MOMBASA CEMENT LTD (VIPINGO UNIT)

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GPS coordinates UTM X-0593567 & UTM Y- 9586780

PROPOSED EXPANSION OF MOMBASA CEMENT VIPINGO CLINKER AND CEMENT PRODUCTION PLANT

ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT

PROJECT REPORT REF NO: NEMA/PR/5/2/13,587

Compiled by:

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DECEMBER 2015

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Environmental Audit Report Submitted by

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HASHUMUKH PATEL

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Director

EXECUTIVE SUMMARY

This report presents finding of an environmental impact assessment study carried out for the proposed expansion of Mombasa Cement Limited Vipingo Unit. The EIA was carried out as provided for in the Environmental Management and Coordination Act, 1999 and the Environmental (Impact Assessment and Audit) Regulations 2003. Other relevant national legislations that were reviewed include; The Environmental Management and Coordination (Water Quality) Regulations, 2006, The Environmental Management and Coordination (Waste Management) Regulations, 2006, The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009, The Public Health Act, The Water Act of 2002, The Employment Act 2007, The Work Injuries Benefits Act 2007, The Labour Institutions Act 2007, The Occupational Safety and Health Act 2007, The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing) Regulations , he Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009, The Environmental (Impact Assessment and Audit) Regulations 2003, The Land Act 2012, The Energy Act 2006, The Environmental Management and Co-Ordination (Amendment) Act, 2015, The Environmental Management and Co-Ordination (Air Quality) Regulations, 2009.

Proposed project location

Mombasa Cement Limited Vipingo factory is located in Kilifi County, Kikambala Division, Takaungu /Mavueni Location at Vipingo off Mombasa-Kilifi Road on two parcels of land namely MN/III/291/2 and MN/III/4391 the GPS coordinates of the proposed expansion are UTM X-0593567 & UTM Y- 9586780.

The project components

The proposed expansion will involve construction of two new cement factories for the manufacture of clinker and cement. The components of the expansion will include construction of a boundary wall to enclose each new cement factory, limestone crusher, limestone pre-blending stockpile, additive storages, raw material hoppers, raw mill building & bag house, blending silo, kiln feed, preheater tower, rotary kiln, clinker cooler building, clinker transport conveyer, clinker storage, gypsum storage, pozzolana storage, coal stockpile, coal mill building, cement mill hoppers, cement Mill building, cement silos, cement packing plant, cement loading for dispatch, clinker dispatch station, main sub-station, central control room, laboratories, engineering offices, stores, weighbridges, dispatch offices, water reservoirs and water treatment plant.

Project cost

The proposed expansion is estimated to cost KSH 7, 360,000,000.00 (seven billion, three hundred and six million Kenya Shillings only.

Raw materials to be used

MCL will grind, mix and burn in a kiln coral limestone, shale and iron ore in a clinkerization process to produce clinker. Coal will be the source of energy in firing the kiln during clinkerization. To produce cement, MCL will mix and grind in a cement mill clinker, pozzolana and gypsum.

Sources of raw material

The limestone that will be used in clinker production will be sourced from existing limestone deposits that MCL is currently extracting for use in clinker and cement production for the existing plant. MCL has an EIA licence for extracting these limestone deposits namely application reference number EIA/217 (registration number 0000337) and application reference number CP/PR.0495 (registration number 0007709). Shale that will be used in clinker production will be sourced from existing shale quarry owned by MCL at Vyambani within Kilifi County. MCL has an EIA licence for the shale quarry application reference number CP/PR/0682 (registration number 0007707). Iron ore and pozzolana will be bought from people who have their own quarries of pozzolana and iron ore while gypsum will be imported as currently is the practice.

Envisaged positive impacts

Potential positive impacts likely to result from the proposed expansion may include:-

- ✓ Increased exploitation of minerals used in cement production
- ✓ Increase in cement production in Kenya
- ✓ Reduction in cement imports
- ✓ Increase in Cement exports
- ✓ Employment opportunities
- ✓ Support of local businesses
- ✓ Increased revenue to government

Potential negative impacts

- ✓ Increased gaseous emissions
- ✓ Increased dust emissions
- ✓ Increased noise disturbance
- ✓ Occupational injuries and or accidents
- ✓ Waste (liquid and solid) related pollution
- ✓ Negative impacts on local fauna
- ✓ Negative impacts on local flora
- ✓ Negative impacts on avifauna

Proposed mitigation measures

- ✓ Emission of sulfur dioxide from clinker production process can be mitigated by using the following technologies; inherent scrubbing, oxygen control (increase), fuel substitution (lower total sulfur), raw material substitution (lower sulfide sulfur), raw material alkali/sulfur balance, in-line raw mill, peheater upper stage hydrated lime injection, calcined feed recirculation, cement kiln dust internal scrubber, preheater upper stage trona injection and calcium-based internal scrubber.
- ✓ Emission of Nitrogen Oxides from clinker production process can be mitigated by using the following technologies; oxygen control (decrease), indirect firing, low-NOX burner, mid-kiln firing, process improvements, process control improvements, low-NOX

calciner, staged combustion, semi-direct firing, mixing air fan and cement kiln dust insufflation.

- ✓ Emission of carbon monoxide from clinker production process may be mitigated using the following technologies; good combustion practice, excess air (increase), raw material substitution, pyroprocessing system design and mixing air fan.
- ✓ Emission of carbon dioxide from clinker production process can be controlled using the following technologies; improved thermal efficiency, clinker substitution, improved electrical efficiency, raw material substitution and mineralizers.
- ✓ Emission of ammonia from clinker production process can be mitigated through raw material substitution and tailpipe scrubber technologies.
- ✓ Dust emission from clinker and cement grinding can be mitigated by use of bag filter technology and electrostatic precipitators' technology.
- ✓ Fugitive dust from clinker and cement production can be mitigated by application of dust suppressant such as water sprinkling and enforcement of the use of appropriate personal protective equipment such as dust masks.
- ✓ Noise can be mitigated by developing and implementation of a comprehensive noise management programme that include assessing the risks, protecting employees, maintaining and equipment use, raining and sensitising of workers, health surveillance and work reviews.

- ✓ Measures that can be put in place to mitigate solid waste generation may include appropriate management practices and deliberate innervations aimed at minimization of waste generation.

- ✓ Impacts on flora, fauna and avifauna can be mitigated by continuous planting of trees and other vegetation in and around the cement plant open areas and undertaking comprehensive quarry rehabilitation in all mined areas.
- ✓ Traffic related negative impacts can be mitigated by developing a comprehensive traffic marshal plan.

Environmental monitoring

Monitoring will involve measuring, observing, recording, evaluation and recording of physical, social and economic variables associated with the development impacts such as air quality, occupational health and safety, soil contamination, water quality, waste management and quarry rehabilitation.

Community basic grievance and redress mechanism

Community grievances that may arise from implementation of the proposed project can be addressed through existing community leadership structures in place from the grassroots level of Nyumba Kumi through to the Deputy County Commissioner and or from the grassroots (Ward) political leadership representation (Member of County Assembly) through to the County Assembly.

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1. BACKGROUND INFORMATION

1.1 Introduction

This is an Environmental Impact Assessment study Report for the proposed expansion of Mombasa Cement Limited (MCL) Vipingo factory. The expansion will involve construction of two new cement plants A and B within the parcels of land of the existing Vipingo factory for the production of clinker and cement. Projects requiring submission of an Environmental Impact Assessment Study report under the second schedule of the Environmental Management and Co-Ordination (Amendment) Act, 2015, the proposed project falls in the category 9 (e) cement works and lime processing.

1.2 Project definition

The proposed expansion of Mombasa cement factory at Vipingo within Kilifi County will involve construction of two new cement factories for the manufacture of clinker and cement. The components of the expansion will include construction of a boundary wall to enclose each new cement factory, limestone crusher, limestone pre-blending stockpile, additive storages, raw material hoppers, raw mill building & bag house, blending silo, kiln feed, preheater tower, rotary kiln, clinker cooler building, clinker transport conveyer, clinker storage, gypsum storage, pozzolana storage, coal stockpile, coal mill building, cement mill hoppers, cement mill building, cement silos, cement packing plant, cement loading for dispatch, clinker dispatch station, main sub-station, central control room, laboratories, engineering offices, stores, weighbridges, dispatch offices, water reservoirs and water treatment plant.

1.3 Proposed project location

Mombasa Cement Limited Vipingo factory is located in Kilifi County, Kikambala Division, Takaungu /Mavueni Location at Vipingo off Mombasa-Kilifi Road on two parcels of land namely MN/III/291/2 and MN/III/4391 (figure 1). The GPS coordinates of the proposed expansion are UTM X-0593567 & UTM Y- 9586780. Each of the new proposed cement plant will be constructed on its own parcel of land i.e. one cement plant will be on land parcel MN/III/291/2 which is 173.7 hectares and the other cement plant will be constructed on land parcel MN/III/4391 which is 499 hectares. These two parcels of land are side by side, the existing cement plant is on land parcel MN/III/291/2. Appendix 1 is certificate of land titles, certificates of postal search, and letters of confirmation of deed plans, change of user from agricultural to industrial and letters from the National Land Commission confirming ownership of the two parcels of land.

