sleeping areas will be provided for men and women, except in family accommodation.
7. A separate bed will be provided for each worker. The practice of "hot-bedding" will be avoided.
8. Each worker will be provided with a comfortable mattress, pillow, cover and clean bedding.
9. Bed linen will be washed frequently and applied with repellents and disinfectants where conditions warrant
10. Facilities for the storage of personal belongings for workers will be provided.

Sanitary and toilet facilities

It is essential to allow workers to maintain a good standard of personal hygiene but also to prevent contamination and the spread of diseases, which result from inadequate sanitary facilities. The workers camp will have sanitary and toilet facilities including all of the following: toilets, urinals, washbasins and showers in each of the rooms.

Sanitary and toilet facilities will be kept in a clean and fully working condition through workers who will be hired by NCCL on a casual basis. Facilities will be constructed of materials that are easily cleanable and ensure privacy.

In the canteen, sanitary and toilet facilities will not be shared between male and female residents. Where necessary, specific additional sanitary facilities will be provided for women.

Toilet facilities

An adequate number of toilets will be provided to the workers in the canteen area as well as the quarrying area. Standards for toilets will range from 1 unit to 15 persons to 1 unit per 6 persons. For urinals, the standards will be 1 unit to 15 persons.

Toilet facilities will be conveniently located and easily accessible to all persons in the canteen area as well as the administrative block. In addition, all toilet rooms in the canteen area and quarry site will be well-lit, have good ventilation and sufficient hand wash basins.

Showers/bathrooms and other sanitary facilities

Hand washbasins and showers will be provided in conjunction with rooms. These facilities will also be kept in good working condition and cleaned frequently. The flooring for shower facilities will be of hard washable materials, damp-proof and properly drained.

Adequate space will be provided for hanging, drying and airing clothes. Suitable light, ventilation and soap should also be provided. Shower/bathroom facilities will be provided with an adequate supply of cold and hot running water.

Canteen, cooking and laundry facilities

Dining facilities will be provided through a canteen with a catering capacity for 500 persons. The area will be dedicated for dining with dining table and chairs. There will be big screen television in the canteen.

Adequate canteen, cooking and laundry facilities and equipment will be provided by NCCL and good standards of hygiene in canteen/dining halls and cooking facilities will be maintained. NCCL will contract caterers to manage kitchens and canteen and workers will not individually cook their meals. In addition, canteen, kitchen, cooking and laundry floors, ceilings and walls will be made of easily cleanable materials. The canteen will have a reasonable amount of space per worker. Food for all workers will be free of charge but those who wish to cook in their rooms will be allowed to do so.

Canteens will be adequately furnished with tables, benches, individual drinking cups and plates among others.

Places for food preparation will be designed to permit good food hygiene practices, including protection against contamination between and during food preparation.

Kitchens will be provided with facilities to maintain adequate personal hygiene including a sufficient number of washbasins designated for cleaning hands with clean, running water and materials for hygienic drying.

Wall surfaces adjacent to cooking areas will be made of fire-resistant materials and food preparation tables will also be equipped with smooth durable washable surface.

All kitchen floors, ceiling and wall surfaces adjacent to or above food preparation and cooking areas will be built using durable, non-absorbent, easily cleanable, non-toxic materials.

Wall surfaces adjacent to cooking areas will be made of fire-resistant materials and food preparation tables will be equipped with a smooth, durable, easily cleanable, non-corrosive surface made of non-toxic materials.

Adequate facilities for cleaning, disinfecting and storage of cooking utensils and equipment will be provided.

Food waste and other refuse will be adequately deposited in sealable containers and removed from the kitchen frequently to avoid accumulation.

Standards for nutrition and food safety

During cooking, hygiene and food safety will be critical and the NCCL will to provide safe and nutritious food. The World Health Organization (WHO) 5 keys to safer food or an equivalent process will be implemented.

Food provided to workers will contain an appropriate level of nutritional value and takes into account religious/cultural backgrounds; different choices of food will be served if workers have different cultural/ religious backgrounds.

Leisure, social and telecommunication facilities

Basic leisure and social facilities for workers to rest and also to socialize during their free time will be provided due to the fact that the workers' accommodation is located in remote areas far from existing leisure or social facilities.

- Exercise and recreational facilities will be provided to increase workers' welfare and reduce the impact of the presence of workers in the surrounding communities. Provision of space for religious observance needs will be considered, taking account of the local context and potential conflicts in certain situations.
- Basic collective social/rest spaces will be provided to workers. These will include providing workers multi- purpose halls to providing designated areas for radio and TV.
- Recreational facilities will be provided. There will be a clubhouse, volleyball playground, a children play ground, exercise equipment, a library among others.
- Workers will also be provided with dedicated places for religious observance if the context warrants.
- Internet facilities will also be provided
- Recreational facilities will be freely available and accessible for workers.
- Other facilities will include an on-site shopping complex, which will serve basic items such as soft drinks, cigarette, biscuits, etc. and will cater for a demand from 500 persons.
- Communications in the form of a telephone room and wireless internet will be available (for 500 persons respectively). There will be 10 office telephones and 2 telephones for private use charged according to telecom rates. NCCL consider this to be adequate, as most workers will have their own personal mobile telephone.

Camp codes of conduct (within camp and outside camp) cover aspects of camp security and visitor policies.

1. Security guards will be in charge of the security of camp. Visitors are allowed to visit the camp if accompanied by staff and employees will only access the site after showing a genuine staff identification.

Medical facilities

NCCL will establish a 24-hour medical clinic/facility in workers' accommodation camp and this is due to the high/significant number of workers who will live on site.

A resident doctor and nurse on a 24-hour basis will provide medical services. The clinic will also have sick beds. The doctor will treat minor injuries, deliver first aid, and provide direction on the best course of care. For serious injuries and emergencies a contract is being established, which can provide good quality hospital and medical facilities.

6.5 Basic camp infrastructure includes:

Power supply: This will be from the grid and a secondary power will be supplied via an emergency diesel generator with a capacity of 15MW. The secondary power supply will be sufficient to ensure normal living and working supply for critical aspects.

Water: To prevent dehydration, water poisoning and diseases resulting from lack of hygiene, workers will have easy access to a source of clean water. An adequate supply of potable water will be made available in the same buildings where bedrooms or dormitories are provided.

Drinking water will meet Kenyan and or World Health Organization (WHO) drinking water standards and water quality will be monitored regularly. This will be taken from the 2 boreholes already existing within the plant area. All tanks and boreholes used for the storage of drinking water will be constructed and covered as to prevent water stored therein from becoming polluted or contaminated. However, the water will require treatment to reduce the high level of fluoride content noted during the chemical analysis.

Solid waste will be collected and transported to a disposal site (constructed in the quarry area). Domestic solid waste will be segregated further as a way of reducing waste loads.

- Specific containers for rubbish collection will be provided and emptied on a regular basis. In addition rubbish containers will be located 30 metres from each shelter on a wooden, metal, or concrete stand. Such containers will be emptied at regular intervals (to be determined based on temperatures and volumes generated) to avoid unpleasant odours associated with decaying organic materials.
- Pest extermination, vector control and disinfection will be carried out throughout the living facilities in compliance with host country requirements and/or good practice. Pest and vector monitoring will be performed on a regular basis.

Wastewater treatment and effluent discharge and disposal will comply with Kenya's effluent discharge standards and will be adequately designed to prevent contamination of any water body,

to ensure hygiene and to avoid the spread of infections and diseases, the proliferation of mosquitoes, flies, rodents, and other pest vectors. Sanitation will be provided for through lined septic tanks that will be constructed in the site for each room and in the administration block.

Drainage: The presence of stagnant water is a factor of proliferation of potential disease vectors such as mosquitoes, flies and others, and must be avoided. The building site will be adequately drained to avoid the accumulation of stagnant water.

Fire Safety Hazards

The workers camp and the administration block will be fitted with fire safety and management equipment.

Heating and Air conditioning: Air-conditioning and ventilation will be available in all the structures appropriate for the climatic conditions and provide workers with a comfortable and healthy environment to rest and spend their spare time this is because the project area gets very hot.

6.6 Occupational Health and Safety

All closed areas will be equipped with the proper ventilation systems to ensure employee protection from suffocation, harmful gases and dust particles. All employees, regardless of their job description, will be provided with the necessary personal protective equipment. Every employee will be given safety shoes, a safety helmet, earplugs and safety goggles.

Employees with specified jobs will be given the necessary personal protective equipment for the job, such as heat-resistant gloves, heat-resistant jackets, earmuffs and respiratory equipment in dusty working places.

All workers engaged in the material handling system shall be regularly examined for lung diseases.

Any worker found to develop symptoms of dust related diseases will be immediately changed over to another job in a cleaner environment within the plant.

All job activity will be controlled by work permit system to make sure that risk assessment prior to work will be carried out.

The Occupational Health, Safety and Environment (OHS&E) Department will carry out constant monitoring of emissions, radiation and noise in all workplace areas. Portable measuring equipment will be used to carry out measurements on a routine basis.

6.7 Health and Safety Training

To ensure a high level of competency and awareness in the area of occupational health and safety, training will be provided in all relevant areas. This training will be integrated with the creative learning program, and place a strong emphasis on risk assessment and management.

NCCL will train its employees in health and safety in a manner that is consistent with the NCCL

Safety Manual. Training will also comply with any legislative requirements.

Formal training for all employees (including contractors) at all levels within NCCL will be provided, and shall address the following:

6.8 Managing Workers' Accommodation

NCCL will establish an office for **works and maintenance**, which will handle issues such as the physical maintenance of buildings, security and consultation with residents and neighbouring communities in order to ensure the implementation of the housing standards in the long term.

Worker camps and housing facilities will have a written management plan, including management policies or plans on health and safety, security, living conditions, workers' rights and representation, relationships with the communities and grievance processes.

6.9 Security of Workers' Accommodation

A security plan will be carefully designed including appropriate measures to protect workers against theft and attacks and to ensure the security of workers and their property on the accommodation site.

NCCL will contract security services whose main responsibility is to provide security to safeguard workers and property.

Fire and safety plans and precautions have been identified and will be put in place in the camp. The NCCL sister company (Devki Group) has a safety department in charge of safety management, including the monitoring of accident statistics. There will be a full time supervisor for safety inspections. Each team will have a safety supervisor in charge of daily safety management.

All staff will attend safety training prior to joining the camp and must pass a safety examination. Further periodic safety training will be undertaken. There will be weekly safety meetings to review the issues of the week and to arrange the safety target in the coming week. Camp and construction site will be equipped with fire extinguishers.

6.10 Communication and Codes of Conduct

1. NCCL policies and codes of conduct forbid the drinking of alcohol in work time and lunch time, and forbid the use of unauthorized drugs and other illegal substances. Keeping of firearms, knives or other weapons. These codes of conduct depend on the workers and camp residents to report infringements.
2. Worker communications will be undertaken on a daily basis through daily team communication, through training and routine periodic meetings. An independent department, with a specific person will be responsible for dealing with worker's grievance.
3. With respect to neighbouring communities a formalized liaison and community

communication policy will be developed by NCCL. Liaison will be based on goodwill and common events such as sporting occasions are arranged jointly.

4. NCCL will design a programme for the cultural sensitization for the workers, covering aspects of communication mutual respect and learning with respect to other's cultural customs and habits.
5. NCCL will design a health awareness and training programme for its workers. This will include but is not limited to: an advance introduction about the STDs and communicable diseases, key aspects for attention, how to avoid and prevent from such diseases; the emergency and curative measures. NCCL's doctor will be responsible for communication on these aspects with the local health institution.

6.11 Impacts on the Local Communities: Opportunities for Employment and Local Procurement

Workers' influx in the vicinity of a community may strain existing infrastructure, in particular the water and sanitation, health, recreational services, electricity and transport systems.

Camp infrastructure and utility requirements (provision of water, disposal of domestic wastewater and solid waste etc.) may put pressure on local services. However, the project area lacks all the normal basic utilities and amenities like sewerage treatment, waste disposal sites, piped water and as such there is no additional pressure that is expected on local utilities as a result of this project.

The nearest local communities with commercial services will be Merrueshi Trading Centre, Emali or Oloitoktok. Each has one or more cafe/bars, billiard rooms, small food and tobacco shops. These localities are served by mini buses, which connect to the towns of Emali and Oloitoktok.

NCCL has opportunities to contribute to the local economy through the procurement of services and sourcing of local labour. These services are expected to include:

- The purchase of fresh vegetables and meat/fish/chicken and foodstuffs (rice and flour, etc.) from local market.
- Employment of some local catering staff in supporting roles.
- Hire of local transport

A liaison committee should monitor the situation to ensure that local shortages or service disruption does not occur as a result of such provisions (e.g. shortage of local buses for local people).

NCCL will be in contact with local community leaders and representatives to discuss areas of co-operation and supply including assistance to adequately take advantage of possible business

opportunities. NCCL should facilitate this by providing one or more trained business consultants who would help both parties to look at the social opportunities and business risks (both for small business providers and from the perspective of NCCL) and to identify potential solutions and compromises as well as to support local initiatives in developing business plans and accessing credit.

6.12 Impacts on the Local Communities

This area in particular has had no previous experience with large numbers of foreign temporary residents. The locals are eager to provide supplies and to take advantage of commercial opportunities offered by the NCCL camp but has had no experience in provisioning and accommodating large numbers of people in the past.

Early and good factual information to local communities on the local camp and its population and on foreign culture and behavior and opportunities for local employment, supply chain and provisioning will help to prepare the local communities and minimize possible suspicion or hostility by the local population.

6.13 Community Health and Safety

The presence of a large number of workers, principally males, can give rise to an increased spread of communicable diseases such as HIV/AIDS in particular and other sexually transmitted diseases.

The community leaders have not identified any potential health risks to the local communities. These communities have tight knit structures and traditional practices. Risks from transmittable diseases and in particular STD's are considered low. Health officials recognize that this might be an issue in larger urban centres (e.g. Oloitoktok and Emali).

Early preventative action, such as STD awareness campaigns, targeted at specific audiences in local urban areas (e.g. Oloitoktok and Emali) should be taken and such campaigns should be organized in co-operation with existing health structures. Local staffs know and understand the population and would be available to undertake this work. National Aids Control Council can support them through training.

In addition, special attention will be paid to risks such as road accidents, and other detrimental consequences of increased traffic generated by the project (dust, noise, and pollution). If the proposed project has major-accident hazards associated with it, emergency response and evacuation plans in accordance to PS4/PR4 will also need to be in place.

6.14 Community Cohesion

The impact of the presence of workers with different lifestyles or cultural backgrounds on the host community may be significant especially in regard to the cultural proscriptions, local traditions and community structure and the relationship between men and women.

6.15 Land Acquisition and Resettlement

Impacts and mitigation plans relating to land used for workers' accommodation facilities will be managed in the same way as for the project as a whole. The land where workers camp will be constructed is within the overall 2,200 acres of land that has been legally acquired by NCCL for

the entire plant operations.

6.16 Management of Community Relations

Workers' living facilities have various ongoing impacts on adjacent communities. In order to manage these, it is good practice to design a thorough community relations management plan.

It is recommended that a local liaison forum or committee should be established to monitor the work camp integration, identify any potential or emerging issues, promote good practice and act as a formal channel of communication between the local communities and work camp. Members of the liaison committee should be appointed from the work camp, and to represent resident interests.

A senior manager is in charge of implementing the community relations' management plan and liaising with the community. This will provide a transparent and efficient process for dealing with community grievances, in accordance with PS1/PR10. The liaison committee will undertake the periodic review, of impacts of workers' accommodation on local communities against the mitigation measures.

This plan will contain the processes to implement the findings of the preliminary community impact assessment and to identify, manage, mitigate or enhance ongoing impacts of the workers' accommodation on the surrounding communities.

Issues to be taken into consideration include: community development – impact of workers' camp on local employment, possibility of enhancing local employment and income generation through local sourcing of goods and services community needs – ways to identify and address community needs related to the arrival of specific infrastructures such as telecommunications, water sanitation, roads, health care, education, housing community health and safety – addressing and reducing the risk in the increase in communicable diseases, corruption, trade in illegal substances such as drugs, alcohol, petty crimes and other sorts of violence, road accidents community social and cultural cohesion – ways to mitigate the impact of the presence of large numbers of foreign workers, often males, with different cultural and religious background, ways to mitigate the possible shift in social, economic and political structures due to changes in access to income generation opportunities.

One or more health representative(s) for the area should also sit on the committee. To work in a flexible manner the committee should not be more than 7 members. The committee should meet as regularly as necessary and at least once a month for the first 6 months. It should continue throughout the life of the work camp.

The forum should be provided with detailed information on the establishment of the work camp, its specification, facilities and provisioning (utility services, food, transport, health etc.), codes of conduct, build up of camp numbers, etc. so any potential issues can be discussed and suitable measures identified in a timely manner. The forum should also receive regular reports summarising key monitoring findings and trends, e.g. on transport availability for workers and local people, on health of workers and local services, numbers and types of grievances made, etc.

Information on the purpose and the committee should be given to local communities through village meetings or local radio, and local communities encouraged to discuss/report any concerns, grievances or issues. The NCCL grievance mechanism set up during the ESIA process should be reviewed (by NCCL and the Liaison forum), amended as necessary and should also remain active. It is noted that NCCL have stated that all construction supervisors will speak English and that translators will also be employed.

Chapter 7.0 TERRESTRIAL ECOLOGY ASSESSMENT

This chapter identifies the environmental impacts that may be caused by the construction phase and operation phases of the project specifically on the **terrestrial ecology** and, where possible, assesses the likely severity of these impacts based on current information. Measures to reduce the severity of the impacts identified are also proposed (termed “mitigation measures”). This report presents the findings, conclusions and recommendations arising from a Supplemental **Terrestrial Ecology Assessment Study** of the impacts associated with terrestrial ecology of the proposed clinker manufacture and production facility and associated quarries (“the Project”).

IFC Performance Standard 1 (PS1) promotes need for (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client’s management of environmental and social performance throughout the life of the project. Performance Standard 6 (PS6) specifically addresses the need for biodiversity conservation and sustainable management of living natural resources.

7.1 Baseline Terrestrial Ecological Conditions

The Merrueshi area is an area that is still under natural vegetation apart from the Merrueshi Township and the main Emali-Oloitoktok road. The dominant vegetation types are open grasslands towards the north and northeast to the Chyulu Hills; Acacia dominated bush land to the south until the forest belt of Kilimanjaro.

Throughout these main types, there are patches of swamp and swamp edge grassland and Acacia woodland following a roughly northwest-southeast line along the park's long axis, with wooded and bush grassland found variously wherever there is seasonal accumulation of water.

The vegetation can be described as a mixture of wood savannah and high savannah characterized by thick woodlands and bushes comprising of thickets and shrubs. The areas under bushes have been largely cleared for firewood, housing or creation of grazing fields for livestock. The most common species of vegetation identified during the assessment included;

Table 9. List of Flora

List of Flora in Project Area
<i>Acacia tortilis</i>
<i>Daryolis caffra</i>
<i>Euphorbia Spp</i>
<i>Acacia gerrardi</i>
<i>Sodom Apple</i>
<i>Hypharrhenia rufa</i>
<i>Hypharrhenia hirta</i>
<i>layanas</i>
<i>Balanites</i>
<i>Commiphora</i>
<i>Sporobolus</i>

Chloris

Pennisetum



Figure 15. Vegetation type in project area

Fauna

The natural fauna of the area is still largely intact due to the limited human settlement and farming activities. This is a savannah woodland area that is lying in between two animal migratory corridors that converge at the same place though one is no longer much visible due to extensive human settlement and development activities. To the southwest and about 60km from the site area is the Amboseli/Lempoti Gate-Chyulu Hills corridor. Some animals using this corridor end up in Tsavo West National Park.



Figure 16. Flora and Fauna in project site

About 60 kms to the west of the project site is the Kyulu Hills National Park, at the end of the Nairobi-Kapiti Plains-Kyulu Hills corridor. The development of farms, towns, and industries on the Athi Kapiti Plains has greatly diminished the value of the Kapiti Plains as an important wildlife migratory corridor. Since the boundaries of these corridors and the National Park are not clearly defined and also depending on the availability of pasture and water, it is common for migrating animals to wander into populated areas.

The large animals include buffaloes, giraffes, elephants and big cats mostly lions and leopards. Other common animals include antelopes and gazelles, dik diks, monkeys, warthogs, hyenas among others. In summary, the project area has wildlife associated with savannah environment. There are many types of reptiles including lizards and snakes as well as avifauna.

Table 10. List of Fauna and Avifauna

List of Fauna in Project Area
<i>Syncerus caffer</i>
<i>Giraffa camelopardalis</i>)
<i>Loxodonta Africana</i>
<i>Panthera leo</i>)
<i>Panthera pardus</i>
<i>Phacochoerus africanus</i>
<i>Crocuta crocuta</i>
<i>Oryx gazella beisa</i>
<i>Acinonyx jubatus</i>
<i>Bucerotidae</i>
<i>Struthio camelus</i>
<i>Guttera pucherani</i>
<i>Bubulcus ibis</i>
<i>Sagittarius serpentarius</i>
<i>Sturnus vulgaris</i>

Taurotragus oryx
Litocranius walleri
Madoqua

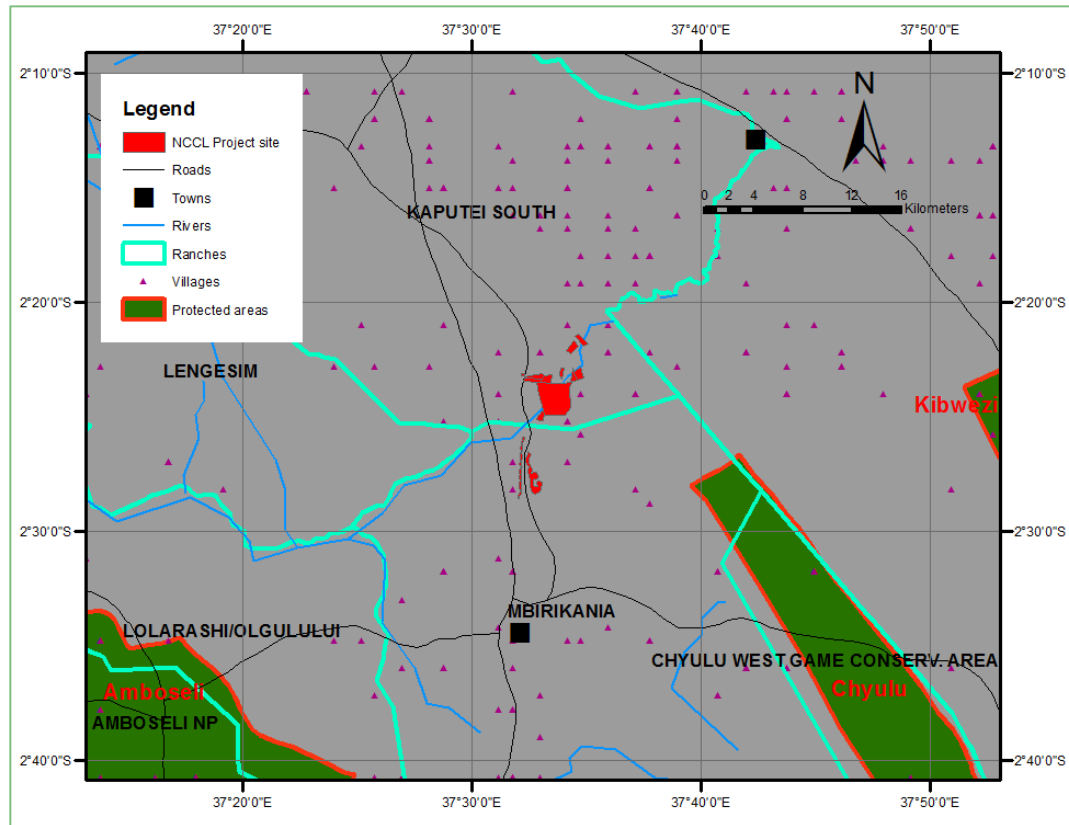


Figure 17. Map of Protected Areas close to project site

7.2 Amboseli Area

The Amboseli Area consists of the world famous Amboseli National Park and surrounding group ranches, including: Kimana/Tikondo, Olgulului/Olararashi, Selengei, Mbirikani and Kuku. The Amboseli ecosystem covers approximately 9000 km² and is adjacent to the Magadi-Natron area to the North West and the Kilimanjaro Area to the south. It also includes the former 48 individual ranches located on the lower slopes of Kilimanjaro along the international border, westwards from Oloitoktok, that are now under crop production, mainly rain fed agriculture as well as under irrigation.

The area consists of basement plains, saline plains with fresh water swamps and the volcanic slopes of the Kilimanjaro. The vegetation reflects the mainly semi-arid environment. According to Pratt and Gwynne (1977), Quaternary volcanic soils on the northeastern Kilimanjaro slope dominate around the southeast area, encouraging rain-fed agriculture; basement rock soils cover most of the rest of Ilkisongo, making only pastoralism possible.

The Amboseli area lies in ecological zone VI on agro-climatic zone map and is generally arid to

semi- arid savanna environment, with low agricultural potential (Croze et al, 2006). The area is characterized by spatial and temporal variation in the hydrology.

Flora

The vegetation in the project areas is mainly bush grassland dominated by acacia tree species, indigenous grasses, shrubs, and *layanas* (creepers). Other tree species include *Balanites spp.* and *commiphora spp.* Some parts have dense vegetation attributed to nearby hills, which act as water catchment areas. These areas are characterized by thick acacia bush and shrubs. Extensive grassland and sparse acacia trees dominate the drier parts. The ground cover is mainly composed of short and medium height perennial grasses and several annual grasses and herbs. The grasses are mainly the *sporobolus spp*, *chloris spp* and *Pennisetum spp.*

Namanga Division however has approximately 765 hectares of forest cover constituting both indigenous and exotic forests. The forests are mainly water catchment areas. There are four other areas, which have been identified for future protection through gazettement. These include Chyulu Hills currently a game conservation area, Sultan Hamud Hills, Enkonka and Maparasha. Re-afforestation and afforestation are priority activities in the area.

The unique setting of the swamps fed by snowmelt from Mt Kilimanjaro, the various habitats, soils and land use resulted in Amboseli being included in the United Nations Educational, Scientific and Cultural Organization (UNESCO), Man and Biosphere Reserve (MAB) program. Amboseli is recognized as an International Biosphere Reserve.