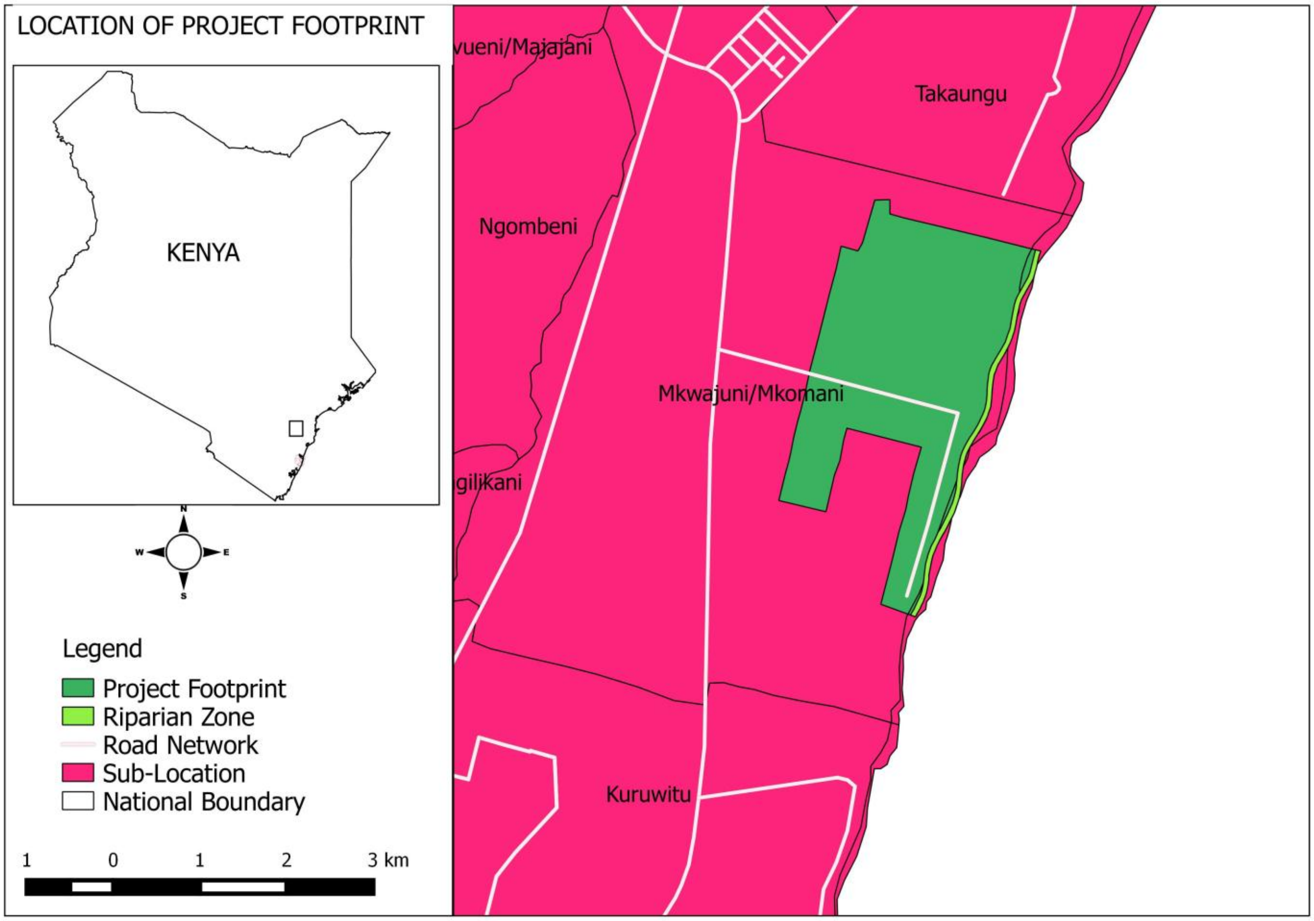


Figure 1: Location plan

1.4 Project proponent

Mombasa Cement Limited, a private company incorporated with limited liabilities in the Republic of Kenya is the project proponent. The company holds a certificate of incorporation number C. 106734 date eleventh November two thousand and three and personal identification number certificate P051159492Z dated second June 2004. Appendix 2 is copy of the certificate of incorporation and copy of personal identification number certificate

1.5 Project objective and scope

The objective of the proposed expansion of Mombasa Cement Vipingo factory is to increase the current clinker production capacity from 3,000 tons of clinker per day to 9,000 tons of clinker per day and that of cement. The scope of the expansion will cover construction of two new cement factories for production of clinker and cement complete with support infrastructure. Appendix 3 is the proposed layout plan.

1.6 Cement manufacturing Companies in Kenya

There are seven operational cement manufacturing plants in Kenya; four of the plants are both at the Kenya Coast and Athi River Machakos County one is only located at Athi River Machakos County and the other at Kitengela Kajiado County. Table 1 summarizes the cement plants, their location and cement brands.

Table 1: Table of cement manufacturing companies in Kenya and their location

Company	location	Brand
Mombasa Cement Limited	Vipingo , Kilifi County and Athi River Machakos County	Nyumba
Athi River Mining	Kalolen Kilifi County i, Athi River Machakos County	Rhino Cement
Bamburi Cement	Bamburi Mombasa County , and Athi River Machakos County	Bamburi Cement
East Africa Portland Cement	Athi River Machakos County	Blue Triangle
National Cement	Athi River-Lukenya Machakos County	Simba Cement
Savannah Cement	Kitengela, Kajiado County	Savannah Cement
Ndovu Cement	Athi River Machakos County	Ndovu Cement

1.7 Project Report

An Environmental Impact Assessment Project Report (NEMA/PR/5/2/13,587) for the proposed expansion of the Mombasa Cement Limited Vipingo Unit was prepared and submitted to the National Environment Management Authority (NEMA) on March 31st 2015; appendix 4 is copy of letter of acknowledgement from NEMA of receipt of the project report. Initial review of the project report revealed that the risks associated with the proposed project demands wider public consultation and in depth coverage of the foreseen impacts and mitigation measures. The proponent was then asked to initiate an environmental impact assessment study to facilitate in depth evaluations of potential impacts associated with the proposed project and to materialise harmony with the affected and interested stakeholders. Appendix 5 is a copy of the letter of the initial review of the Project Report from NEMA.

1.8 Terms of reference

Terms of reference (ToR) for the environmental impact assessment study were developed and submitted to NEMA. The ToR was approved by NEMA on May 8th 2015 TH. This paved way for data collection and compilation of this environmental impact assessment study report. Appendix 6 is copy of the ToR approval letter from NEMA.

2. BACKGROUND TO ENVIRONMENTAL IMPACT ASSESSMENT

2.1 Definition of Environmental Impact Assessment

Broadly environmental impact assessment (EIA) refers to the need 'to identify and predict the impact on the environment and on man's health and wellbeing of legislative proposals, policies, programmes, projects and operational procedures, and to interpret and communicate information about the impacts'(Munn 1979). UNECE (1991) defines EIA as 'an assessment of the impacts of planned activity on the environment', IAIA (2009) on the other hand defines EIA as 'the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of proposed development proposals prior to major decision being taken and commitments made'. Glasson *et.al* (2012) defines EIA as 'a systematic process that examines the environmental consequences of development actions in advance'. EIA is thus a vital tool that aid formulation of development actions, decision making, an instrument for sustainable development and vehicle for stakeholder consultation and participation (Glasson *et.al* 2012).

2.2 The purposes of EIA

2.2.1 An aid to decision making

EIA is an aid to decision-making. For the decision maker, for example, a local authority, it provides a systematic examination of the environmental implications of a proposed action, and sometimes alternatives, before a decision is taken. The EIA can be considered by the decision-maker along with other documentation related to the planned activity. EIA is normally wider in scope and less quantitative than other techniques, such as cost-benefit analysis (CBA).It is not a substitute for decision making, but it does help to clarify some of the trade-offs associated with a proposed development action, which should lead to more informed and structured decision-making. The EIA process has a potential, not always taken up, to be a basis for negotiation between the developer, public interest groups and the planning regulator. This can lead to outcome that balances well the interests of the development action and the environment.

2.2.2 An aid to the formulation of development actions

Developers may see the EIA process as another set of hurdles to jump before they can proceed with their various activities; the process can be seen as yet another costly and time-consuming activity in the development consent process. However, EIA can be of great benefit to them, since it can provide a framework for considering location and design issues and environmental issues in parallel. It can be an aid to the formulation of development actions, indicating areas where a project can be modified to minimize or eliminate all together its adverse impacts on the environment. The consideration of environmental impacts early in the planning life of a development can lead to more environmentally sensitive development; to improved relations between the developer, the planning authority and the local communities; to a smoother development consent process, and sometimes to a worthwhile financial return on the extra expenditure incurred. O'Riordan (1990) links such concepts of negotiation and redesign to the important environmental themes of 'green consumerism' and 'green capitalism'. The growing demand by consumers to goods that do no environmental damage, plus a growing market for clean technologies, is generating a response from developers. EIA can be the signal to the developer of potential conflict; wise developers may use the process to negotiate 'environmental gain' solutions, which may eliminate or offset negative environmental impacts, reduce local opposition and avoid costly public inquiries. This can be seen in the wider and contemporary context of corporate social responsibility (CSR) being increasingly practiced by major businesses (Crane et al.2008)

2.2.3 A vehicle for stakeholder consultation and participation

Development actions may have wide-ranging impacts on the environment, affecting many different groups in society. There is increasing emphasis by government at many levels on the importance of consultation and participation by key stakeholders in the planning and development of projects. EIA can be a very useful vehicle for engaging with communities and stakeholders, helping those potentially affected by a proposed development to be much better informed and to be more fully involved in the planning and development process.

2.2.4 An instrument for sustainable

Existing environmentally harmful developments have to be managed as best as they can. In extreme cases, they may be closed down, but they can still leave residual environmental problems for decades to come. It would be much better to mitigate the harmful effects in advance, at the planning stage, or in some cases avoid the particular development together. This of course leads on to the fundamental role of EIA as an instrument for sustainable development- a role some writers have drawn attention to as one often more hidden than it should be when EIA effectiveness is being assessed (Jay et al.2007)

2.3 Origins and development of EIA

The first EIA legislation was formerly established in the United States of America in 1969 (NEPA 1970), in Europe the 1985 European Community directive on EIA (Directive 85/337) introduced broadly uniform requirements for EIA for all member states (CEC, 1985). In Australia, the Commonwealth EIA system was established in 1974 under the Environmental Protection (Impact of Proposal) Act (Wood 2003, Ellott and Thomas, 2009). The United Kingdom enacted a formal legislation on EIA in 1988 (Glasson *et.al* 2012). China formerly enacted its first EIA legislation in 1979 (Moorman and Ge 2007). In Africa and the Middle East, Israel and Algeria pioneered in enactment and implementation of EIA legislations in 1982, 2003 and 1983, 1990 respectively (Economic Commission for Africa, (2005) Almagi *et.al* (2007). In East Africa Uganda pioneered in enacting EIA legislation in 1998, Kenya EIA legislation was enacted in 2000, and implemented in 2003 (Morara *et.al* 2011).

2.4 The Environmental Impact Assessment Study

The environmental impact assessment study for the current proposed project involved, but was not necessarily limited to, the following:

- ✓ Collection of baseline data and information
- ✓ Description of affected environments
- ✓ Participation of stakeholders
- ✓ Identification and assessment of potential impacts (both negative and positive) of the project to the environment
- ✓ Proposal of possible mitigation measures to curb any potential negative impacts.
- ✓ Development of an appropriate Environmental Management Plan (EMP).

The role of the stakeholder participation was to:

(a) Establish common stakeholder needs and ensure that the project continues to satisfy these needs or even enhance the needs.
(b) Provide background information which will form an important part of baseline data.
(c) Create awareness amongst the stakeholders and sensitise them on environmental issues related to the project.

2.5 Preparation of the EIA Study Report

EIA Study Report prepared for the proposed project contains detailed information on the project, including the following:-

- ✓ Location of the project
- ✓ The objectives of the project
- ✓ Baseline information such as descriptions of the natural, social and operational environments the current policy and legal framework and the administrative arrangement under which the project will operate.
- ✓ The technology, procedures and processes to be used in implementation of the project.
- ✓ Alternative technologies and processes available and reasons for preferring the chosen technology and processes.
- ✓ The wastes to be generated by the project and ways of handling it.
- ✓ A description of potentially affected environments.
- ✓ The environmental effects of the project: including the social and cultural effects and the direct, indirect, cumulative, irreversible, short term and long term effects anticipated.
- ✓ An EMP proposing measures for eliminating, minimising or mitigating adverse impacts on the environment, while enhancing the positive effects; including the cost, time frame, and responsibility to implement these measures.
- ✓ Provision of an action plan for the prevention and management of foreseeable accidents and hazardous activities.
- ✓ Measures to prevent health hazards and to ensure security in the working environment for the employees and users of the facility, and for management of emergencies.
- ✓ An economic and social analysis of the project.
- ✓ An identification of gaps in knowledge and uncertainties which were encountered in compiling the information.

- ✓ A non-technical summary outlining the key findings, conclusions and recommendations of the study.

2.6 Team of Experts

The Team of Experts who undertook the environmental impact assessment study are James Morumbasi Mong'oni a registered EIA/EA Lead Expert a licensed Safety Advisor and authorized Inspector of pressure vessels and lifting equipment, Dr. George Eshiamwata registered EIA/EA Lead Expert, an ornithologist and ecologist, Philip Manyi Omenge EIA/EA Lead Expert, Natural resources management scientist and rural development specialist, Dickens Odeny Land Ecologist and GIS specialist and Brenda Nyaboke Nyandika a Botanist. Appendix 7 is certificate of registration and practicing licence of the lead experts, table 2 is the details of the team of specialists.

Table 2: Team of specialists

Name	Profession / Designation	Education Background/Status
James.Morumbasi. Mong'oni (MBA)	EIA/EA Lead Expert, Occupational Safety and Health (OSH) Practitioner Trainer in Occupational Safety and Health in the workplace OSH Risk Assessment Expert Fire safety Auditor Authorized Plant Inspector (Pressure Vessels and Lifting Appliances)	❑ Master Business Administration, MBA ❑ Postgraduate Certificate in Occupational safety and Health Risk Assessment ❑ Postgraduate certificate in Environmental Impact Assessment ❑ Postgraduate Certificate on Advanced Information Processing, ❑ Postgraduate Certificate in Occupational Safety and Health ❑ Bachelor of Science in Mechanical Engineering, BSc(Mech Eng)

Dr. George Eshiamwata (PhD)	EIA/EA Lead Expert, Ornithologist/ ecologist	◻ PhD; land cover change at key biodiversity sites vs. site protection, community conservation, agricultural intensity and human population density in Eastern Africa using remote sensing ◻ M.Sc.; Conservation Biology, ◻ Bsc; Natural Resources Management
Philip Manyi Omenge (MSc.)	EIA/EA Lead Expert, Natural Resources Management Scientist/Rural Development specialist	❖ Currently undertaking PhD in Natural Resources & Peace in Egerton University, Njoro. Area of specialization: Environmental Impact Assessment in Conflict Mitigation. Research thesis: Assessment of the Effectiveness of Environmental Impact Assessment (EIA) Process in Development Projects in Kenya ❖ MSc. (with dissertation) with specialization in Rural Development Studies, Swedish University of Agricultural Sciences, SLU; Uppsala, Sweden ❖ BSc. (Hons), Natural Resources Management, Egerton University, Njoro Kenya ❖ Cert. Environmental Audit; KNCPC, Nairobi

Dickens Odeny (MSc.)	Land Ecologist/ GIS Specialist	➢ Currently undertaking PhD in GeoInformation University of Nairobi. Topic biodiversity and carbon storage modelling in eastern Africa mountain forests: Taita Hills (Kenya) and Mt. Kilimanjaro Area (Tanzania). ➢ MSc. Water and Coastal Management University of Plymouth (Plymouth City, United Kingdom) and Universidade do Algarve (Faro, Portugal) ➢ BSc. Environmental Science. Kenyatta University
Brenda Nyaboke Nyandika (B.Phi Biotec)	Ecologist/Botanist	- Bachelors of Philosophy in Biotechnology University of Nairobi. - DNA Barcording of Plants University of Johannesburg, - Higher Diploma in Biotechnolog Kenya Polytechnic University College - Diploma in Applied Biology Mombasa Polytechnic

3. POLICY AND LEGAL FRAMEWORK

3.1 Introduction

Legislation, laws, policies and regulations specific to environmental management can directly or indirectly affect the implementation of proposed project. Kenya is a signatory to many international conventions and treaties. Some of the International Treaties and Conventions Binding Kenya include:

- Agenda 21
- The World Commission on Environmental and Development (The Brundtland Commission) – signed/ratifies 1987
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – ratified 1978
- Convention on Biological Diversity (CBD) – signed/ratified 1992
- United Nations Framework Convention on Climate Change (UNFCCC) – signed/ratified 1994
- United Nations Framework Convention on Climate Change (UNFCCC) – Kyoto Protocol signed/ratified (1997)
- African Convention on the Conservation of Nature and Natural Resources
- International Union for Conservation of Nature

Kenyan Environmental Legislation are determined and enforced through various levels of statutes the majority of which are sector specific. The Environment Management and Coordination Act (EMCA) 1999 is the governing law for the Protection and Development of the Environment in the Kenya. It is considered the base for various environmental regulations and guidelines. Some of the legislation that arse relevant to this project include

- □ The Environmental Management and Coordination Act of 1999

- The Environmental Management and Coordination (Water Quality) Regulations, 2006
- The Environmental Management and Coordination (Waste Management) Regulations, 2006
- The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009
- The Public Health Act
- The Water Act of 2002
- The Employment Act 2007
- The Work Injuries Benefits Act 2007
- The labour Institutions Act 2007
- The Occupational Safety and Health Act 2007
- The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing) Regulations
- The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009
- The Environmental (Impact Assessment and Audit) Regulations 2003
- The Land Act 2012
- The Energy Act 2006
- The Environmental Management and Co-Ordination (Amendment) Act, 2015
- The Environmental Management and Co-Ordination (Air Quality) Regulations, 2009

3.2 Binding multilateral agreements/ conventions

3.2.1 Agenda 21

Kenya continues to implement Agenda 21 to support sustainable development through the integration of environmental concerns into the national development policies, plans, and programmes

3.2.2 The World Commission on Environmental and Development (The Brundtland Commission) – signed/ratifies 1987

The commission focuses on the environmental aspects related to development and requires all development projects to be sustainable economically, socially and environmentally. The principle of the organisation emphasis that development project should not have permanent negative impact on the biosphere and in particular the ecosystems.

3.2.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – ratified 1978

This is an international agreement to which countries adhere voluntarily. CITES is legally binding on the parties but it does not take the place of national law. Kenya has signed this convention and it seeks to regulate trade in certain species and their parts, as well as products made from such species e.g. certain tree and fish species. This convention protects forests as habitat for endangered species.

3.2.4 Convention on Biological Diversity (CBD) – signed/ratified 1992

Commonly known as the Bio-diversity Treaty, this is one of the treaties that was open for signature at UNCED, 1992. This convention is a practical tool for translating the principles of Agenda 21 (Rio Earth Summit) into reality. The Convention is dedicated to promoting sustainable development. Parties to the treaty solemnly affirm sovereign rights over their biological sources, while accepting responsibility for conserving biological diversity and using biological resources in a sustainable manner. All developers need to ensure their operation promote national strategies, legislation, plans and programmes and avoid loss of biodiversity within their property.

3.2.5 United Nations Framework Convention on Climate Change (UNFCCC) – signed/ratified 1994

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. Kenya and other states gather and share information on greenhouse gas (GHG) emissions, national policies and best practices.

3.2.6 African Convention on the Conservation of Nature and Natural Resources

This convention reaffirms the importance of natural resources both renewable and non-renewable, particularly the soil, water, flora and fauna. The main objective is to facilitate sustainable use of the above resources. The convention was adopted in Algiers on 15th September 1966 and came into force on 16th June 1969.

3.2.7 International Union for Conservation of Nature

International Union for Conservation of Nature (IUCN) helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN categorises protected areas by management objective and has identified six distinct categories of protected areas according to their management objectives. The categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

3.3 Kenya Environmental legislation

3.3.1 Environmental Management and Co-Ordination Act (EMCA), 1999

The EMCA, 1999 provides the legal framework for management of the environment and other related issues in Kenya. It is the policy of the Government of Kenya that EIA be conducted for planned projects that are likely to cause, or will have, significant impacts on the environment, so that adverse impacts can be foreseen, eliminated or mitigated. It is also policy of the government that the EIA process be interdisciplinary, fully transparent so that the stakeholders have access and can express their views. This is in order that the process serves to provide a balance between environmental, economic, financial, social and cultural values for purposes of sustainable development of the entire country. The policy therefore, through the use and application of EIA, seeks to integrate environmental concerns in all development policies, plans, projects and programs at national, regional, district and local levels with full public participation of all stakeholders.

The undertaking and administration of the EIA process for the proposed project will be in accordance with the Environmental (Impact Assessment and Audit) Regulations, 2003. Some of the administrative procedures of EMCA include:

- ❖ The EIA process will be applicable to both public and private sector development projects and programs.
- ❖ The projects to be subjected to EIA are specified in the second schedule of the EMCA, 1999. Besides the scheduled activities, the Act empowers the Minister in charge of environment to prescribe for EIA appraisal any other activities, which in his view carries significant environmental impacts.
- ❖ NEMA will designate environmental committees to oversee implementation at Provincial and District levels.
- ❖ NEMA will initiate public participation through uses of public notices and meetings with regard to proposed EIA studies and review of reports.
- ❖ A scheduled activity will not receive the necessary authorisation from NEMA to proceed, until all EIA requirements have been fulfilled and accepted by NEMA and relevant lead agencies.
- ❖ EIA License will be granted when NEMA and the Minister are satisfied that an EIA has been satisfactorily conducted and that an Environmental Management Plan of the activity has been sufficiently developed.
- ❖ Complains with regard to compliance with EIA licensing requirements and procedures that NEMA may not resolve will be subject to a review by the Environment Tribunal. Under the Act there are general provisions for appeal to high courts and to bring proceedings in a court of law where necessary, for judicial review by third parties including concerned citizens and/or organisations other than the Government.

3.3.2 The Environmental Management and Coordination (Water Quality) Regulations, 2006

The regulations protect all water resources. Relevant features of this regulation as far as this study is concerned include:-

- ✓ Every person shall refrain from any act which will directly or indirectly cause pollution and it shall be immaterial whether or not the water resource was polluted before the enactment of these regulations;

- ✓ No person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance as to cause pollution;
- ✓ Discharge of effluent from sewer must be licensed according to the act; and the carry out daily effluent discharge quality and quantity monitoring and shall comply with the standard set in the fifth Schedule of the act.
- ✓ Water abstraction must only be done after approval of an Environmental Impact Assessment study;
- ✓ The regulations also set out standards to be followed for effluent discharge to the environment.
- ✓ No person shall be permitted to use waste water for irrigation purposes unless such water complies with the quality guidelines set out in the 8^{th} Schedule of the act.
- ✓ No person shall use or allow to be used any natural water body for recreational purposes unless the water body meets the quality standards for recreational standards as set out in the tenth schedule of the regulation.