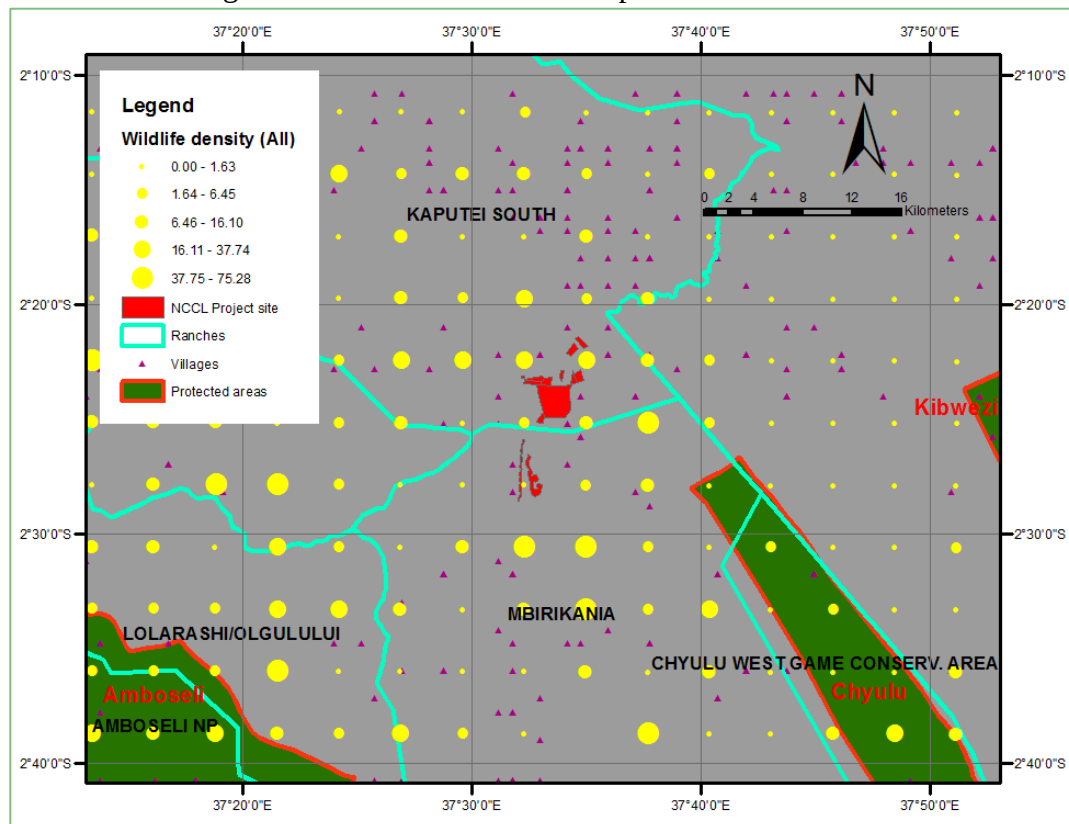


Figure 18. Wildlife density around project site and ranches

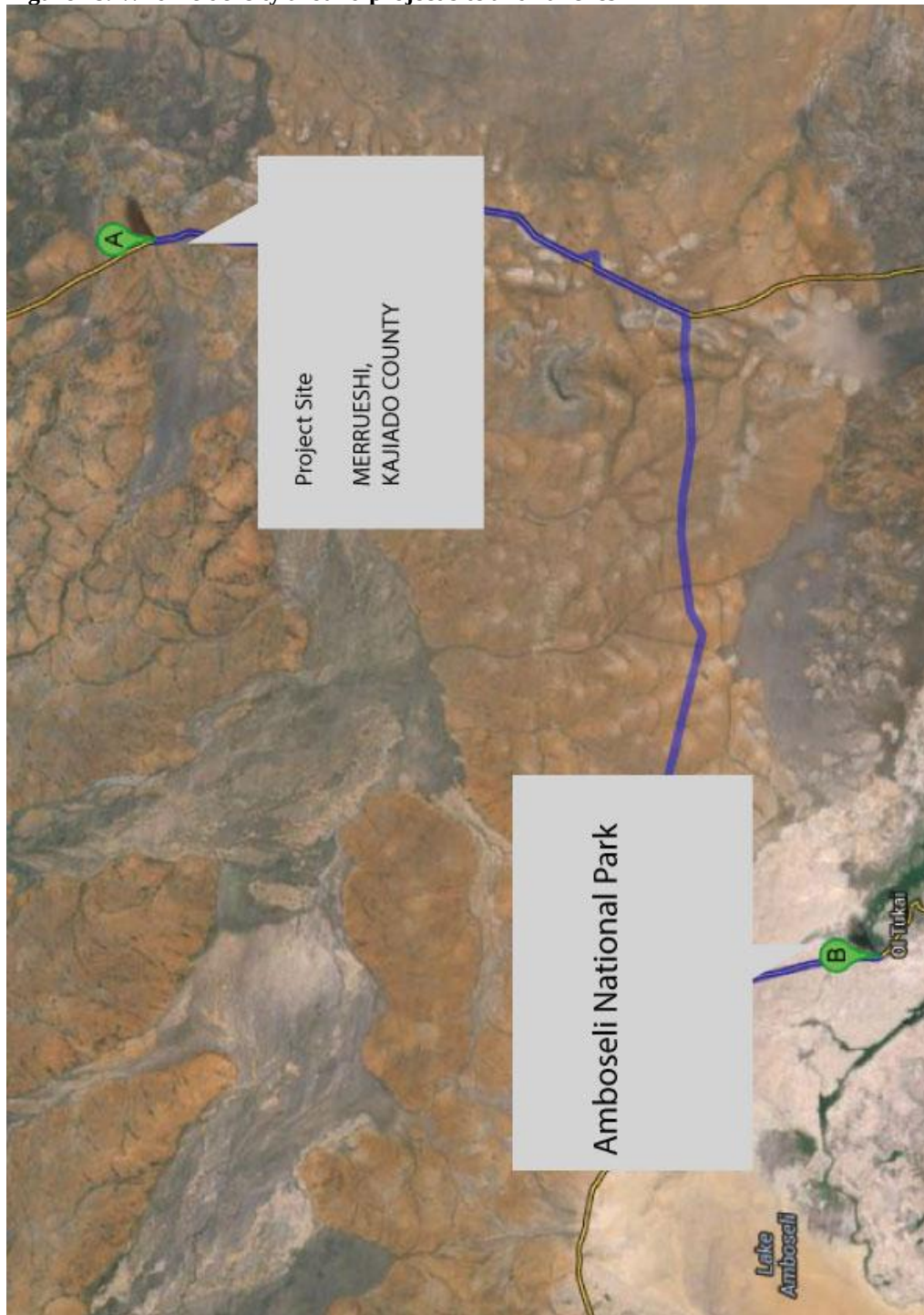


Figure 19. Location and distance of project site to Amboseli National Park

Fauna

Wildlife is regarded in high esteem in Kajiado County and is found generally within and around Amboseli and Tsavo West National Parks and the dispersal areas. The ecology of the area

favours game and livestock cohabitation and sparse human settlement. The majority of wildlife found in the dispersal areas are migratory species, and includes elephants, cape buffaloes and wildebeests. Other animals found in the dispersal areas include Impala, Giants gazelle, Thompson's gazelle, Oryx, Topi, Cheetahs, Hyenas, Nightingale, Zebra, Giraffe, Leopards and occasionally Lions.

There is a wide variety of bird species in the parks and along the access roads including Hornbills, Maasai Ostrich, Starlings, Crowned Guinea fowl, Egrets, Bustards, go-away birds, Cranes and Secretary birds. This wildlife interaction makes Amboseli an important wildlife conservation area in Kenya

Of the various faunal resources that have been recorded in the area, the famous Amboseli Elephants have been studied for more than 30 years. The Amboseli ecosystem has an elephant population of about 1400 individuals, which have been a major driving force in the ecology of the Amboseli Ecosystem and are closely associated with habitat changes in the Amboseli National Park.

Amboseli National Park is also one of the 60 Important Bird Areas (IBAs) in Kenya and thus it is recognized as globally significant for bird conservation. Many local bird species as well as migrant birds have been recorded. The ecosystem has a rich birdlife, with over 400 species recorded, of which 40 are birds of prey.

It has globally threatened bird species (e.g. Lesser Kestrel), restricted-range birds that are found only in a very small area such as the Taveta golden weaver, bird species that live only in a particular vegetation type such as the Grosbeak weaver, and regionally threatened bird species such as Martial eagles. The bird life in Amboseli is diverse due to the varying habitats. In October-December when the rains are on or about, the local birds are joined by migrants such as European storks from the Northern hemisphere, sometimes in fairly large numbers, and bird watching around the swamps and seasonal lakes can be a very rewarding venture.

The construction and use of the proposed project is not expected to disrupt wildlife habitats and dispersal areas around Amboseli National Park or Chyulu Hills National Park because of the fact that the project site is over 60kms and 70 Kms away from the wildlife dispersal corridor and is buffered by the Imbirikani Group Ranch.

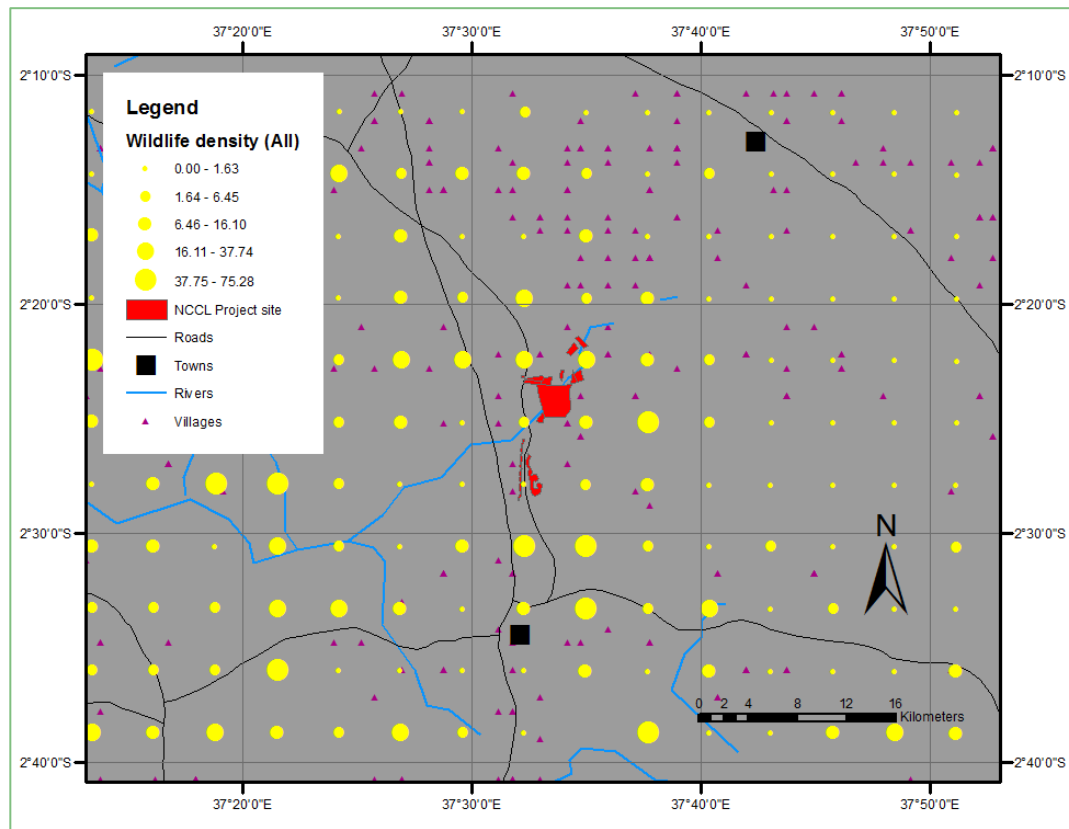


Figure 20. Wildlife Densities

Below is a summary of the types of wildlife species found in the dispersal areas of the along the Amboseli-Kaputei areas:

1. Namanga town - Meshanani Gate Few animals are found in this section of the road as this area is neither a migratory route nor a dispersal area. Browsers such as Gerenuk, Giraffe, Grant's gazelle and Impala dominate this route. Oryx and Eland are rare in this area. There are a good number of Ostrich and some Dik dik and occasionally Lesser Kudu. Elephants are beginning to filter back to the area in search of watering points. On the plains immediately before Amboseli (within 10km), herds of Zebra and Wildebeest can be seen. Zebra are also sometimes seen in the bush country on route to Namanga.



Figure 21. Location and distance of project site to Chyulu Hills National Park

2. Meshanani Gate to junction on E397 to Iremito Gate and through Namelok to Lemongo junction near Kimana Gate on C103 Most of the animals are seen within this region since it is within the wet season dispersal area. These include often Zebra and Wildebeest in the open grassy areas, Giraffes, abundant Granti and often Tommy. Within the bush country one can find Gerenuk, Ostrich and a few Lesser Kudu. Elephants can also be spotted from time to time. In the rains, Zebra and Wildebeest along this route can reach up to 500 or more. Oryx are also commonly seen. The Eastern side along the Namelok ridge is the migration corridor from Amboseli National Park through the Chyullu Hills to Tsavo West National Park.
3. Kimana Gate - Emali/Oloitokitok road junction (CI02). The Kimana Gate to the Emali/Oloitokitok road junction (CI02) passes through built settlement, and as a result

the numbers of wildlife along the road has visibly fallen in the last two decades. There are however, good numbers of Granti, Elephants, Giraffe, Ostrich, and sometimes Eland and rarely Oryx. Dik dik are often seen along this route. Zebra are scattered throughout this dispersal area although seldom can more than a few dozen be seen. Lesser Kudu are now uncommon compared to the past.

The number of wildlife species found within the dispersal areas is dictated by climate. During the rains, they move into the parks and graze where there is plenty of pasture. In the dry season when most water points and water pans have dried up, most of the wildlife moves into the dispersal area and onto higher grounds in the Chyulu Ranges and Oloitokitok.

Figure 22 below show the wildlife dispersal areas. The different routes of animals have been marked by the different colors. The routes show that animals generally disperse Northwards of the Amboseli National Park. The different colors signify the different animals (Elephants, Wildebeests etc) while each route shows the movement of the animal.