3.3.3 The Environmental Management and Coordination (Waste Management) Regulations, 2006

Relevant parts of this regulation include

- ⇒ Prohibition of any waste disposal on a public highway, street, road, recreation area or in any public place except in designated waste receptacle;
- ⇒ All waste generator to collect, segregate and dispose such waste in a manner provided for under these regulations;
- ⇒ All waste generators to minimize waste generated by adopting cleaner production methods through:
  - improvement of production process;
  - monitoring the product cycle from beginning to the end;
  - incorporating environmental concerns in the design and disposal of products;
- ⇒ All waste transporters to be licensed according to the act;
- ⇒ All vehicles used to transport waste to be labelled in such a manner as may be directed by the Authority;
- ⇒ Collection and transportation of the waste to be done in such a manner no to cause scattering of the waste;

- ⇒ The vehicle and equipment for waste transportation to be in such a manner not to cause scattering of or flowing out of waste; and
- ⇒ The vehicles for transportation and other means of conveyance of waste to follow the scheduled routes approved by the authority from the point of collection to the disposal site.
- ⇒ No person shall engage in any activity likely to generate any hazardous waste without a valid EIA licence issued by Authority
- ⇒ Every generator of hazardous waste shall ensure that every container or package for storing such waste is labelled in easily legible characters, written in both English and Kiswahili: 'CAUTION', 'WARNING', 'POISON', 'DANGER', 'KEEP AWAY FROM UNAUTHORISED PERSON' and pictogram of skull and crossbones.

The proposed project shall generate solid wastes and liquid wastes which must be subjected to the mentioned parts of the regulations.

3.3.4 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009

Part II of the general prohibition of this regulation state that except as otherwise provided for in this regulations, no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Part (2) of the general prohibitions stated that in determining whether noise is loud, unreasonable, unnecessary or unusual the following factors may be considered:-

- ⇒ Time of the day;
- ⇒ Proximity to residential area;
- ⇒ Whether the noise is recurrent, intermitted or constant;
- ⇒ The level and intensity of the noise;
- ⇒ Whether the noise has been enhanced in level or range by any type of electronic or mechanical means; and
- ⇒ Whether the noise can be controlled without much effort or expense to the person making the noise.

Part 2 of section III states that any person wishing to operate or repair any machinery, motor vehicle, construction equipment or other equipment, pump, fan, air-conditioning apparatus or similar mechanical device or engage in any maisonettes or industrial activity which is likely to emit noise or excessive vibrations shall carry out the activity or activities within relevant levels prescribed in the first schedule to these regulations. Part III section 13 (1) states that except for the purpose specified in sub-Regulation (2)… no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the second schedule of the regulations.

3.3.5 The Public Health Act

The Public Health Act outlines how different aspects of a project have to be undertaken to ensure the safety and health of users and neighbours. The Act gives guidelines on construction, maintenance and inspection of drainage system, septic tanks, cesspool or latrines.

3.3.6Water Act 2002

The water Act of 2002 aims to "make better provision for conservation, apportionment and use of water resources of Kenya". Section 5 of the Act prohibits any persons from diverting, abstracting, obstructing or using water from a body of water except as provided for in the Act. The Act stipulates that a permit shall be required in all cases of proposed diversion, obstruction, storage or use of water with exception in the use for domestic purposes. However, general rules within the Act provide that any rights acquired under the permit are subject to the Public Health Act and the Malaria Prevention Act in addition to the Water Act.

Definitions

a) Catchment Area ……….. This is a designated area from which rainwater flows into watercourses.
b) Catchment Area Advisory Committee………This refers to a Committee of not more than 15 members appointed by the Minister.
c) "In-Stream Habitat"…………These includes the physical structure of a water resource and the associated vegetation in relation to the bed of the water course.

d) “Ground water”……….Means the water of underground streams, channels, artesian basins, reservoirs, lakes and other bodies of water in the ground, and includes water in interstices below the water table;

e) “Landholder” In relation to lands, means the registered of the land or the person whom the land is otherwise vested by law, and includes:-

- Any person who by any established right, custom or estate whatsoever is, or is entitled to be the holder or possession of the land;
- Any person lawfully holding or occupying land in accordance with the provisions of any law empowering the allotment of land upon the promise of title, subject to the fulfilment by the allottee of prescribed conditions; and
- Any person to whom a mining lease or mining location has been granted under the Mining Act.

f) Pollution…….. In relation to water resource, means any direct or indirect alteration of the physical, thermal, chemical or biological properties of the water resources so as to make it:-

- Less fit for any beneficial purpose for which it is or may reasonably be expected to be used; or
- Harmful or potential harmful to –

- The welfare, health safety of human beings;
- Any aquatic or non-aquatic life or property; or
- The Environment

g) “Resource Quality”……..This means the quality of all the aspects of a water resource including:-

- ✓ The water Quality stipulated for the reserve;
- ✓ The Quantity, pattern, timing, water level and assurance of in stream flow;
- ✓ The physical, chemical and biological characteristics of the water;
- ✓ The character and condition of the in-stream and the riparian habitat; and
- ✓ The characteristics, condition and distribution of the aquatic biota.

h) “Riparian habitat”……….means the dynamic complex of plant, animal and microorganism communities and their non-living environment adjacent to and associated with a water course;

i) “Spring”…..means water emerging from beneath the surface of the ground otherwise than as a result of drilling or excavation operations;

j) “Stream”…….Means the water contained in a watercourse, and includes a river;

k) “Water resource”……….This refers to any lake, pond, swamp, marsh, stream, watercourse, estuary, aquifer, artesian basin, or other body of or standing water, whether above or below ground;

l) “Watercourse”……..This means any natural channel or depression in which water flows regularly or intermittently, unless declared not to be a watercourse.

Ownership and Control of Water

In the section 3 of the Act, it is therefore stated that every water resource is hereby vested in the State, subject to any rights of user granted by or under the Act or any other written Law.

a) Powers and duties of the Minister

The Minister shall have and may exercise control over every water resource in accordance with this Act.

It shall be the duty of the Minister to promote the investigation, conservation and proper use of water resources throughout Kenya and to ensure the effective exercise and performance by any authorities or persons under the control of the Minister of their powers and duties in relation to water.

The Minister shall be assisted in the discharge of his duties under this section by the director of water.

b) Right to use water

The right to use of water from any water resource is hereby vested in the Minister, except to the extent that it is alienated by or under section 5 of the Act.

c) Acquisition of water rights

In section 6 of the Act, it is stipulated that from the commencement of the Act, no conveyance, lease, or other instrument shall be effectual to convey, assure, demise, transfer or vest in any person any property or right or any interest or privilege in respect of any water resource, and no such property, right, interest or privilege shall be acquired otherwise than under this Act.

Water Resources Management

a) Establishment of the Authority

In section 7 of the Act, there is established Authority known as the Water Resources Management Authority which is a body corporate with perpetual succession and a common seal and shall have power, in and by its corporate name, to sue and be sued and, in the exercise and performance of its powers and functions, to do and permit all such things as may lawfully be done or permitted by a body corporate in furtherance of its objects

b) Powers and functions of the Authority

Section 8 of the Act thereby enlists the powers and functions of the Authority as:-

To develop principles, guidelines, and procedures for the allocation of water resources;

To monitor, and from time to time re-assess, the national water resources management strategy;

To receive and determine applications for permits for water use;

To monitor and enforce conditions attached to permits for water use;

To regulate and protect water resources and quality from adverse impacts;

To manage and protect water catchments;

In accordance with guidelines in the national water resources management strategy, to determine charges to be imposed for the use of water from any water resource;

To gather and maintain information on water resources and from time to time to publish forecasts, projections and information on water resources,

To liaise with other bodies for the better regulation and Management of water resources; and

To advise the Minister concerning any matter in connection with water resources.

c) Catchment Management Strategy

Section 15 of the Act states that the Authority, following the public consultation, shall formulate a catchment management strategy for the management, use, development, conservation, protection and control of water resources within each catchment area.

A catchment management strategy shall:-

- ✓ Take into account the class of water resource and resource quality objectives for the water;
- ✓ Be consistent with the national water resources strategy;
- ✓ Prescribe the principles, objectives, procedures and institutional arrangements of the Authority for the Management, use, development, conservation and control of water resources within each catchment area;
- ✓ Contain water allocation plans which set out principles for allocating water; and
- ✓ Provide mechanisms and facilitates for enabling the public and communities to participate in managing the water resources within each catchment area.

d) Catchment area advisory committee

In Section 16 of the Act, there states that the Authority, in consultation with the Minister, shall appoint a committee of not more than 15 members in respect of each catchment area. The Catchment area advisory committee shall, in relation to the catchment for which it is appointed, advise officers of the Authority at the appropriate regional office concerning:-

- ✓ Water resources conservation, use and apportionment;
- ✓ The grant, adjustment, cancellation or variation of any permit; and
- ✓ Any other matters pertinent to the proper management of water resources.
- ✓ The members of the catchment area advisory committee shall be chosen from among:-

- ✓ Representatives of Ministries or public bodies responsible for matters relating to water resources in the catchment area;
- ✓ Representatives of any regional development authorities and local authorities whose areas of jurisdiction or any part thereof fall within the catchment area concerned;
- ✓ Representatives of farmers of pastoralists within the catchment area concerned;
- ✓ Representatives of the business community operating within the catchment area concerned;
- ✓ Representatives of the Non-Governmental Organizations engaged in water resources management programmes within the catchment area concerned; and
- ✓ Other persons who have demonstrated competence in matters relating to the management of water resources.

National Monitoring of and information on water resources management

The National water resources management strategy shall provide for national monitoring and information systems on water resources.

The system shall provide for-

- ❖ The collection and management of Data and information regarding water resources and the management; and
- ❖ Procedures for gathering data and the analysis and dissemination of information on water resources.

3..37 Employment Act 2007

General Principal

The Act constitutes minimum terms and conditions of employment of an employee and any agreement to relinquish vary or amend the terms set shall be null and void.

The act stipulates that no person shall use or assist any other person, in using forced labour. Clause 5 of the act states that its shall be the duty of the Minister, Labour officer, the National Labour Court and the subordinate labour courts to; Promote equality of opportunity in employment in order to eliminate discrimination in employment Promote and guarantee equality of opportunity for a person who, is a migrant worker or a member of the family of the migrant worker lawfully within Kenya

No employer shall discriminate directly or indirectly, against an employee or prospective employee or harass an employee or prospective employee on the following grounds; race, colour, sex, language, religion, political or other opinion, nationality, ethnic or social origin, disability, pregnancy, mental status or HIV status. An employer shall pay his employees equal remuneration for work of equal value

Part IV Rights and duties of employment

The provisions of this part and part VI constitute basic minimum and conditions of contract of service. The employer shall regulate the hours of work of each employee in accordance with provisions of this Act and any other written law. Subsection (2) of section 27 states that an employee shall be entitles to at least one rest day in every period of seven days. An employee shall be entitles to not less that twenty-one working days of leave after every twelve consecutive months. Section 29 of the Act stipulates that a female employee shall be entitled to three months maternity leave with full pay. Subsection 8 of section 29 further states that no female employee shall sacrifice her annual leave entitlement on account of having taken her maternity leave. *Section 37 (conversion of casual employment to term contract)* Where a casual employee works for a period or a number of continuous working days which amount in the aggregate to the equivalent of not less than one month; or performs work which cannot reasonably be expected to be completed within a period, or a number of working days amounting in the aggregate to the equivalent of three months or more. The contract of service of the casual employee shall be deemed to be one where wages are paid monthly. In calculating wages and the continuous working days, a casual employee shall be deemed to be entitled to one paid rest day after a continuous six days working period and such rest day or public holiday which falls during the period under consideration shall be counted as part of continuous working days.

3.3.8 Work Injuries Benefits Act 2007

Obligations of Employers

Section 7 of the Act stipulates that every employer shall obtain and maintain an insurance policy, with an insurer approved by the Minister in respect of any liability that the employer may incur under this Act to any of his employees.

Registration of employer

Every employer carrying on business in Kenya shall within the prescribed period and in the prescribed manner register with the Director of Occupational Health and Safety Services and any other information as the Director may require.

Subsection 4 of section 8 of the Act states that where an employer carries on business in more than one workplace, or carries on more than one class of business, the Director may require the employer to register separately in respect of each place or class of business.

Employer to keep record (Section 9)

Section 9 states that an employer shall; Keep a register or other record of the earnings and other prescribed particulars of all employees and produce the same on demand by the director for inspection. Such records shall be retained for at least six years after the date of last entry.

Right to compensation

An employee who is involved in an accident resulting in the employee's disablement or death is subject to the provisions of this Act, and entitled to the benefits provided for under the Act. Subsection 3 of section 10 of the ACT however states that no employee shall be entitled to compensation if an accident, not resulting in serious disablement or death, is caused by the deliberate and wilful misconduct of the employee. Section 12 of the act stipulates that if an employee is injured in an occupational accident or contracts an occupational disease while the employee, with the consent of the employer. is engaged in any organized first aid, ambulance or rescue work, or fire fighting or other emergency services, the accident or disease is for the purpose of this Act, deemed to have arisen out of an in the course of the employee's employment

Reporting of accidents

A written or verbal notice of any accident shall be given by or on behalf of the employee concerned to the employer and a copy to the Director of occupational health and Safety within twenty-four hours of its occurrence in case of fatal accident.

Lapse of right to benefits

A right to benefits in accordance with this Act shall lapse if the accident is not reported to the employer within twelve months after the date of such accident. However, it shall not be bar to compensation if it is proved that the employer had knowledge of the accident from any other source. Section 30 of the Act states that compensation for permanent disablement shall be calculated on the basis of ninety six months earnings subject to the minimum and maximum amounts determined by the minister after consultation with the board. In case of a fatal accident compensation shall be paid to the dependants of the employee in accordance with the set provisions in the third schedule. The employer shall further be liable to pay reasonable expenses for the funeral of the deceased employee subject to the maximum amount determined by the minister, after consultation with the National council for occupational Health and Safety

The First Schedule of the Act gives the minimum degree of Disablement for various body parts while the second Schedule gives a list of work description and the associated occupational disease.

3.3.9 Labour Institutions Act 2007

The Act establishes the National Labour Board whose functions shall be to advice the minister on;

- All matters concerning employment and labour
- Legislation affecting employment and labour
- Any matter relating to labour relations and trade unionism
- Labour inspection service
- Reported strikes and lockouts
- Labour facility information and indices etc.
- The board shall in consultation with the minister, establish;
- Work permit committee
- National manpower development committee
- Trade dispute committee
- Productivity committee and such other committees or panel as are necessary for the performance of board’s functions.

Section 34 of the act stipulates that an authorized officer may either alone or in the presence of another person, enter any premises or place where persons are, or may be employed for the purpose of performing his duties as specified under the Act.

The labour officer may, for the purpose of monitoring or enforcing compliance with any law require the production of wages sheets or other employment records kept by an employer, enter inspect and examine all latrines and other sanitary arrangements or water supply, inspect and examine all food provided or appearing to be provided for employees, and take samples thereof in duplicate, in the presence of the employer or the employers representative which samples shall be sealed and one sample so sealed shall be left with the employer, order that all buildings and premises where employees are housed or employed be kept in a clean and sanitary condition.

Section 37 of the act states that the medical officer shall exercise the powers conferred upon the labour officer and in addition;

- Order an employee who, in his opinion is sick and for whom the conditions prevailing at the place of employment are not conducive to rapid recovery of his health to proceed to hospital and in that case the employer shall at the earliest opportunity and at his own expense send the employee to the place of work or to a hospital, as the case may be.
- Condemn any food provided for employees which, in the opinion of the medical officer, is unfit for human consumption, and all food so condemned shall be destroyed forthwith in the presence of the medical officer.
- Order at the expense of the employer, such variety of food for an employee as he may deem necessary
- Inspect all drugs and medicine provided for the use of employees

3.3.10 The Occupational Safety And Health Act 2007

Part II – General Duties of the Occupiers

In Section 6 (1), it is stated that the occupier shall ensure the safety, health and welfare at work of all persons working in his work place.

Without prejudice to the generality of an occupier's duty under sub section 1 above, the duties of the occupier includes:-

- The provision and maintenance of plant and systems and procedures of work that are safe and without risk to health;
- Arrangements for ensuring safety and absence of risks to health and connection with the use, handling, storage and transport of articles and substances;
- The provision of such information, instruction, training and supervision as is necessary to ensure the safety and health at work of every person employed;
- The maintenance of any workplace under the occupier's control, in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks to health;
- The provision and maintenance of a working environment for every person employed that is, safe, without risks to health, and adequate as regards facilities and arrangements for the employees welfare at work;
- Inform all persons employed of:-
    - Any risks from new technologies; and
    - Imminent danger; and
- Ensuring that every person employed participates in the application and review of safety and health measures.

Every occupier shall carry appropriate risk assessments in relation to the safety and health of persons employed and adopt preventive and protective measures to ensure that under all conditions of their intended use without risk to health and comply with the requirements of safety and health provisions.

The occupier shall send a copy of a report of Risk Assessment carried out under this section to the area occupational safety and health officer and shall take (occupier) immediate steps to stop any operation or activity where there is an imminent and serious danger to safety and health and to evacuate all persons employed as appropriate.

Duty to prepare a safety and health policy statement

In Section 7 (1) (a) and (b), it is established that except in such cases that as may be prescribed, it is the duty of every occupier to:-

- Prepare and, as often as may be appropriate, revise a written statement of his general policy with respect to the safety and health at work of his employees and the organization and arrangements for the time being in force for carrying out that policy; and
- To bring the statement and any revision of it to the notice of all of his employees.

Discrimination against employee

Sub section (1) of Section (8) states that the occupier shall not dismiss an employee, injure the employee or discriminate against or disadvantage an employee in respect of the employee's employment, or alter the employee's position to the detriment of the employee by reason only that the employee:-

- Makes a complaint about a matter which employee considers is not safe or is a risk to his health;
- Is a member of a safety and health committee established pursuant to this Act; or
- Exercises any of his functions as a member of the safety and health committee.

Safety and Health Committee

Section (9) (1) Illustrates that an occupier shall establish a safety and health committee at the workplace in accordance with the regulations prescribed by the Minister if:-

- There are twenty or more persons employed at the workplace; or
- The Director directs the establishment of such a committee at any other workplace.

Duty not to charge employees for things done or provided

Section (10) (1) states that an Employer shall not make any deduction from an employee's remuneration or levy, or permit to be levied on any of his employees any charge in respect of anything done or provided in pursuance of this Act or any regulation made there under.

Safety and Health Audits

Section 11 (1) of the Occupational Safety and Health Act 2007 outlines that the occupier of a workplace shall cause a thorough safety and health audit of his workplace to be carried out at least once in every period of twelve months by a safety and health advisor, who shall issue a report of such an audit containing the prescribed particulars to the occupier on payment of a prescribed fee and shall send a copy of the report to the Director. The Audit report referred above shall be preserved and be kept available for inspection by the Occupational Safety and Health Officer.

Duties of Self Employed person

Every self-employed person shall:-

⇒ Take all the necessary precautions to ensure his own safety and health and that of any other person in his workplace or within the environs of his workplace;

⇒ All times use appropriate systems of work, preventive and control measures and where not feasible, use suitable personal protective appliances and clothing required under this Act;

⇒ Comply with any safety and health rules, regulations instructions and procedures issued under this Act;

⇒ Report to the Director:-

- Any situation which he has reason to believe would present imminent danger or hazard and which he cannot correct, and
- Any incident or injury that arises in the course of or in connection with his works, as required under this Act.

Duties of Employee

Every employee shall, while at workplace:-

- Ensure his own safety and health and that of other persons who may be affected by his Acts or omissions;

Co-operate with his employer or any other person in the discharge of any duty or requirement imposed on the employer or that other person by this Act or any regulation made hereunder;

- At all times wear or use any protective equipment or clothing provided by the employer for the purpose of preventing risks to his safety and health;

- Comply with the safety and health procedures, requirements and instructions given by a person having authority over him for his own or any other person's safety;
- Report to the supervisor, any situation which he has reason to believe would present a hazard and which he cannot correct;
- Report to his supervisor any accident or injury that arises in the course of or in connection with his work; and
- With regard to any duty or requirement imposed on his employer or any other relevant statutory provision, co-operate with the employer or other person to enable that or requirement to be performed or compiled with.

Notice of accidents and dangerous occurrences

Section 21(1) Stipulates that; an employer or self-employed person shall notify the area Occupational Safety and Health Officer of any accident, dangerous occurrence, or occupational poisoning which has occurred at the work place.

Where an accident in a workplace, causes the death of a person therein, the employer or self-employed person shall:-

- Inform the area occupational safety and health officer within twenty-four hours of the occurrence of the accident; and
- Send a written notice of the accident in the prescribed form to the area occupational safety and health officer, within seven days of the occurrence of the accident.
- Where an accident in the workplace cause non-fatal injuries to a person therein, the employer shall send to the area occupational safety and health officer, a written notice of the accident in the prescribed form within seven days of the occurrence of the accident; and
- In case of death due to a workplace accident, non-fatal injuries arising from a workplace accident, an occupational disease or a dangerous occurrence at the workplace, involving a self-employed person incapable of submitting notification, such notification shall be submitted to the area occupational safety and health officer.

Health - General Provisions

Under Section 47 (1) It is established that Every workplace shall be kept in a clean state and free from effluvia arising from any drain, sanitary convenience or nuisance, and, without prejudice to the generality of sub section (1):-

- Accumulations of dirt and refuse shall be removed daily by a suitable method from the floors and benches of workrooms, and from a staircases and passages;
- The floor of every workroom shall be cleaned at least once in every week by washing or, if it is effective and suitable, by sweeping or by any other method;
- All inside walls and partitions, and all ceilings or tops of rooms, and all walls, sides and tops of passages and staircase, shall:-
  - ✓ Where they have a smooth impervious surface, at least once in every period of twelve months, be washed with hot water and soap or cleaned other suitable method;
  - ✓ Where they are kept painted with oil paint or varnished, be repainted or varnished at least once in every period of five years, or such other period as the director may deem necessary, and at least once in every period of twelve months be washed with hot water and soap or cleaned by other suitable method; and
  - ✓ In other cases, be kept whitewashed or colour washed and the white washing or colour washing shall be repeated at least once in very period of twelve months.