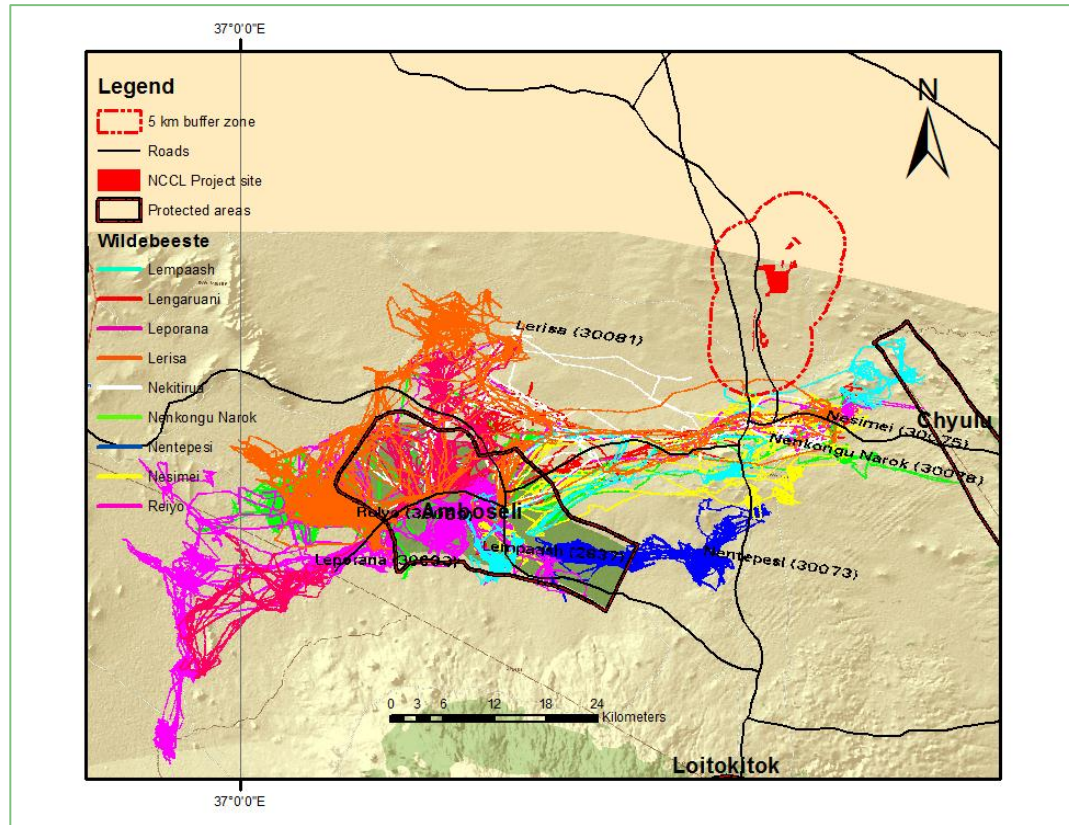


Figure 22. Wildlife Migratory Routes

7.3 Impact on Terrestrial Ecology

Flora and Fauna

The Amboseli National Park does not have any live boundaries such as an electric fence or live hedges. The animals use the park as a dry season refuge and during the wet season they move out of the Park and into the Ranches.

The Kimana Gate to the Emali/Oloitokitok road junction (CI02) passes through built settlement, and as a result the numbers of wildlife along the road has visibly fallen in the last two decades. There are however, good numbers of Granti, Elephants, Giraffe, Ostrich, and sometimes Eland and rarely Oryx. Dik diks are often seen along this route. Zebra are scattered throughout this dispersal area although seldom can more than a few dozen be seen. Lesser Kudu are now uncommon compared to the past.

The proposed project will not impact significantly on the movement of wildlife within the area this is because the dispersal area is Northwards of the Amboseli National Park, which is off the clinker manufacture plant. There are no species in the project area on the Red List.

However, once in a while the wildlife may migrate towards the project site along Imbirikani Group Ranch and this may lead to adverse impacts on wildlife include collisions between vehicles and wildlife during construction and operation.

Workers may be tempted to kill the wildlife for bush meat or for the trophies (horns, tusks etc.) and this could adversely affect the wildlife.

Noise from blasting (at the limestone quarry), from plant operating at the quarry and clinker factory sites and from haulage vehicles transporting raw materials and finished products are likely to disturb wildlife, at least in the short term.

Light will have a potential impact on the wildlife in view of the fact that the plant operations will be on a 24 hour basis, a situation that may disturb the wildlife over the plant life hence long term.

General human activity at these sites is also likely to deter certain wildlife species that are sensitive to disturbance. However, since the project site is far from the dispersal area, the additional noise and human disturbance impacts from the project may not be great.

Finally, there is an increased risk of wildlife “road-kills” along the quarry and clinker plant access roads.

The NCCL will not fence the entire project area (2,600 acres) other than the quarry sites, clinker plant and workers’ camp which will be fenced the rest of the project site will remain un-fenced. Fencing has adverse impacts curtailing the movement of and migration of wildlife by blocking paths. However, as stated, the project site is not close to the dispersal area hence the fence will not affect movement of wildlife. Wildlife that may stray towards the project area will be managed through the participatory community game scout and problem animal control division by Kenya Wildlife Service.

7.4 Proposed Mitigation Measures

- It is therefore important to ensure that the wildlife corridors are mapped in conjunction with KWS and left for the animals to be able move freely;

- As this project will be undertaken close to a wildlife dispersal area, the Contractor needs to be advised that wildlife poaching is illegal and habitat destruction is also discouraged; and
- NCCL should work with Imbirikani Group Ranch and Kenya Wildlife Service (KWS) and establish community game scouts who will be on the look out for stray animals and ensure that they are relocated back to the dispersal area.

7.5 Dust Emission Impacts

The main potential impacts on ecology associated with operation of the quarries are considered to arise from dust particles, released as a result of quarrying (including blasting at the limestone quarry) at quarry sites and transport of quarried materials and finished product.

Dust will be deposited on the leaves of the vegetation and may affect plant growth and condition by reducing photosynthesis and damaging the leaf cuticle. Dust that settles on the soil could also change the pH of the soil and this can lead to changes in the species composition of plant communities. However, on the assumption that most dust deposition will be localised and the chemical composition/pH of the dust will be similar to that of the soil forming rocks where it falls (e.g. limestone dust falling on soils of limestone origin), such changes are likely to be minor.

Where the vegetation is negatively affected by the dust, this may have a secondary affect on the health and species composition of animal communities supported by the vegetation. The productivity and quality of the vegetation for herbivores may be reduced and the direct ingestion of dust with the leaves may affect their digestibility.

Other than planting belts of trees to provide local screening to reduce dispersion from the main sources of dust, little can be done to protect the vegetation and wildlife from deposition of dust from project activities. The main mitigation that can be undertaken relates to reducing emissions at source (filters, covering of trucks etc.) and these are described elsewhere in the air quality supplementary study report.

Particular attention should be paid to the quarry access roads as sources of dust, given the number of anticipated truck movements. Consideration should be given to asphaltting the surface, which would also reduce wear and tear on vehicles; regular spraying/damping of the graded surface will also be undertaken.

Similarly, measures to reduce noise levels over extensive areas (i.e. at receptor sites) are not practical and the main steps to be adopted to mitigate against noise impacts relate to achieving reductions in noise at or near the source.

To reduce impacts on the local ecology as a result of increased human presence, disturbance and exploitation, an educational programme is recommended to inform employees and their families of legal requirements and responsibilities towards wildlife.

This should be conducted in a participatory manner since many of the local population may

already be well informed on the renewable natural resources of the area and be a useful source of knowledge. The environmental educational programme could be conducted/facilitated by the on-site specialist already referred to in the construction impacts section.

Road signs warning should be erected on trails and imposing stricter speed limits can be erected at suitable locations.

Depending on the wildlife that is detected, drivers should be given briefings to operate in such a way as to reduce road-kills and to report sightings of wildlife of interest.

Chapter 8.0 AMBIENT AIR QUALITY

This chapter identifies the environmental impacts that may be caused by the construction phase of the project specifically workers camp related construction and operation, and, where possible, assesses the likely severity of these impacts based on current information. Measures to reduce the severity of the impacts identified are also proposed (termed “mitigation measures”). This chapter presents the findings, conclusions and recommendations arising from a Supplementary Study of the impacts on **Ambient Air Quality** the proposed clinker production facility and associated quarries (“the Project”).

This study is prepared in line with IFC’s Performance Standard 3 (PS3), Pollution Prevention and Abatement which aims to ensure that emissions to air and water arising from transport of raw materials including fuel, clinker manufacturing and quarrying operations, energy efficiency and possible use of alternative fuels, and issues related to the large number of trucks and drivers servicing facilities are minimized. This section presents the assessment of the potential impacts on the environment and local communities of quarry operation and clinker operational plant emissions and of vehicle emissions from plant traffic using the local trunk roads network.

8.1 Point Source Emissions

The pollutant emitted from the cement plant is Particulate matter. Sources of PM at cement plants include (1) limestone mining and crushing, (2) raw material storage, (3) grinding and blending (4) clinker production, (5) finish grinding, and (6) packaging and loading. The largest emission source of PM within cement plants is the pyro-processing system that includes the kiln and clinker cooler exhaust stacks.

Dust from the kiln is collected and recycled into the kiln thereby producing clinker from the dust. However, some of the dust is discarded or leached before returning it to the kiln. Additional sources of PM are raw material storage piles, conveyors, storage silos, and unloading facilities.

The sources of particulate emission from the proposed cement plant constitute flue gases from kiln and cooler. Other sources of particulate system include ventilation systems from limestone weigh feeder, Raw material storage silo, raw meal blending silo, clinker stock pile, clinker transport to cement mill, clinker transport at discharge end, clinker hopper at cement mill section, cement silo and packing machines.

All the pollution control equipment in the proposed cement plant are designed for an outlet emission of less than 30 mg/Nm^3 and the plant designers have to guarantee these values (performance guarantee) and these values will have to be verified during the production testing after construction.

NCCL has thus stated that the plant will be designed and operated to meet IFC and World Bank emission limit standards as stated in the EHS Guidelines for Cement Manufacturing. Therefore, the emissions from the facility should not exceed:

- Particulates 30 mg/Nm^3

- Oxides of Nitrogen (NO_x) 600 mg/Nm³
- Oxides of Sulphur (SO_x) 400 mg/Nm³

The maximum concentrations for all pollutants will have to be achieved without dilution (i.e. main stack to contain only process gases), at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours and for that reason NCCL will have to ensure controls on all pollutants and adhere to the guidelines laid out.

It is proposed to install a bag house for raw mill/kiln, bag filter for coal mill, and ESP for cooler. At all other sources, it is proposed to install suitable bag filter systems. The dust collected from the various pollution control equipment will be recycled in the cement manufacturing process

Sulphur dioxide is generated both from the sulphur compounds in the raw materials and from sulphur in the fuel. However, the alkaline nature of the cement provides for direct absorption of SO₂ into the product, thereby mitigating the quantity of SO₂ emissions in the exhaust stream. SO₂ emissions of the kiln are influenced by the operation of the raw mill kiln, where considerable amount of SO₂ generated in the kiln process gets absorbed in the raw material (about 80%).

Oxides of nitrogen are generated during fuel combustion by oxidation of chemically bound nitrogen in the fuel and by thermal fixation of nitrogen in the combustion air. As flame temperature increases, the amount of thermally generated NO_x increases, and the amount of NO_x generated from fuel increases with the quantity of nitrogen in the fuel. In the cement manufacturing process, NO_x is generated in the burning zone of the kiln and the burning zone of a pre-calcining vessel. Fuel use affects the quantity and type of NO_x generated.

In order to control NO_x emission of kiln, an automatic kiln control system will be installed for maintaining constant burning conditions in kiln thereby reducing the NO_x emission. A well-designed burner system shall limit the core flame temperature to ensure a reasonably low value of NO_x generation.

In view of the firing technique of keeping a positive oxygen balance, emission of CO shall be minimal.

Each point source is identified based on the location of the each stack and emission strength and flue gas properties.

The list of point sources and their characteristics are discussed in **Table 11**. For the purpose of air pollution modeling, controlled emissions at the outlet of each pollution control system have been considered.

8.2 Area Source Emissions

Area source emissions are described as the emissions generated during the handling of raw material and other intermediate material in the plant. In cement plants, the major area source emissions will be the dust generation from clinker stockpile and raw material stockpiles etc.

However, in the proposed plant, a closed clinker stockpile has been proposed and suitable ventilation system with bag filter is proposed and hence the emissions from the stockpiles have been considered as point sources with controlled emissions.

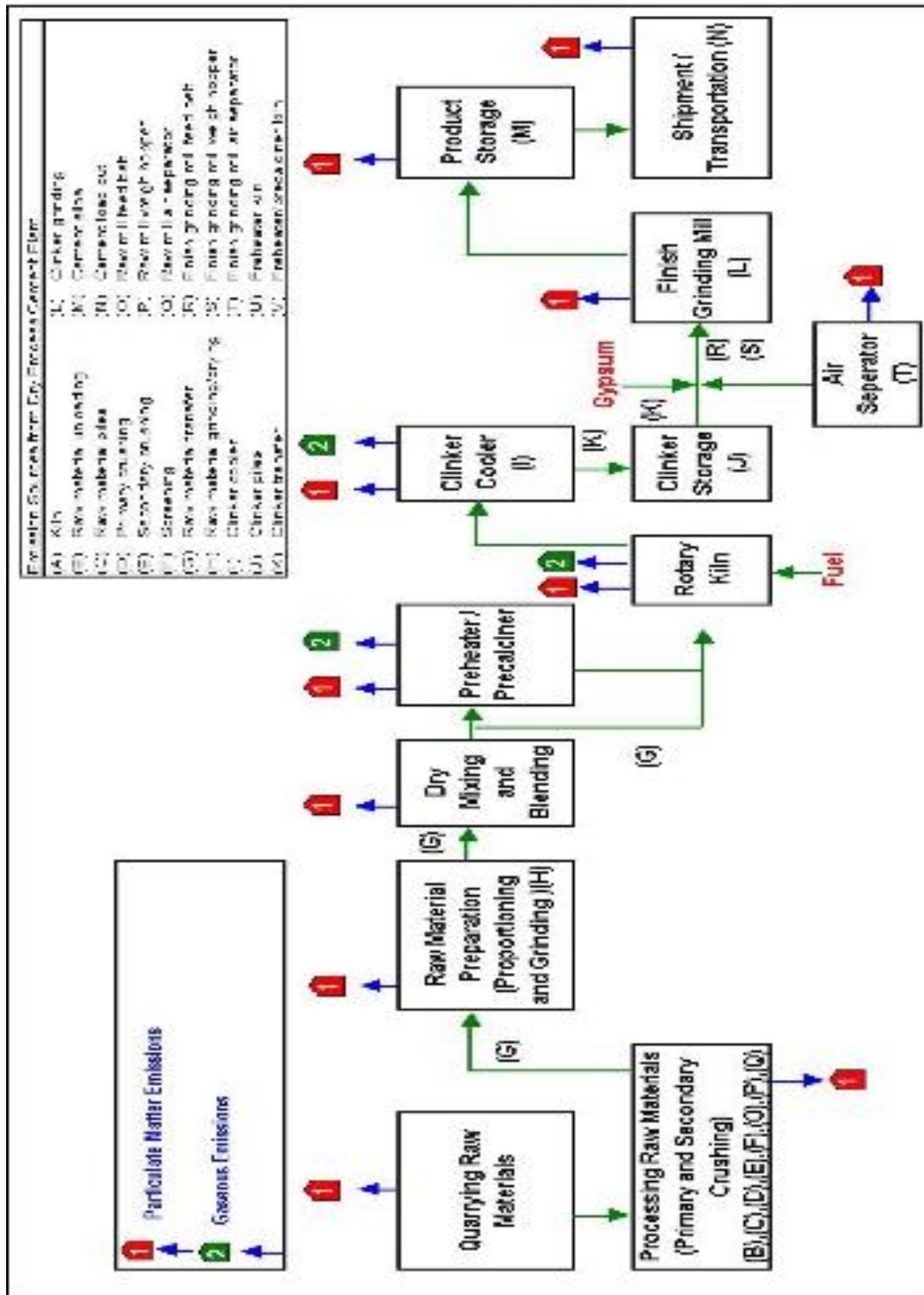


Figure 23. Diagram of Emission Sources

A detailed air dispersion modeling study was undertaken for the proposed plant including the quarries. The aim of the study was to determine increases to ground level concentrations of pollutants resulting from the routine stack emissions during the operation of the plant.