After the completion of the proposed project so many local people will be absorbed and employed. Foreigners will also visit the place and they will be from different parts of the country and outside the country. As required by the law the employer shall comply with the Occupational Safety and Health Act 2007.

3.3.11 The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing) Regulations

The Environmental Management and Coordination *Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing Regulations – 2006* regulation applies to conservation of biodiversity which includes conservation of threatened species, inventory and monitoring of biodiversity and protection of environmentally significant areas, access to genetic resources, benefit sharing and offences and penalties. As per this Act *"no person shall engage in any activity that may have an adverse impact on any ecosystem; may lead* *to the introduction of any exotic species or to unsustainable use of natural resources, without an Environmental Impact Assessment License issued by the Authority under the Act".*

3.3.12 The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009

The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009 ensures the conservation and sustainable use of wetlands, river banks, lake shores and sea shore. This regulation provides guidelines on management of these areas. This regulation also provides precautionary principal when working near wetlands in order to conserve them.

3.3.13 The Environmental (Impact Assessment and Audit) Regulations 2003

The *Environmental Impact Assessment and Audit Regulations, 2003* provide guidelines for conducting an EIA as well as environmental auditing and monitoring. The Regulations state in Regulation 3 that *"the Regulations should apply to all policies, plans, programmes, projects and activities specified in Part III and V of the Regulations"* basically lists the guidelines of undertaking, submission and approval of the EIA/ESIA/SEA Report.

3.3.14 The Land Act 2012

The Land Act 2012 is "an Act of Parliament to give effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources, and for connected purposes". Part I of the act is preliminary provisions, part II of the act deals with management of public land, part III of the act deals with administration of public land (Leases, Licenses and Agreements), part IV of the act deals with community land, part V of the act deals with administration and management of private land, part VI of the act deals with general provisions of leases, part VII of the act deals with general provisions of charges, part VIII of the act deals with compulsory acquisition of interests in land, part IX of the act deals with settlement programmes, part X of the act deals with easements and analogous rights, part XI of the act deals with miscellaneous, the schedule lists repealed laws i.e. The Wayleaves Act, Cap. 292 and The Land Acquisition Act, Cap. 295.

3.3.15 The Energy Act 2006

An act of parliament to amend and consolidate the law relating to energy, to provide for the establishment, powers and functions of the energy regulatory commission and the rural electrification authority, and for connected purposes enacted by the parliament of Kenya

"*Biomass*" means non-fossilized and biodegradable organic material originating from plants, animals and micro-organism and includes bio-ethanol, bio-diesel, biogas, charcoal, fuel wood and agro waste;

"*energy*" means any source of electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, or thermal power for any use; and includes electricity, petroleum and other fossil fuels, geothermal steam, biomass and all its derivatives, municipal waste, solar, wind and tidal wave power;

"*Energy conservation*" means the efficient, economic and cost effective production and use of energy;

"*electrical energy*" means energy involving the use of electric current which may be produced either by

mechanical, chemical, photovoltaic or any other means;

"*petroleum*" includes petroleum crude natural gas and any liquid or gas made from petroleum crude, natural gas, coal, schist, shale, peat or any other bituminous substance or from any product of petroleum crude, natural gas and includes condensate;

Energy regulatory commission

There is established a Commission to be known as the Energy Regulatory Commission whose objectives and functions shall be to–

a) regulate–
    i. importation, exportation, generation, transmission, distribution, supply and use of electrical energy;

ii. importation, exportation, transportation, refining, storage and sale of petroleum and petroleum products;
iii. production, distribution, supply and use of renewable and other forms of energy;
iv. Protect the interests of consumer, investor and other stakeholder interests.
v. maintain a list of accredited energy auditors as may be prescribed;
vi. monitor, ensure implementation of, and the observance of the principles of fair competition in the energy sector, in coordination with other statutory authorities;
vii. provide such information and statistics to the Minister as he may from time to time require; and
viii. collect and maintain energy data;
ix. prepare indicative national energy plan;

b) perform any other function that is incidental or consequential to its functions under this Act or any other written law

Electrical Energy

Subject to the provisions of this Act, a license or

a) generation, importation or exportation, transmission or distribution of electrical energy; or
b) supply of electrical energy to consumers: is provided that for undertakings involving a capacity not exceeding 3,000 kW, the provisions of subsections (2), (3) and (4) shall apply.

Any undertaking operating pursuant to a permit granted under this Act shall–

i. in any case where conveyance of electrical energy to or from any transmission or distribution network is possible, meet the minimum requirements of the owner or operator of the transmission or distribution network as approved by the Commission, and the owner or operator of any such undertaking shall inform the network owner or operator of all connected load and generation equipment that might have material effect on the network; and
ii. be subject to such conditions as may be specified by the Commission.

The Commission may suspend or revoke a license or permit where–

(a) the undertaking or the execution of the works related thereto has not commenced at the expiry of twenty-four months from the date on which the license or permit was granted, or at the expiry of any extended period which the Commission may allow;

(b) it is satisfied that the license or permit holder is either wilfully or negligently not operating in accordance with the terms and conditions of the license or permit, or the provisions of this Act or any regulations thereunder;

(c) the licensee or permit holder is adjudged bankrupt; or

(d) the licensee or permit holder, at any time after

Commencement of the license or permit, makes representation to the Commission that the undertaking cannot be carried on with profit, and ought to be abandoned, and, upon inquiry the Commission is satisfied that the representation is true.

Petroleum

Under this form of energy:-

- ✓ A person shall not conduct a business of petroleum business, importation, refining, exportation, wholesale, retail, storage or transportation of petroleum, except under and in accordance with the terms and conditions of a valid license.
- ✓ A licensee shall not sell petroleum to a person for the purpose of exportation or for resale in Kenya unless that person has a valid exporters or retail license under this Act.
- ✓ A person shall not use a vehicle for the purpose of transporting petroleum unless there is in force, in respect of that vehicle, a valid petroleum permit issued under this Act.
- ✓ No person shall drive a vehicle, or engage a driver, for the purpose of transporting petroleum unless such driver is certified for that purpose in accordance with this Act.

The Commission may, in accordance with section 23 appoint competent and impartial persons to be licensing agents for the purpose of issuing licenses under this Act.

Any person desirous of obtaining a license under this Act shall make an application to the Commission or licensing agent in the manner prescribed by the Commission, and the Commission or licensing agent may, within thirty days–

- ✓ Grant a license accordingly, either without conditions or subject to such conditions as the commission may deem fit and shall be accompanied by the prescribed fee.

- ✓ Refuse to grant such license.

Subject to the provisions of this Act, a person may make an application in the prescribed manner for amendment of the license, and the Commission or the licensing agent may, upon payment of the prescribed fee, amend the license and endorse it accordingly.

Where the Commission or the licensing agent refuses to amend a license under subsection (1), the Commission or licensing agent shall give to the applicant, if the applicant so requests, the reasons in writing for the refusal.

A license amended under this section shall retain the existing expiry date.

Renewable Energy, Energy Efficiency and Conservation

a) The Minister shall promote the development and use of renewable energy technologies, including but not limited to biomass, biodiesel, bioethanol, charcoal, fuel wood, solar, wind, tidal waves, hydropower, biogas and municipal waste.
b) The Minister may perform such functions and exercise such powers as may be necessary under this Act to promote the development and use of renewable energy, including but not limited to–
    - ✓ formulating a national strategy for coordinating research in renewable energy;
    - ✓ providing an enabling framework for the efficient and sustainable production, distribution and marketing of biomass, solar, wind, small hydros, municipal waste, geothermal and charcoal;
    - ✓ promoting the use of fast maturing trees for energy production including biofuels and the establishment of commercial woodlots including peri-urban plantations;
    - ✓ promoting the use of municipal waste for energy production, and

- ✓ promoting the development of appropriate local capacity for the manufacture, installation, maintenance and operation of basic renewable technologies such as bio-digesters, solar systems and hydro turbines;
- ✓ promoting international co-operation on programmes focusing on renewable energy sources;
- ✓ harnessing opportunities offered under clean development mechanism and other mechanisms including, but not limited to, carbon credit trading to promote the development and exploitation of renewable energy sources;
- ✓ promoting the utilization of renewable energy sources for either power generation or transportation;
- ✓ promoting co-generation of electric power by sugar millers and sale of such electric power through the national grid directly to the consumers;
- ✓ Promoting the production and use of gasohol and biodiesel.

The Minister may perform such functions and exercise such powers as may be necessary under this Act to enhance energy efficiency and conservation, including but not limited to–

- ✓ making, in consultation with the Kenya Bureau of Standards, requirements for the particulars to be displayed on labels on equipment or on appliances;
- ✓ taking all measures necessary to create awareness and for the dissemination of information for efficient use of energy and its conservation;
- ✓ strengthening consultancy services in the field of energy conservation;
- ✓ promoting research and development in the field of energy conservation;
- ✓ formulating and facilitating implementation of pilot projects and demonstration projects for promotion of efficient use of energy and its conservation;
- ✓ giving financial assistance to institutions for promoting efficient use of energy and its conservation;
- ✓ supporting the preparation of educational curriculum on efficient use of energy and its conservation for educational institutions, and coordinate with them for inclusion of such curriculum in their syllabus;
- ✓ implementing international co-operation programmes relating to efficient use of energy and its conservation; and

- ✓ giving financial incentives for any investment made to replace or install additional capital investments to improve energy efficiency;

The Energy Tribunal

- under this Act, the provision is made for appeals from the decisions of the Commission, all such appeals shall be made to the Energy Tribunal, in accordance with the provisions of this Part.

. For the purpose of hearing and determining appeals in accordance with section 107 and of exercising the other powers conferred on it by this Act, there is established a tribunal to be known as the Energy Tribunal, hereinafter referred to as the "Tribunal".

The members of the Tribunal shall be appointed from among persons with a university degree and not less than fifteen years relevant experience in matters related to electricity, petroleum, finance, economics, engineering, energy or law and shall consist of–

a) a Chairperson and vice Chairperson appointed by the President, in consultation with the Judicial Service Commission from among persons qualified to be judges of the High Court;
b) three other members who are persons possessing, in the opinion of the Minister, expert knowledge of the matters likely to come before the Tribunal and who are not in the employment of the Government or any state corporation; and
c) the members under paragraph (b) shall be appointed by the Minister in consultation with the Attorney General. A member of the Tribunal shall hold office for appointment for a period of three years and shall be eligible for re-appointment for one further term of three years.

A member of the Tribunal shall hold office on such terms and conditions as shall be prescribed in the instrument of appointment.

The provisions set out in the Third Schedule shall have effect in relation to the membership and conduct of business and affairs of the Tribunal.