The AUSPLUME prognostic air dispersion model was used in the air quality assessment. AUSPLUME is a Gaussian plume dispersion model with algorithms based on the Industrial Source Complex - Short Term (ISCST3) model.

The model uses the Gaussian dispersion model equations to simulate the dispersion of a plume from point, area or volume sources. Mechanisms for determining the effect of terrain on plume dispersion are also provided.

AUSPLUME operates on an hourly time step, and, therefore, requires hourly wind speed, wind direction and other dispersion parameter data. The dispersion of each pollutant plume is determined for each hour using conventional Gaussian model assumptions. It should be noted that Gaussian models are best used to identify pollutant concentrations at receptor locations close to emissions sources, as they can overestimate concentrations at longer distances.

Atmospheric dispersion modelling was conducted using AUSPLUME 6.0 (the latest approved version of the model) in accordance with the Department of Environment, Climate Change and Water (DECCW) Approved Methods (DEC NSW, 2005). The document prescribes calculation modes for accounting for terrain effects, building wake effects, horizontal and vertical dispersion curves, buoyancy effects, surface roughness, plume rise, wind speed categories and wind profile exponents.

Model Inputs

AUSPLUME requires six main categories of data to estimate the dispersion of air emissions:

- Meteorology;
- Terrain effects;
- Building wake effects;
- Modeling scenarios - worst case typical operations
- Source characteristics; and
- Emissions inventory.

The plant discharge characteristics were as advised by NCCL.

This section describes;

1. Methodology used for the air dispersion including various meteorological and geographical/topography data inputs used;
2. Emissions to the air from the clinker plant
3. Results of the air dispersion modeling;

8.3 Dispersion Modelling

The study examined combustion gas emissions from the kiln stack and particulate emissions from kiln, clinker cooler and coal mill.

Table 11. Stack Characteristics/Source and Release Characteristics

	Height	Diameter	Velocity	Temp	Emission Rate (g/s)			IFC Standard			Des. Capacity of PM
Source	M	M	M/S	0c	SPM	SO ₂	NO _x	SPM (mg/Nm ³)	SO ₂ (mg/Nm ³)	NO _x (mg/Nm ³)	
Clinker Cooler ESP	36m	2.5m	14.15	300	5.76	0	0	50	-	-	25
Kiln Raw Mill	144.5m	5.1m	8.72	94	2.13	31.44	130.46	30	400	600	25
Fuel/Coal Mill	40m	1200mm	13.67	95.3	0.41	0	0	50	-	-	25

8.4 Ambient Air Quality Findings

The concentration of NO₂, SO₂, CO and the weighed substances reflect a baseline condition of a surface layer of atmosphere in the territory of projected plant. The area does not experience any form of significant anthropogenous influence and the screening content in a surface layer of atmosphere, heavy metals in soils and plants remained at environmental level.

This project must provide assurance that the appropriate benchmarks for air emissions will be followed and that the project will comply with in particular oxides of nitrogen.

NCCL has stated that the plant will be designed and operated to meet IFC and World Bank emission limit standards as stated in the EHS Guidelines for Cement Manufacturing. Therefore, the emissions from the facility should not exceed:

- Particulates 30 mg/Nm³
- Oxides of Nitrogen (NO_x) 600 mg/Nm³
- Oxides of Sulphur (SO_x) 400 mg/Nm³

The maximum concentrations for all pollutants will have to be achieved without dilution (i.e. main stack to contain only process gases), at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours and for that reason NCCL will have to ensure controls on all pollutants and adhere to the guidelines laid out.

According to the NCCL designs and operation the clinker plant, quarries and associated infrastructure developments will comply with the appropriate IFC design and operational standards.

With regards to emissions of oxides of nitrogen the plant will operate in line with Kenyan requirements and World Bank international standards. NCCL indicate that they will operate within the IFC limits without the need for NO_x abatement technologies.

There will be no adverse impact on local air quality as a result of the proposed emissions of oxides of nitrogen according to the air impact modeling assessment.

An assessment when the plant is operational of the air emissions impact and whether the installation of abatement technologies is necessary will be undertaken by the operator as part of the management plan. The plant has been designed to ease the retrofitting of abatement technologies should this be deemed necessary at a later date.

With regards to emissions to air, construction activities can generate dust that can cause a nuisance to local residents and cause a health risk to construction workers. As the nearest residential receptors are approximately 2km from the main development site (Merrueshi Trading Centre) it is considered unlikely that there will be an impact on local people.

The main risk is considered to be the exposure of workers on site. Dust control measures, together with the use of appropriate personal protective equipment and appropriate maintenance of vehicles will be used to mitigate this impact. The impact of emissions of vehicle exhaust gases on air quality is considered negligible.

Ambient Air Quality

The prime objective of the ambient air quality study is to establish the existing ambient air quality within the study area and its conformity to standards specified. The study area represents mostly rural environment with sparse habitation and the ambient air quality levels are expected to be much less than the standards set by EHS guidelines.

The sources of air pollution in the Merrueshi area are dust arising from unpaved roads and vehicular movement, etc. Other air pollution sources in the area include, cooking using fuel wood, charcoal production, etc.

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality-monitoring network based on the following considerations:

1. Topography of the study area
2. Representatives of likely impact areas within the study area
3. Meteorological conditions
4. Location of residential areas representing different activities

The following three sampling sites selected are:

1. Quarry site
2. Clinker Plant Site
3. Merrueshi Trading Centre (closest settlement area from project)

The ambient air quality monitoring was carried out during the period 10th -20th September. The parameters monitored include;

1. Oxides of Nitrogen (NO_x),
2. Sulphur Dioxide (SO₂),
3. Total Suspended Particulate Matter (TSPM),

4. Respirable Particulate Matter (PM₁₀), and
5. Carbon Monoxide (CO).



Figure 24. Air Emission Expert sampling air on site



Figure 25. Equipment for air emission sampling on site

8.5 Results of The Ambient Air Quality Monitoring

The results of the air quality monitoring at three locations are summarized in **Table 12 below**. Eight hourly sampling for 24 hours continuously has been carried out on 10 days at each location.

Table 12. Results of Ambient Air Quality

Parameters	Concentration ($\mu\text{g}/\text{m}^3$)		
	Clinker Plant Site	Quarry Site	Merrueshi Trading C
SPM	1.12	1.12	1.1
PM 10	1.12	1.09	1.0
So _x			

	< 0.01	< 0.01	< 0.01
NO_x			
	< 0.01	< 0.01	< 0.01
CO₂			
	< 0.01	< 0.01	< 0.01

The WHO Air Quality Guidelines as revised in their Global Update 2005 are summarized in Table 13.

Table 13. Updated WHO Air Quality Guidelines Values, $\mu\text{g}/\text{m}^3$

Pollutant	Average Time	Guideline Value $\mu\text{g}/\text{m}^3$
Particulate Matter		
PM _{2.5}	1 Year	10
	24 hour (99 th percentile)	25
PM ₁₀	1 Year	20
	24 hour (99 th percentile)	50
Nitrogen dioxide, NO ₂	1 Year	40
	1 Hour	200
Sulphur dioxide, SO ₂	24 Hour	20
	10 minute	500

The table above shows that all the parameters monitored are within the WHO guidelines and standards. The concentrations of SO₂, CO, and NO₂ are below the international guideline values.

Table 14 below gives the emission guidelines for the cement sector. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques. These levels should be achieved, without dilution, at least 95% of the time that the plant is operating, to be calculated as a proportion of annual operating hours.

Table 14: EHS Emission Guidelines Cement Sector

	Pollutants	Units	Guideline Value
1	Particulate Matter (new kiln systems)	mg/ Nm ³	30a
2	Dust (Other point sources including clinker cooling, cement grinding)	mg/ Nm ³	50
3	SO ₂	mg/ Nm ³	400
4	NO _x	mg/ Nm ³	600
5	HCl	mg/ Nm ³	10b
6	Hydrogen fluoride	mg/ Nm ³	1b
7	Total organic carbon	mg/ Nm ³	10
8	Dioxins-furans	mgTEQ/Nm ³	0.1b
9	Cadmium & Thallium (Cd+Tl)	mg/ Nm ³	0.05b
10	Mercury (Hg)	mg/ Nm ³	0.05b
11	Total Metalsc	mg/ Nm ³	0.5

Notes

* Emissions from the kiln stack unless otherwise noted. Daily average values corrected to 273K, 101.3 kPa, 10 percent O₂ and dry gas, unless otherwise noted

^a 10 mg/ Nm³ if more than 40 percent of the resulting heat release comes from hazardous waste.

^b If more than 40 percent of the resulting heat release comes from hazardous waste average values over the sample period of a minimum of 30 minutes and a maximum of 8 hours.

^c Total Metals = Arsenic (As), Lead (Pb), Cobalt (Co), Chromium (Cr), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V) and Antimony (Sb)

Table 15. Maximum Pollutant Increments at Representative Locations, µg/m³

Pollutant	PM ₁₀ (ug/m ³)		CO (mg/m ³)		SO ₂ (ug/m ³)			NO _x (ug/m ³)			NO ₂ (ug/m ³)		
Receptor	24hr	Annual	8hr	Annual	1 hr	24hr	Annual	1 hr	99.79th percentile	Annual	1 hr	99.79th percentile	Annual
Coal Mill	2.39	0.19	0.29	0.63	37.3	1.88	0.09	1212	253	5.38	188	45	0.52
Kiln	1.45	0.12	0.08	0.17	12.2	0.74	0.04	479	43.5	0.88	54	5.8	0.06
Cooler ESP	3.37	0.27	0.42	0.97	4.8	0.309	0.02	155	27.2	0.63	9	3.7	0.04

8.6 Adverse Impacts

Construction Phase

During the construction process (quarry, clinker plant) certain activities are likely to affect air quality mainly as a result of dust created by activities during demolition, completion of ground works and construction. In addition, construction plant and vehicles can affect air quality as a result of exhaust emissions. Dust emission is likely to adversely affect the human health and affect the vegetation cover.

Areas with or experiencing dry weather combined with high winds are favourable conditions for dust generation. Continual or severe concerns are most likely near to dust sources, usually within 100 metres, which in this case mean that there are no severe concerns because the project site is not within any residential habitation.

Mitigation Measures

Measures that may be employed include:

1. Sheeting vehicles carrying dusty materials to prevent materials being blown from the vehicles whilst travelling;
2. Employing suitable measures to ensure that vehicles leaving the site do not entrain dust onto public roads.
3. Enforcing speed limits for vehicles on unmade surfaces to minimise dust entrainment and dispersion; and
4. Water-spraying of roads, surfaces prior to being worked, and material stockpiles to minimise dust raising, as required;

Effects During Operation

The potential effects of the proposed development during operation can be divided as follows:

- Impacts on air quality as a result of emissions from the clinker production process and dust from the quarry activities and crushing and grinding processes.
- Also, international scale impacts as a result of the emissions of greenhouse gases from the production process.

It was concluded that at all sensitive receptors, the maximum changes in sulphur dioxide, carbon monoxide, particulate matter and annual average nitrogen dioxide concentrations due to plant operation are a small fraction of the relevant air quality criteria, and future air quality will remain well within these criteria.

The principal emission from the kiln is oxides of nitrogen. This leads to increases in nitrogen dioxide concentrations (a secondary pollutant). Given the likely very good existing background air quality in these largely rural locations, air quality will remain well within the hourly limit value.

The overall conclusion from the dispersion modeling study is that when the plant is in operation future air quality will be well within the IFC limits and WHO guidelines specified for the protection of human health. These limits are set well below the levels at which there are any observable effects on human health or respiratory function in order to protect vulnerable individuals within the population. On that basis, it is concluded that there will be no adverse health effects in the local population due to the operation of the cement plant.

The project does not intend to use ammonia (NH₃) or other additives be needed for a Selective Non-Catalytic Reduction (SNCR) to reduce NO_x emissions to within IFC EHS Guidelines for Cement Manufacturing.

8.7 Impact of technology choices and process design on energy, water efficiency and minimization of GHGs

Process Technology

Well known and established, dry process shall be used for manufacturing of cement. A production process technology has been recommended which consumes only the minimum possible process water and cooling water. The installation of bag filters instead of ESPs eliminates the need of water spray towers for exhaust gas conditioning.

Energy Supply

The availability of power in Kenya is largely based on hydroelectric generation and may be considered reliable. The main feeder line passes close to the project site and a substation shall be constructed here and a power line at 132 kV will be drawn over a distance of 36 km. Sufficient power is available for supply to the plant. This project will not adversely affect demand for electricity in a significant way.

Fuel Supply

Imported coal has been considered as the main fuel for the plant and will be sourced from South Africa.

Water Efficiency

The exploitation of water resources during the operation will not affect the water availability in the area for other competing users and the overall impact may be rated as adverse, long term and medium.

Chapter 9. NOISE EMISSION BASELINE-LUKENYA PLANT

EMC Consultants Limited carried out noise level survey at National Cement Company Limited (NCCL), which is situated off Mombasa road and opposite Lukenya hills. This chapter describes the noise survey methodology, the measurement parameters and the results of the noise survey including the likely impacts of noise emissions by the plant on the environment.

The noise emission baseline assessment of the cement manufacturing plant in Lukenya is a supporting technical document to assist in assessing the effects of the existing project (NCCL) on noise levels.

Even though, the Terms of Reference (ToR) for this assessment required use of computer based noise model prediction, in view of the fact that the project is already operational, with no further intention by NCCL to expand in the near future, use of a computer-based noise prediction model to predict noise levels area for various scenarios (operating cases) was not undertaken, instead, the assessment measured the actual noise levels which serve as a baseline for future monitoring and mitigation.

This study based on the findings concludes that noise levels recorded from locations within the boundary and the sensitive receptors are within the IFC/World Bank Environmental, Health and Safety Guidelines which indicate that for industrial and commercial areas, noise levels should not exceed 70 dB (A).

The noise propagation towards the western boundary is slightly higher; this implies that the distance between point source and the western boundary is very small. The mills need to be partially covered so as to reduce the noise levels being emitted to the boundary points and warning signage's to be erected at the entrance.

9.1 Objective

The objective of the survey was to compare the surveyed noise data emanating from the cement plant with the stipulated national and international regulations. The measurements were carried out at various point sources, the plant boundary and identified sensitive receptors. The methodology used was SGS protocol on noise data collection, which borrows heavily from ISO 1996/1, 2, 3 standards.

9.2 Project Description

The National Cement Company Limited (NCCL) plant has 3 cement milling lines with a total combined capacity of 4,400 tonnes per day. The plant has 3 crusher machines, 3 packing plants, 3 silo stores for finished products and raw materials warehouses. The raw materials used in the plant are mainly clinker (imported) as well as pozollana (ordinary and Portland) and gypsum.



Figure 26. Aerial view of National Cement Plant in Lukenya

9.3 Project Site Description

The project site is located off Mombasa road opposite Lukenya hills. The location of the plant is predominantly rural with dotted residential structures and accommodation facilities. Towards the south boundary of the plant, an upcoming building (Golden Africa Limited), an edible oil manufacturing industry, 2 **Kilometres** away towards Lukenya Hill, an educational facility (an orphanage) exists, and 1.5 **Kilometers** northwards there is a hotel (Small World), which is found at the junction to Acacia Camp, which is another accommodation facility.

At the main entrance gate of NCCL, passes the main highway (Mombasa road), which has traffic load of approximately 150 motorists per every ten minutes on a weekday. The described locations (sensitive receptors) are distributed around the site and are within a radius of 3 kms. A topographical map showing the general developments in the area is shown in **Figure 27**.

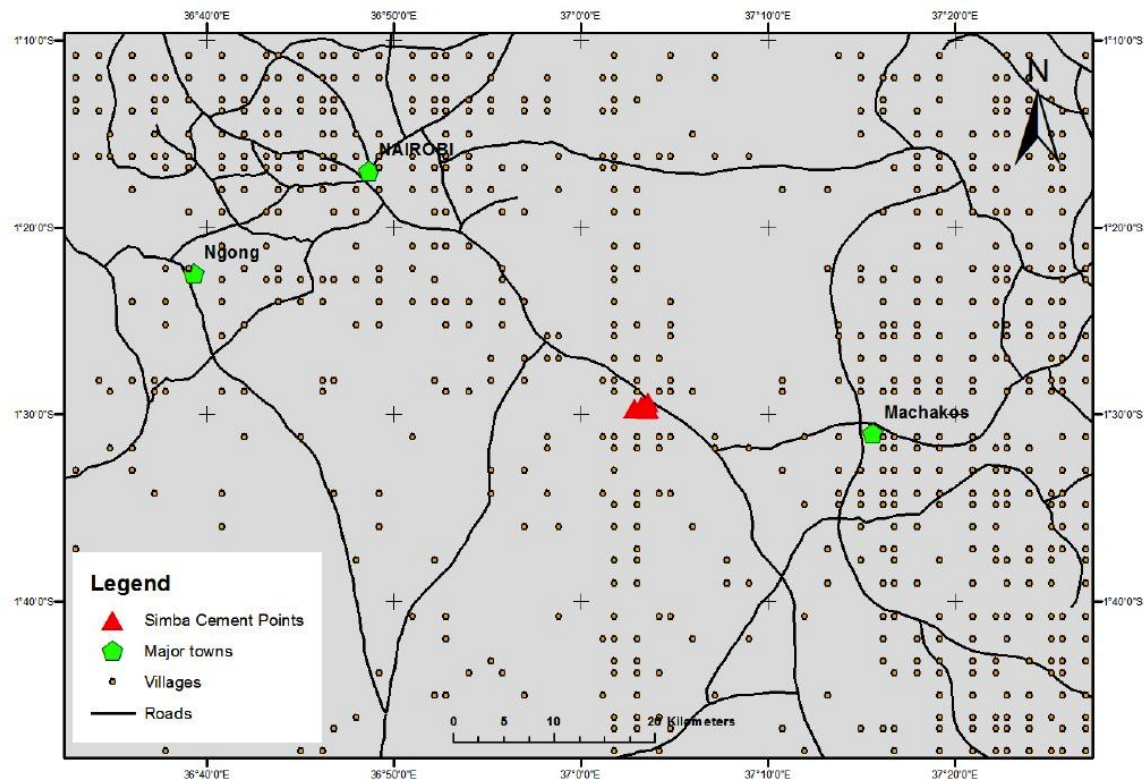


Figure 27. Map showing Lukenya Plant and Settlements

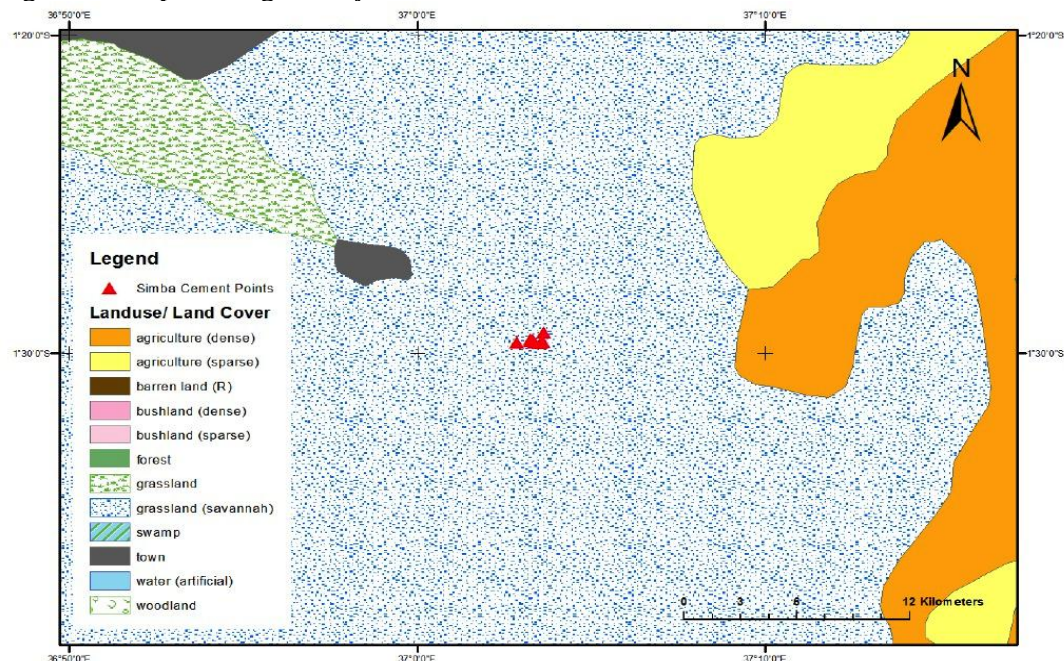


Figure 28. Map showing Lukenya Plant and adjacent land uses/cover

9.4 International and National Legislation

The noise level measurements were undertaken against the following legislation and guidelines; namely: Excessive Noise and Vibration Control Rules, 2009 (Legal Notice, No. 61); World

Health Organization (WHO) guidelines for community noise and World Bank (IFC) Environmental, Health and Safety Guidelines (EHS).

IFC/World Bank Environmental, Health and Safety Guidelines

IFC Noise Management Guidelines propose that where predicted or measured noise impacts from a project exceed the applicable noise level guideline at the most sensitive point of reception, noise prevention and mitigation measures be put in place. The guidelines indicate that for industrial and commercial areas, noise levels should not exceed **70 dB(A)**. For residential, institutional and educational areas, noise levels should not exceed **55 dB(A)** during day (07:00 to 22:00 Hrs) and **45 dB(A)** during night (22:00 to 07:00 Hrs). In both cases a maximum increase of 3 dB (A) is allowed where background noise already exceeds the guideline value.

Table 16: (WB/IFC Group) Noise Management Guidelines

Receptor	One Hour LA _{eq} (dBA)	
	07:00 – 22:00hrs	22:00 – 07:00hrs
Residential; institutional; educational	55	45
Industrial; commercial	70	70

World Health Organization, Guidelines for Community Health

Table 17: WHO Guidelines for Community Noise In Specific Environments

Specific Environment	Critical health Effects	LA _{eq} (dB)	Time Base (Hrs)	L _{Amax} , (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
School, Playground Outdoor	Annoyance (External source)	55	During play	-

9.5 Noise Measurement Methodology

The noise measurements were carried as per the ISO 1996 standards, entailing the following:

1. Suitable monitoring locations were identified taking cognizance of sensitive receptors. The measured points were identified with a GPS. Photographs and physical descriptions were also detailed for each point.
2. Measurements were done in all the identified locations during the 24-hour period. For all the measured points, L_{Aeq} , L_{Amax} and L_{Amin} , were noted. The total measurement was divided into 10 minutes periods for each point covering different conditions.
3. Verification/calibration of the sound level meter was undertaken before and after the measurements.
4. Noise levels were measured at a height of 1.5m above local ground level and at least 3 meters from any façade at the measurement points.
5. Measurements were only collected in dry, clear conditions. Wind speed was less than 5m/s the speed was measured using a handheld anemometer.

Survey Locations

The following areas were chosen to be representative of the closest sensitive receptor points to the cement plant and were within a radius of 3kms. The **table** below describes the monitoring areas identified:

Table 18: Survey Locations

Points	Points Coordinates	Descriptions
1	01° 29' 34.8'' S 037° 03' 19.8'' E 1606 M	<u>Packing Plant</u> This is a source measurement point, whereby conveyer belts are used to aid in the loading of cement to the trucks.
2	01° 29' 36.9'' S 037° 03' 17.0'' E 1588 M	<u>Milling Plant 1, 2 and 3</u> This is the where the milling of raw materials take place including gypsum, clinker etc.
3	01° 29' 39.5'' S 037° 03' 22.6'' E 1604 M	<u>Road Pathway</u> This is the pathway used by trucks ferrying raw materials to and from the warehouses
4	01° 29' 33.9'' S 037° 03' 16.0'' E 1604 M	<u>Plant Boundary-Western</u> The point is located within a perimeter of the plant toward the western side, the immediate zone is a covered with mixture of tall trees and low lying shrubs
5	01° 29' 41.1'' S 037° 03' 33.6'' E	<u>Plant Boundary-Eastern</u> This point is located within the perimeter of the plant

	1608 M	east of the plant
6	01° 29' 38.8" S 037° 03' 36.6" E 1621 M	<u>Golden Africa Limited (Edible Oil Industry)</u> This point is located within a camp site 800 metres away from the western side of plant
7	01° 29' 39.3" S 037° 02' 52.2" E 1581 M	<u>Acacia Camp</u> This point is located 30 meters away from the perimeter fence east of the plant
8	01° 29' 19.9" S 037° 03' 38.2" E 1656 M	<u>Educational Facility (Kanini Orphanage)</u> This point is located 500 meters north east of site and is a homestead with tall trees covering the entire area

Table 19. Photographs of Survey Locations

SITE IDENTIFICATION	GPS COORDINATES	ELEVATIONS
Point Source Locations		
Packaging Plant Area	01° 29' 34.8" S 037° 03' 19.8" E 1606 M	
In front of Cement Mill 2, with mill 1 & 3 off	01° 29' 36.9" S 037° 03' 17.0" E 1588 M	

Pass way within site	01° 29' 39.5'' S 037° 03' 22.6'' E 1604 M	
Boundary Locations		
Boundary west of site	01° 29' 33.9'' S 037° 03' 16.0'' E 1604 M	
Boundary east of site	01° 29' 41.1'' S 037° 03' 33.6'' E 1608 M	
Receptors Locations		
Within Golden Africa ltd, east of site	01° 29' 38.8'' S 037° 03' 36.6'' E 1621 M	

Acacia camp site entrance, west of site	01° 29' 39.3'' S 037° 02' 52.2'' E 1581 M		
Kanini Orphanage, north east of site	01° 29' 19.9'' S 037° 03' 38.2'' E 1656 M		