Miscellaneous Provisions

- ✓ The Minister may, on the recommendation of the Commission and subject to sections 63 and 102, make regulations for or with respect to any matter that by this Act is required or permitted to be prescribed, or that is necessary or expedient to be prescribed for carrying out or giving effect to this Act.
- ✓ The regulations to be made under this Act may be made by the Commission on its own motion or may be proposed to the Commission by any licensee or person.
- ✓ Before making recommendation of any regulations to the Minister under this Act, the Commission shall publish the proposed regulations for purposes of inviting proposals from the public, in such manner as it may deem fit, at least forty days before the regulations are submitted to the Minister.
- ✓ The regulations made by the Minister in accordance with this section may, impose conditions, requiring acts or things to be performed or done to the satisfaction of the Commission, prohibiting acts or things from being performed or done and may prescribe periods or dates upon, within or before which such acts or things shall be performed or done or within which such conditions shall be fulfilled.
- ✓ The regulations made under this Act may be made for a limited period or without limit of period, and may be made subject to such conditions as the Minister deems fit, and may contain such supplemental and consequential provisions as the Minister considers necessary for giving full effect to the regulations.

- ✓ No person shall use or employ for or in connection with any of the purposes of producing, generating, transforming, transmitting, distributing, supplying, or importing, exporting, transporting, refining, storing, selling or using, any form of energy, any mode, material or apparatus other than that which complies with the specification or standard of the Kenya Bureau of Standards or where no such standard exists, any international standard approved by the Kenya Bureau of Standards.

- ✓ While discharging its functions and exercising its powers under the Act, the Commission shall ensure that no particular person is given undue preference or subjected to any undue disadvantage.

- ✓ All persons engaged in any undertaking or activity pursuant to a license or permit under this Act shall

notify the Commission in writing, in the form and manner prescribed by the Commission, of any accident or incident causing loss of life, personal injury, explosion, oil spill, fire or any other accident or incident causing significant harm or damage to the environment or property which has arisen in Kenya or within Kenya's Exclusive Economic Zone or Outer Continental Shelf.

- ✓ The Commission may direct an investigation to be carried out into any accident or incident under subsection (1) and take such action as it deems necessary.

3.3.16 Mining Act, Cap 306

Exploitation of mineral resources in Kenya is regulated by, the Mining Act Cap. 306 of the Laws of Kenya established in 1940.

Section 2 of the Mining Act define minerals as precious metals, precious stones or non-precious minerals, but does not include mineral oil, clay, murram, limestone, sandstone, or other stone or such other common mineral substances as the Minister may by notice in the Gazette declare not to be minerals for the purposes of this Act.

Ownership of the minerals is vested in the Government of Kenya and includes minerals found within Kenya's Continental Shelf, Territorial waters and the Exclusive Economic Zone. Currently the Government policy in mineral resources development is to ensure that the private sector takes the leading role in mineral development while it assumes a promotional, encouragement and regulatory role by providing basic geological data and necessary fiscal incentives. The Government of Kenya undertakes reviews of policies, mineral legislation, promotion measures and publicizes the mineral investments in Kenya through the Mines & Geology Department in the Ministry of Mining. This Department also undertakes regional mapping and exploration, encouragement of industrial mineral prospecting and exploitation to local miners, evaluation and investigation of mineral deposits using drilling rigs, rehabilitation of disused mines and quarries among other things. Over 90% of the country has been geologically surveyed.

3.3.17 National Construction Authority Act No. 41 of 2011

This is an Act of Parliament to provide for the establishment, powers and functions of the National Construction Authority and for connected purposes.

The Act defines “construction works” as the construction, extension, installation, repair, maintenance, renewal, removal, renovation, alteration, dismantling, or demolition of:-

a) Any building, erection, edifice, structure, wall, fence or chimney, whether constructed wholly or partly above or below ground level;
b) Any road, harbour works, railway, cableway, canal or aerodrome;
c) Any drainage, irrigation or river control works;
d) Any electrical, mechanical, water, gas, petrochemical or telecommunication works; or
e) Any bridge, via-duct, dam, reservoir, earthworks, pipeline, sewer, aque-duct, culvert, drive, shaft, tunnel or reclamation works, and includes any works which form an integral part of, or are preparatory to or temporary for the works described in paragraphs (a) to (e), including site clearance, soil investigation and improvement, earth-moving, excavation, laying of foundation, site restoration and landscaping.

The Act establishes the National Construction Authority which among its functions include to oversee the construction industry and coordinate its development. The National Construction Authority (N.C.A) is mandated to streamline, overhaul and regulate the construction industry in Kenya and establish a code of conduct for the industry.

Among the powers of the Authority include; with the approval of the Minister, to facilitate, or promote the establishment or expansion of, companies, corporations or other bodies to carry on any activities related to construction either under the control or partial control of the Authority or independently.

The Act states the conditions required for one to be registered to trade as a contractor in the country, whether a local or a foreigner. It defines a contactor as;

A person who carries on business as a contractor where such person, for reward or other valuable consideration, undertakes the construction, installation or erection, for any other person, of any structure situated below, on or above the ground, or other work connected therewith, or the execution, for any other person, of any alteration or otherwise to any structure or other work connected therewith, and undertakes to supply:-

a) The materials necessary for the work, or is authorized to exercise control over the type, quality or use of the materials supplied by any other person;
b) The labour necessary for the work, or is authorized on behalf of the person for whom the work is undertaken or any other person, to employ or select workmen for employment for the purposes of the execution of the work, whether under a contract of service or otherwise.

3.3.18 The Environmental Management and Co-Ordination (Amendment) Act, 2015

This is an Act of Parliament to amend the Environmental Management and Co-ordination Act, 1999. The interpretations for the following terms are redefined; "coastal zone", "exclusive economic zone", "natural resources", "wetland". The terms "District Environment Committee"; and "District Environment Action Plan" have been entirely deleted.

The following terms have been (in a proper alphabetical order) inserted; "Cabinet Secretary", "continental shelf”, "County Environment action plan", "County Environment Committee", "County Government", "Environmental Organization", "Indigenous knowledge”, "Ministry", “natural resource agreements", "person", "Strategic Environmental Assessment", "traditional knowledge”, “Voluntary Environmental Management”, "wildlife".

The principal Act is amended by deleting the words in the first column and substituting therefore the words in the second column wherever they appear in the Act-

First Column	**Second Column**
Minister	Cabinet Secretary
Chairman	Chairperson
Complaints Committee	Department
District	County
District Environment Committee	County Environment Committee
High Court	Environment and Land Court
Permanent Secretaries	Principal Secretaries
Non-Governmental organizations	Public benefit organizations

A new subsection is inserted immediately after subsection (2) of section 2 of the Act, which states; "Every person shall cooperate with state organs to protect and conserve the environment and to ensure the ecological sustainable development and use of natural resources".

The principal Act is amended by inserting a new section immediately after section 3, which about Access to information and states that;

1) Subject to the law relating to access to information, every person has the right to access any information that relates to the implementation of this Act that is in the possession of the Authority, lead agencies or any other person.
2) A person desiring the information referred to in subsection (1) shall apply to the Authority or a lead agency and may be granted access to such information on payment of the prescribed fee.

The principal Act is amended by repealing section 4 which was on the Establishment of the National Environment Council. The principal Act is amended by repealing section 6 which was on the Procedure of the Council. The principal Act is amended by repealing section 8 and replacing it with a new section which states; “The headquarters of the Authority shall be in Nairobi but the Authority shall ensure its services are accessible in all parts of the Republic”.

The principal Act is amended by repealing section 29 which was on Provincial and District Environment Committees and replacing it with a new section on County Environmental Committee.

The principal Act is amended by repealing section 30 that was about the Functions of Provincial and District Environment Committees, and replacing it with a new section on Functions of the County Environment Committee.

The principal Act is amended by repealing section 3l which was about Public Complaints Committees and replacing it with a new section on National Environmental Action Plan.

The principal Act is amended by repealing section 39 which was on Provincial Environment Action Plans.

The principal Act is amended by repealing section 40 which was about District Environment Action Plans and replacing it with a new section on County environment action plan.

The principal Act is amended by repealing section 4l which was about Contents of Provincial and District Environment Action Plans and replacing it with a new section on the contents of county environment action.

The following new sections have been inserted immediately after section 41; “Purpose of Environmental Action Plans”, “Monitoring, Compliance and Environmental Plans”.

The principal Act is amended by inserting a new section immediately after section 56 about “Guidelines on Climate Change”.

The principal Act is amended by inserting a new section immediately after the heading of Part VI on “Strategic Environmental Assessment”.

Section 69 of the principal Act on Environmental Monitoring is amended by inserting a new subsection immediately after subsection (l) as follows- Every lead agency shall establish an environmental unit to implement the provisions of this Act.

Section 70 of the Act that was on “Establishment of Standards and Enforcement Review Committee” is repealed.

The principal Act is amended by repealing section 7l that was about "Functions of Standards and Enforcement Review Committee" and, replacing it with a new section on "Water quality standards".

The principal Act is amended by repealing section 78 on "Air quality standards" and replacing it with a new section.

The principal Act is amended by repealing section 101 on "Standards for noise" and replacing it with a new section.

The principal Act is amended by inserting a new section on "County Legislation" immediately after section 147, which states that; "A County may make legislation in respect of all such matters as are necessary or desirable that are required or permitted under the Constitution and this Act".

The principal Act is amended by repealing section 148 which was on Existing laws relative to the environment and replacing it with a section on "Effect of existing Laws".

The principal Act is amended by repealing the Second Schedule and substituting therefore a new Schedule altogether.

3.3.19 The Environmental Management and Co-Ordination (Air Quality) Regulations, 2009

These regulations apply to:-

a) all internal combustion engines,
b) all premises, places, processes, operations, or works to which the provisions of the Act and Regulations made thereunder apply, and
c) Any other appliance or activity that the Minister may by order in the Gazette, specify.

The fourteenth schedule to the regulations lists Portland cement plants (clinker plants included) among controlled facilities where these regulations apply. Part VIII of the Fifth schedule to these regulations gives Guidelines on sources of fugitive emission air pollutants. The following are listed as the sources of fugitive emissions:

a) construction activities;

b) storage and handling, including loading and unloading, of materials such as bauxite, alumina, gypsum, or Portland cement or the raw materials therefore;
c) mining and quarrying activities;
d) haul roads;
e) haul trucks;
f) tailings piles and ponds;
g) demolition activities;
h) blasting activities; and
i) Sandblasting operations.
j) wind breaks; and
k) The paving of roads.
l) conveyor belts

Table 4 below is an excerpt from the third schedule to these regulations on the emission limits for cement plants and mining & quarry.

Table 3: An excerpt from the third schedule to these regulations on the emission limits for cement plants and mining & quarry

Air Pollutant/ Industry	**Opacity**	Particulate (Dust) PM_{10} (mg/ Nm^3)	Sulphur oxide (SO_X) (mg/ Nm^3)	Nitrogen oxides (NO_x) (mg/ Nm^3)	Carbon monoxide (mg/ Nm^3)	Carbon dioxide (mg/ Nm^3)	Hydrocarbons (mg/Nm^3)	Hydrogen sulphide (mg/ Nm^3)	Hydrogen chloride (mg/ Nm^3)	Hydrogen fluoride (mg/ Nm^3)	Dioxins /Furans
Cement plants		50	400	1500		500	300				0.5ng/Nm^3
Mining & Quarry	20%	400									

The fourth schedule to these regulations gives a table of guidelines on air pollution monitoring parameters from stationary sources. Table 4 below is an excerpt from the said table, the shaded areas represents parameters to be monitored. Monitoring is on a quarterly basis.