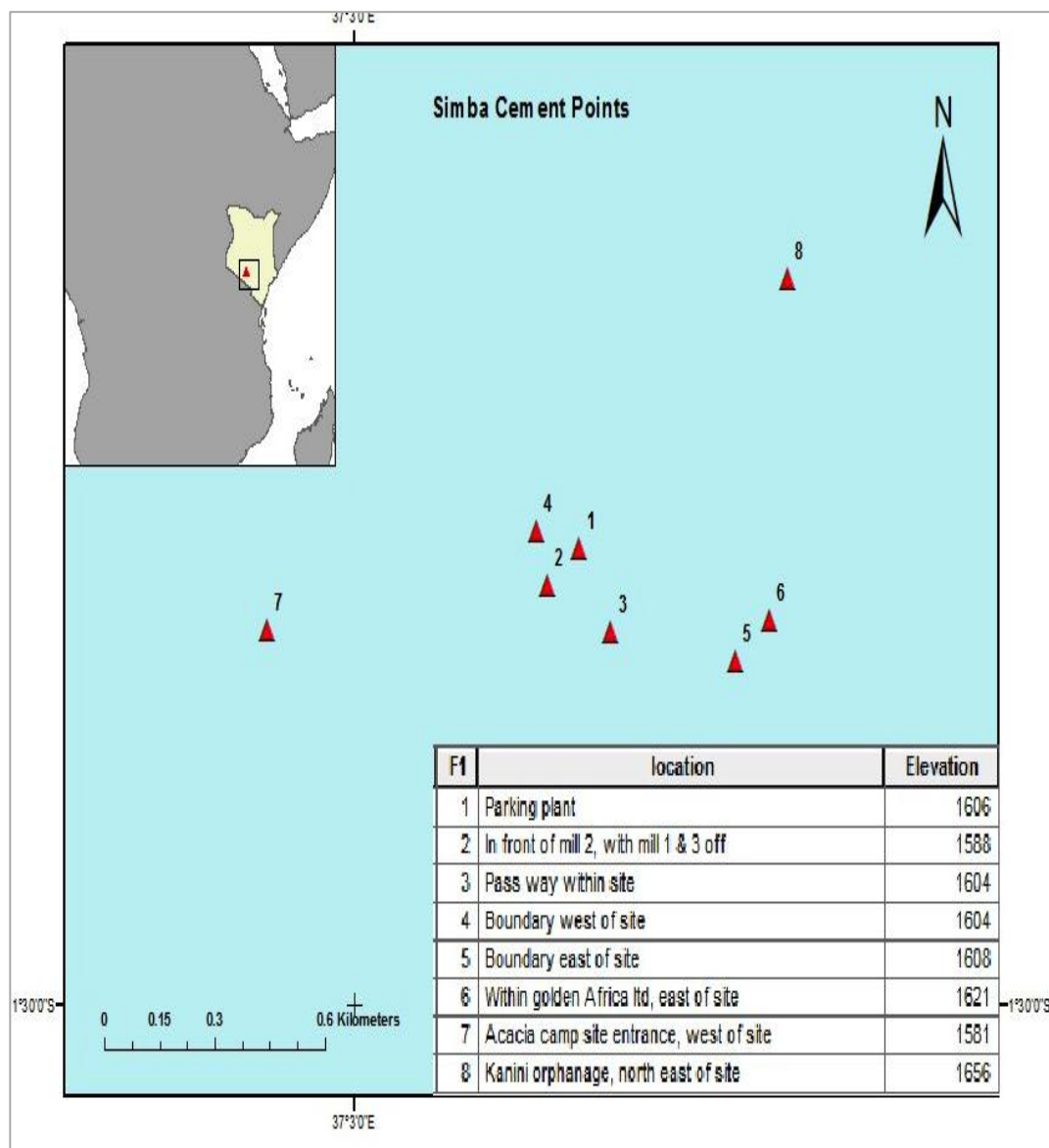


Figure 29. Map of GPS coordinates of survey locations

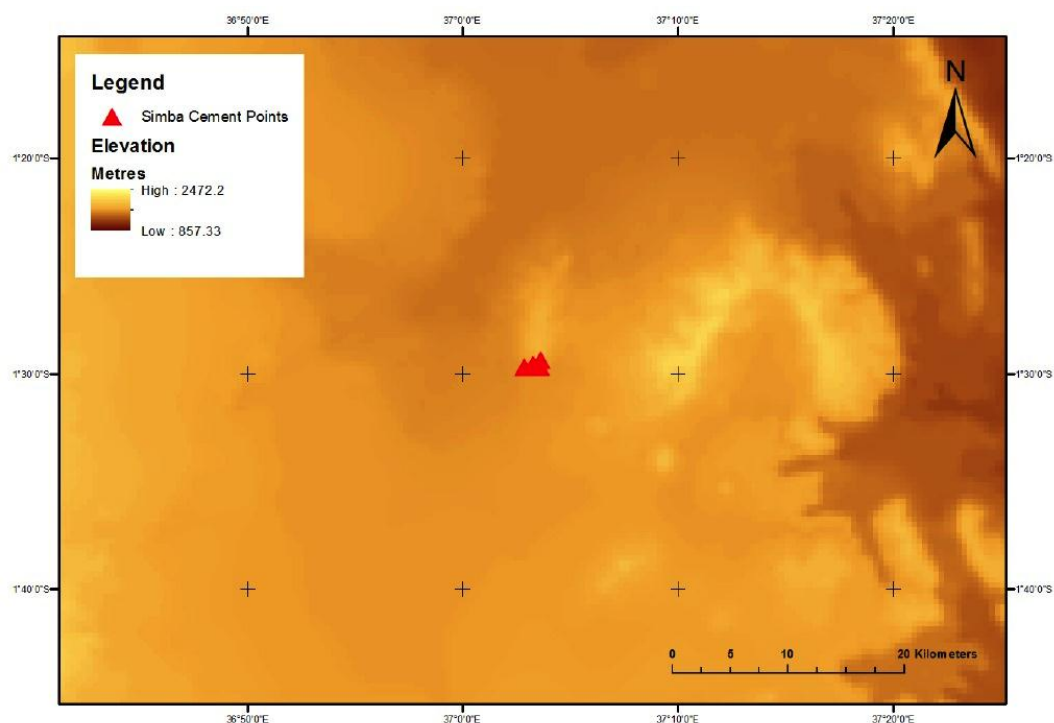


Figure 30. Elevation Map of Project Area

Weather conditions

Weather conditions during the survey were good. During the measurement day, the weather was dry with clear skies, day temperatures peaked at 31°C Wind speed were typically <1.0 m/s.



Figure 31. Photo above taken on the measurement date indicates clear sky.

Noise Sources

The major sources of noise within the plant area are shown in the table below.

Table 20. Noise Emission Sources

Noise Sources
Milling Plant Area
Crushing Machine Area
Conveyor Belt Areas
Passing Trucks
Packaging Plant Area

Instrumentation

The following instruments were used during the measurement:

1. Integrating Sound Level Meter (Manufacturers: Larson and Davis Model 824 SLM (with precision Type 1 accuracy) serial number: 002005
2. Open Field Microphone
3. GPS, Germin eTrex 12-Channel

Health and Safety

Prior to commencement of works the following health and safety measures were implemented to prevent any incidents while on site. The consultants were taken through the existing Health and Safety procedures of NCCL and provided with the safety gears before embarking on the survey.

The following parameters were measured as shown in Table 21 below.

Measurement Parameters
Lmax: Maximum sound pressure level obtained during the measurement period
Lmin: Minimum sound pressure level obtained during the period of measurement
Leq: The equivalent, continuous value of A-weighted sound pressure level of a continuous steady sound that, within a specified interval, has the same mean square sound pressure as sound under consideration whose level varies with time.
L90: Value of sound pressure, which is the level , exceeded for the 90% of the time under consideration.
L10, Value of sound pressure, which is the level , exceeded for the 10% of the time under consideration.

Noise Reading Results

Table xx below shows the results of the measurement taken from the different points within the plant and outside including the sensitive receptors.

Table 22. Noise Measurement Results

SITE IDENTIFICATION		GPS COORDINATES		Noise levels in decibels (dBa)					
				Leq	Lmax	Lmin	L90	Units	
Source Locations									
Packaging Plant	01° 29' 34.8'' S 037° 03' 19.8'' E 1606 M	75.2	80.0	72.6	73.1	dB(A)			
In front of mill 2, with mill 1 & 3 off	01° 29' 36.9'' S 037° 03' 17.0'' E 1588 M	94.1	95.2	92.6	93.1				
Pass way within site	01° 29' 39.5'' S 037° 03' 22.6'' E 1604 M	67.4	76.6	61.8	63.3				
Boundary Locations									
Boundary west of site	01° 29' 33.9'' S 037° 03' 16.0'' E 1604 M	67.3	71.5	60.5	61.9				
Boundary east of site	01° 29' 41.1'' S 037° 03' 33.6'' E 1608 M	57.0	65.7	52.9	53.9				
Receptors Locations									
Within golden Africa ltd, east of site	01° 29' 38.8'' S 037° 03' 36.6'' E 1621 M	48.9	52.4	47.2	47.6				
Acacia Camp Site entrance, west of site	01° 29' 39.3'' S 037° 02' 52.2'' E 1581 M	52.4	60.4	47.7	49.9				
Kanini Orphanage, north east of site	01° 29' 19.9'' S 037° 03' 38.2'' E 1656 M	40.2	50.8	36.0	36.8				

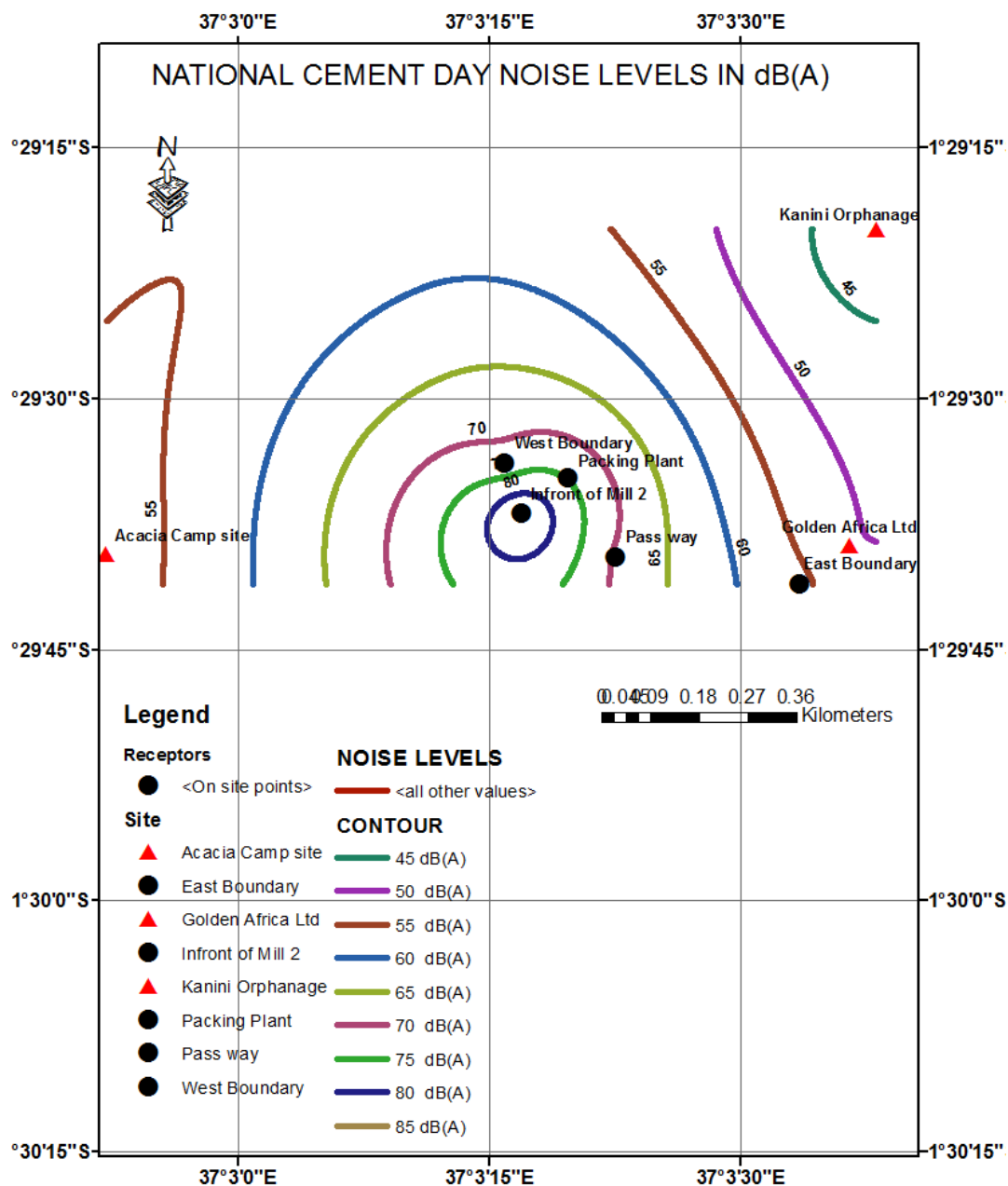


Figure 32. Noise Measurement Results at different points

From the collected noise survey data, it is clearly indicative that the noise level is higher at the source point and reduces as one increases distance outwards from the source point. The highest levels recorded was from the source point and it was **94.1 dB (A)**, while the lowest levels was registered from one of the receptor which is towards the hilly side at **40.2 dB (A)**.

The noise level propagations is on the decreasing mode and the affect could possibly be due to: the diminution of noise level due to distance as the sound energy spreads outwards from the source; the effects that natural and artificial barriers have on the sound, and the absorption of sound energy by the atmosphere, where some of the vibration energy of the sound is converted to heat in the atmosphere. Some sound energy is absorbed by vegetation.

The first cause of diminution of sound level due to distance (**see above**) is due primarily to geometric factors and is 6 dB each time the distance from the source to the receptor is doubled. The effect of natural and artificial barriers depends on the frequency of the sound and the geometry of the arrangement of the source, receptor and barrier as the larger area surrounding the site is majorly on vegetation cover. The absorption of noise in the atmosphere depends primarily on the frequency of the sound and the temperature and humidity of the atmosphere.

The registered schedule noise levels from measured locations within the boundary and receptors fulfill the IFC/World Bank Environmental, Health and Safety Guidelines, which indicate that for industrial and commercial areas, noise levels should not exceed 70 dB (A).

Calibration Verification Before and After Measurements

Calibration verification was carried out by the use of testo noise calibrator, which had been calibrated by Kenya Bureau of Standards (KEBS).

Table 23. Calibration Verification

Noise Monitoring Stations	Calibration in dB(A)			
	Diurnal		Nocturnal	
	Before	After	Before	After
Packaging Plant	94.5 104.5	94.4 104.4	94.4 104.3	94.3 104.4
In front of mill 2, with mill 1 & 3 off	94.3 104.4	94.4 104.6	94.4 104.4	94.3 104.2
Pass way within site	94.6 104.5	94.5 104.4	94.5 104.4	94.4 104.3
Boundary west of site	94.7 104.9	94.5 104.8	94.6 104.7	94.5 104.6

Conclusion

Mitigation measures to reduce noise emission are already almost fully developed within the plant. The noise propagation towards the western boundary is slightly higher; this implies that the distance between point source and the western boundary is very small. The mills need to be enclosed partially so as to reduce the noise levels propagation to the boundary points and warning signage's to be erected at the entrance. Within the plant, NCCL should continue applying the international standards for occupational health and safety by ensuring that all workers within the plant are equipped with earmuffs to reduce the occupational related hazards to noise.

Chapter 10. AIR EMISSIONS BASELINE –LUKENYA PLANT

The chapter describes the methodology used in conducting the air emission measurements at the Lukenya Plant as well as the findings and mitigation measures proposed.

The objective of the study was to establish the ambient air quality data in and around the NCCL cement manufacturing plant at Lukenya; (ii) assess the current impact of the plant's operations on air quality.

The measurements were done to evaluate concentrations of the following: particulate matter PM, in the environment in relation to the applicable guidelines provided by the Draft Air Quality guidelines and the World Health Organization (WHO). The data was collected for a maximum of 24 hours. The data is reported for the period of collection.

10.1 Scope of Work

The scope of work was as follows:

- Identify suitable monitoring locations taking cognizance of wind patterns within the vicinity of the measured site.
- Undertake monitoring for PM₁₀, collecting a twenty four hours sample per location/point.

10.2 Legislation and Guidelines

The air quality was assessed against the following legislation and guidelines; The Environmental management and coordination (Draft Air Quality Regulations) and the WHO air quality guidelines for particulate matter, *Global update 2005*.

NEMA (Air Quality Standards) Regulations, 2008 (Draft)

The draft air quality guidelines have the objective to provide for prevention, control and abatement of air pollution to ensure clean and healthy ambient air. Part 65 and 66 details the requirements on monitoring and assessment of ambient air quality, part 85 shows the need for establishment of baseline levels of priority air pollutants listed in the first schedule of the guideline and include; particulate matter, nitrogen dioxide and sulphur dioxide. The limits included in the Draft Air quality guidelines are shown in **Table 24** below.

Table 24: Ambient Air Quality Tolerance Limits

Pollutant	TWA	Industrial Area	Residential, rural and other area
Particulate Matter (<10µm)	24hrs*	120µg/m ³	60 µg/m ³

*These 24hr limits may not be exceeded more than three times in one year. Further, Table 25. Ambient Air quality at Property Boundary and further provides guidelines for pollutant concentrations at the property boundary.

Table 25. Ambient Air quality at Property Boundary

Pollutant	TWA	Property Boundary
-----------	-----	-------------------

Particulate Matter	24hrs	70 $\mu\text{g}/\text{m}^3$
	Annual Average	50 $\mu\text{g}/\text{m}^3$

WHO Air Quality Guidelines, Global Update 2005

The WHO air quality guidelines (AQGs) are designed to achieve air quality that protects public health in different contexts and to offer guidance in reducing the health impacts of air pollution. The guidelines are based on expert evaluation of current scientific evidence. The guidelines recommend that pollutant concentrations be measured at monitoring sites that are representative of population exposures.

Table 26: WHO Ambient air quality guidelines

Particulate matter	Guideline Value
PM ₁₀	20 $\mu\text{g}/\text{m}^3$ annual mean 50 $\mu\text{g}/\text{m}^3$ 24-hr mean

10.3 Air Emission Collection Methodology

Minivol samplers

Minivol air samplers were used at the selected locations for fine particulate monitoring. The Minivol portable air sampler is an ambient air sampler for particulate matter. The sampler is positioned with the intake upward in an unobstructed area, free from any obstruction to airflow. The sampler is fitted with a PM₁₀ inlet, which only allows for particles of an aerodynamic diameter of less than 10 μm (PM₁₀) to pass through it. The sample is drawn through the unit at a predetermined flow rate and collected onto filter papers over typically 24-hr sampling periods. **Figure 33** below shows an image of the Minivol sampler.



Figure 33: An image of Minivol air sampler

While not a reference method sampler, the mass concentrations of the MiniVol™ TAS gives results that closely agree with reference method concentrations in accuracy and precision. The MiniVol™ TAS features a programmable timer, a constant flow control system, an elapsed time totalizer, rechargeable battery packs, and an all-weather enclosure.

10.4 Sampling Locations and Description

The location of the plant is in a designated industrial zone with very few developments. Within the vicinity of the site, there are few sensitive receptors i.e. Acacia Camp and Kanini Orphanage situated to the North East of the facility.

Table 27. Sampling Points

Points	Points coordinates	Descriptions
PT 1 MILL 1	01° 29' 38.3'' S 037° 03' 18.4'' E 1608 M	This is a source measurement point, area around mill 1, where milling is conducted
PT 2 MILL 2&3	01° 29' 38.0'' S 037° 03' 17.5'' E 1600 M	This is the area around mill 2 & 3, where the milling of raw materials take place

PT 3 CRUSHER	01° 29' 42.9'' S 037° 03' 18.6'' E 1597 M	This is the pathway used by the trucks ferrying raw materials to the warehouses
PT 4 PACKING PLANT	01° 29' 34.8'' S 037° 03' 19.8'' E 1606 M	This is a source measurement point, whereby conveyer belts are used to aid in the loading of cement to the trucks
PT 5	01° 29' 33.9'' S 037° 03' 16.0'' E 1604 M	The point is located within a perimeter of the plant toward the western side, the immediate zone is a covered with mixture of tall trees and low lying shrubs
PT 6	01° 29' 41.1'' S 037° 03' 33.6'' E 1608 M	This point is located within the perimeter of the plant east of the plant
PT 7	01° 29' 38.8'' S 037° 03' 36.6'' E 1621 M	This point is located within a camp site 800 metres away from the western side of plant
PT 8	01° 29' 39.3'' S 037° 02' 52.2'' E 1581 M	This point is located 30 meters away from the perimeter fence east of the plant

Figure 28. Photographs of sampled sites

	Measurements at PT 1 Underway
	Fugitive dust being blown by wind at PT 2
	Measurement at PT 2

	Settled cement dust within the mill area
	Photo showing mill 1 & 2
	Measurement at crusher area
	Measurement at one of the receptor (acacia camp)

	Measurement within the packing plant
	Measurement taking place at the main gate
	Boundary west of site, machine mounted on electric pole
	Measurement at kanini orphanage

Meteorological Conditions

Weather conditions observed during the survey period were mainly dry with clear skies. Day temperatures peaked at 31°C during the day. Wind speed was averagely below 5m/s.

Figure 34. Sampling locations



PM₁₀ Sampling Results

Figure 35 show the trend analysis of the PM₁₀ and the performance against the Draft Air Quality Guidelines and the WHO guidelines for each of the measurement locations.

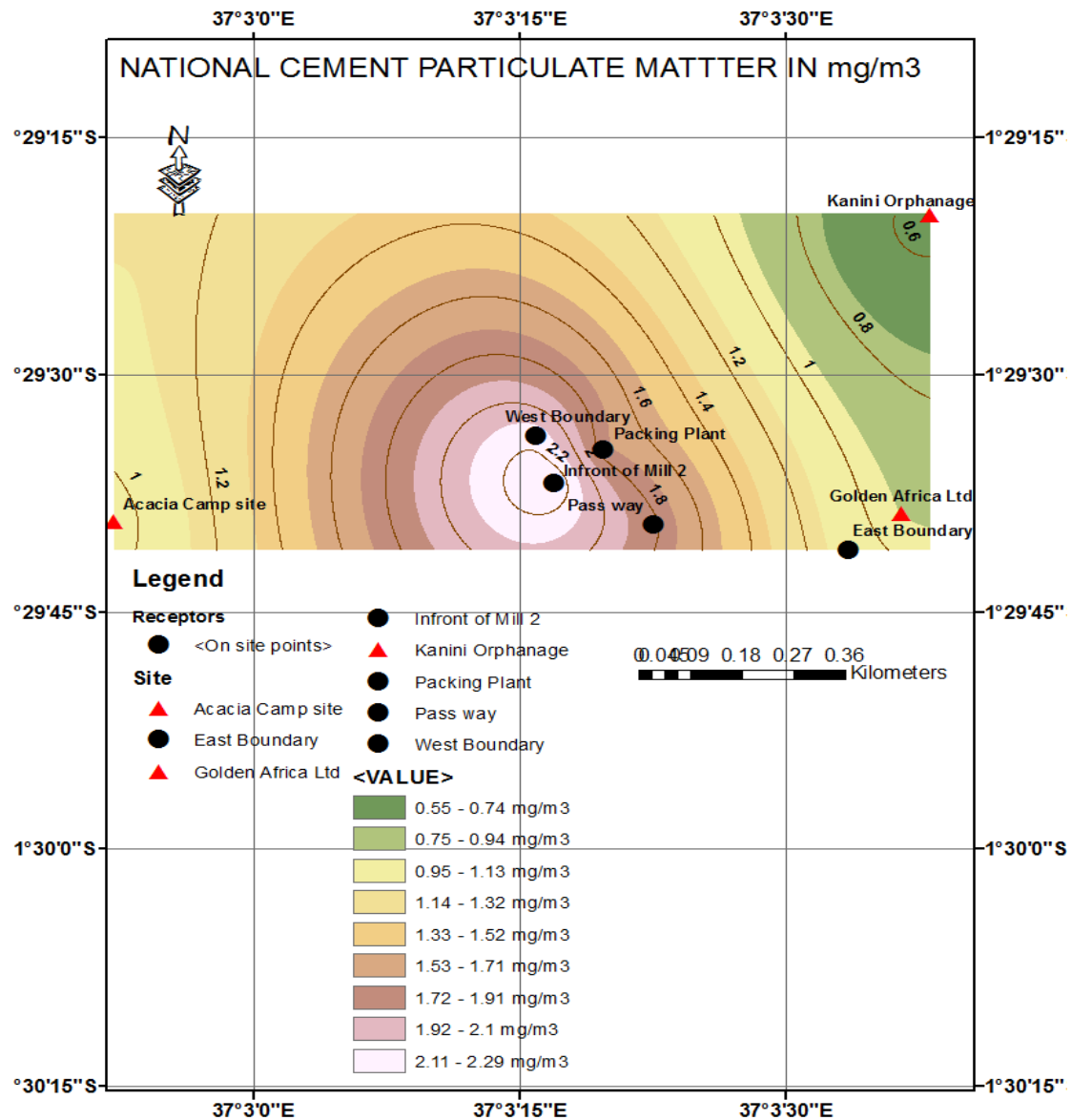


Figure 35. Sampling results

10.5 Existing Mitigation Measures

A series of mitigation measures have been put in place by the NCCL to minimise the impacts associated with dust within and outside of the plant and are described below.

1. Cement Packing Plant Area

NCCL has installed centralised bag filters for each packing plant and the bag filters are used to minimise emissions during transportation, packaging and distribution.

2. Raw Material Storage/Transfer Point

At each point where raw materials are transferred, bag filters have been installed. Raw materials including pozzolana and gypsum are stored in a **Covered Stock Pile (CSP)**. Raw materials from various destinations are transported in containerised/covered trucks.

3. Mills

In each mill, 2 bag filters have been installed as a mitigation measure to control dust emission.

4. Silos

All the 3 silos have been equipped with a bag filter.

5. Occupational Health and Safety

- All staff within NCCL are provided with dust masks and goggles to mitigate impacts associated with dust emissions.
- The plant is partially paved, however, consideration to pave the entire areas as mitigation measure should be given a priority.

10.6 Conclusion

The ambient PM concentration for the cement plant and its surrounding environment exceeded the WHO guideline value of $50 \mu\text{g}/\text{m}^3$ in all the measured points. The factors contributing to this scenario include among others;

1. Lukenya plant is located in an area, which is typically dusty and dust emissions emanate from various sources including adjacent cement production plants and in effect these findings are not fully attributed to the cement plant only.
2. The data was collected when NCCL was constructing a clinker plant and a cement bag manufacturing plant within the site and this has increased the dust emissions, which is expected to reduce once the constructions are completed.
3. The data was collected during a generally dry and dusty period (January) when dusts are a significant baseline phenomenon.

10.6 Recommendations

1. NCCL should pave the entire factory floor for ease of collection and removal of accumulated dust and to minimize dust emissions.

2. NCCL should conduct a risk assessment/exposure to silica quarts within the work place environment
3. Even though the plant has bag filters, NCCL should either install electronic monitors to establish levels of emissions (real time) or alternatively, in view of costs, conduct quarterly dust emission monitoring to establish levels in order to undertake remedial measures.
4. Landscape the site by growing trees in the site to reduce dust dispersal