Table 4: An excerpt from table on the forth schedule of the regulations on parameters to be monitored

Air Pollutant/ Industry	**Opacity**	Particulate (Dust) PM_{10} (mg/ Nm^3)	Sulphur oxide (SO_X) (mg/ Nm^3)	Nitrogen oxides (NO_x) (mg/ Nm^3)	Carbon monoxide (mg/ Nm^3)	Carbon dioxide (mg/ Nm^3)	Hydrocarbons (mg/N m^3)	Hydrogen sulphide (mg/ Nm^3)	Hydrogen chloride (mg/ Nm^3)	Hydrogen fluoride (mg/ Nm^3)	Dioxins /Furans
Cement plants											
Mining & Quarry											

4. BACKGROUND TO KILIFI COUNTY

4.1 Administrative, Geographic and Physical Description.

This section provides a description of the County profile, with background formation of administrative boundaries, physiographic and natural conditions, settlement patterns and other background information that are critical. All the information in this section was sourced from the former Malindi and Kilifi District Development Plans.

4.1.1 Position and size of the County

Kilifi County is located in the Coast Province of Kenya. It covers a total surface area of 12,610 km² and accounts for 2.17 per cent of Kenya's total surface area. It borders the counties of Tana River to the North, Taita Taveta to the West, Mombasa and Kwale to the South and the Indian Ocean to the East.

4.1.2 Administrative and Political Units in Kilifi County

The county has six sub counties namely, Kilifi North, Kilifi South, Ganze, Malindi, Magarini, Rabai and Kaloleni. It has 17 divisions, 54 locations, 175 sub-locations. In terms of administrative units Malindi District is the largest while Rabai is the smallest in terms of area in Km².Kilifi

4.1.2.1 Electoral Units

The county is divided into 7 constituencies and 35 wards.

The constituencies are:

- ✓ Malindi,
- ✓ Magarini,
- ✓ Kaloleni,
- ✓ Ganze,
- ✓ Rabai,
- ✓ Kilifi North, and
- ✓ Kilifi South.

Table 5: County statistics

County	Populationn 2009 Census	Area	No of wards	Wards
Ganze Sub-County	137,664	2,942	4	Dungicha,Bamba, Jaribuni, Sokoke
Kaloleni Sub-County	139,302	651	4	Mariakani, Kayafungo, Kaloleni, Mwanamwinga
Kilifi North Sub-County	207,587	405	7	Tezo, Sokoni, Kibarani, Dabaso,Matsangoni, Watamu, Mnarani.
Kilifi South Sub-County	171,607	401	5	Junju, Mwarakaya, Shimo la Tewa, Chasimba,Mtepeni
Magarini Sub-County	177,241	6,979	6	Maarafa, Magarini, Gongoni, Adu, Garashi,Sabaki
Malindi Sub-County	162,712	627	5	Jilore, Kakuyuni, Ganda, Malindi Town, Shella
Rabai Sub-County	113,622	241	4	Mwawesa, Ruruma, Jibana, Rabai/Kisurutun

Source: Kilifi County Website

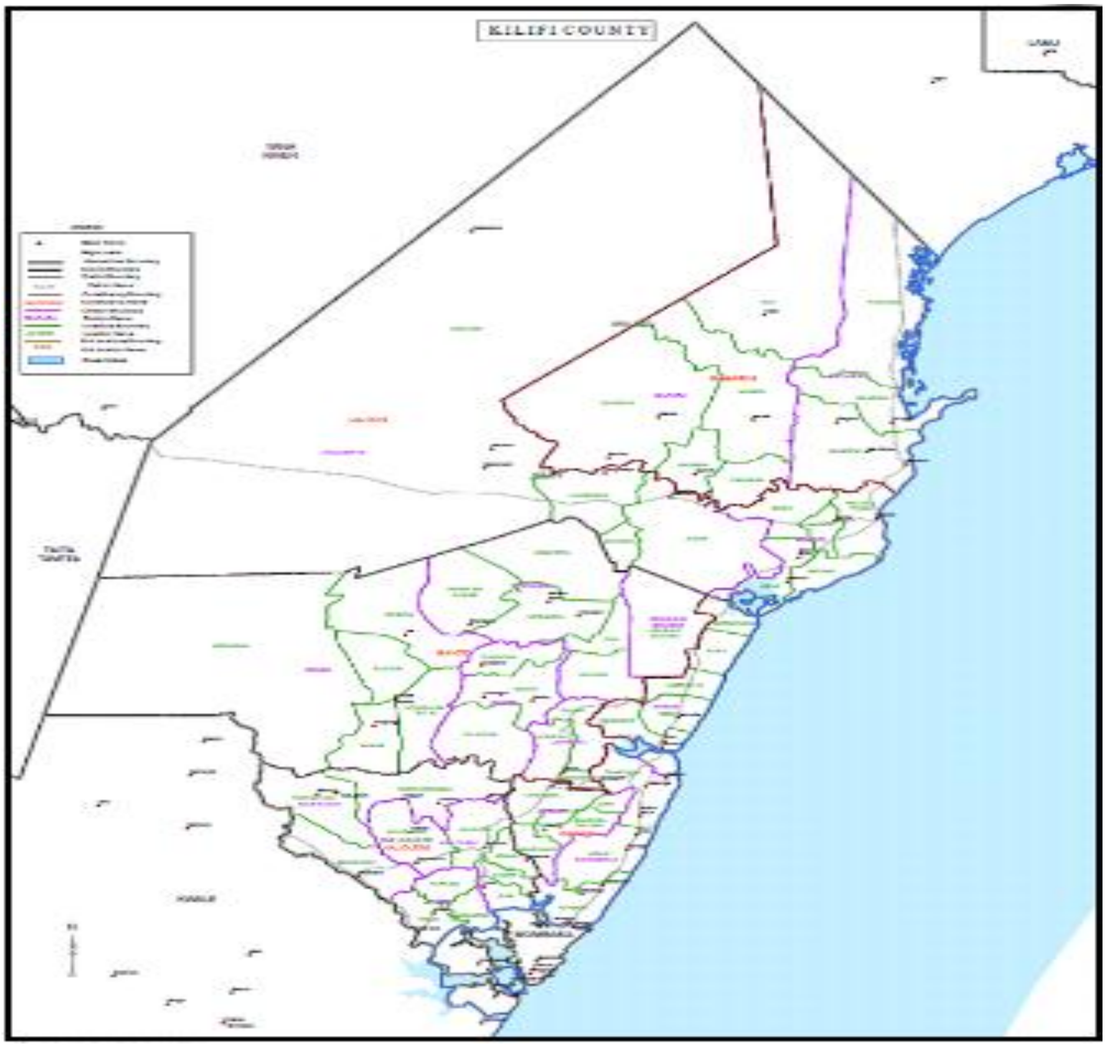


Figure 2: ***Map of the County's Political and Administrative boundaries. Source: Kilifi County Government website.***

4.2 Settlement patterns

Human settlement in the County is influenced by urbanization, industrial development, climatic conditions and soils, accessibility to water points which are linked to the livelihood zones, namely; Fishing and Sand Harvesting, Forestry and Tourism, Mixed Farming, Ranching, Salt Works and Urban Zone.

4.3 Major Towns in Kilifi County

The County's capital is the coastal town of Kilifi which lies on the Kilifi Creek between Mombasa and Malindi towns. Other major towns include:

- ✓ Malindi
- ✓ Mtwapa
- ✓ Watamu
- ✓ Mariakani
- ✓ Kaloleni
- ✓ Gongoni

4.4 Geography and climate

The topography of the County is dominated by low-range sand-stone hills, and a terrain that generally slopes towards the sea. Kilifi County has 21 forests cumulatively, covering 246 km^2. River Sabaki, a perennial fresh water river, runs 150km across the county, supporting various human and livestock activities. Seasonal rivers in the county include the Nzovuni, Rare, Goshi and Wimbi. There are also many seasonal streams found across the county. The average annual rainfall ranges from 300mm in the hinterland parts of the County to 1,300mm along the coastal belt.

4.5 The People of Kilifi County

Based on the 2009 Kenya Population and Housing Census, the county had about 200 000 households and a population of 1,109,735 which accounted for 2.9 percent of the total Kenyan population. The main communities residing in Kilifi County include seven Mijikenda sub-groups (Giriama, Chonyi, Jibana, Kambe, Kauma, Rabai and Ribe), the Bajuni, Swahili, and people of Arab, Indian and European descent who have permanently settled in the county. There are other Kenyan communities who have also settled in the County because of their employment or for purposes of doing business. Over time, these people have had close interactions with each other, and fostered the Swahili culture and language. Most of the people in Kilifi County are either Christians or Muslims, though other smaller religious communities exist.

4.5.1 Religion and Traditional Culture

Majority of people living in Kilifi County are either Muslims or Christians, although the county has several smaller religious communities such as the Africa Indigenous Religion and Hindu.

Kiswahili and Mijikenda language are widely spoken across the county. The Mijikenda (nine cities) is a wider grouping that comprises nine sub-tribes; Giriama, Digo, Chonyi, Kamabe, Jibana, Kauma, Duruma, Rabai and Ribe. All of these sub-groups speak the Mijikenda language.

Traditionally, the Mijikenda believed in a supreme god, Mulungu. The community has a sacred forest - the Kaya - which is used by the elders as a place of prayer to Mulungu. The Kaya forest was enlisted as a World Heritage Site in August 2008.

Mijikenda are small scale farmers mainly growing coconut palm, cassava, cashew nuts, yams, millet and sweet potatoes. They are renowned for their rich folk music tradition that involves rhythmic percussion.

4.6 Economy of Kilifi County

4.6.1 Agriculture and Rural Development

Most farmers in the County are subsistence and most of the purchased inputs are certified seeds. There is limited use of both organic and inorganic fertilizers. Most of the farm holdings are less than a hectare. The County's variety of micro-climates makes the area suitable for the production of a variety of crops such as mangoes, cashew nuts, maize, beans, pigeon peas and cow peas. The main livestock enterprises include Dairy Cattle, Beef Cattle, Poultry, Sheep, Goats, Pigs, Rabbits and Bee-keeping. The major potentials which exist in the fisheries sub-sector include mariculture development; exploitation of deep sea fisheries; ice production for fish preservation; acquisition, securing and development of fish landing sites; empowering of fishers to enhance sustainable utilization of fisheries resources. The major activities under cooperatives are savings and credit cooperatives (SACCOs) are fishing cooperatives. Other types of cooperatives include ranches, transport, quarrying and multi-purpose.

4.6.2 Potential crops for cultivating in Kilifi

The average precipitation of 900 mm and mean-annual temperature of 27°C hold potential for agricultural development. Horticultural crops and vegetables such as chillies, brinjals, okra, onions and tomatoes can be cultivated along the Coastal plains. Staples like maize, rice, bananas, cow peas, green grams and beans can also do well. Northwards, along the Sokoke Forest, is land with medium agricultural potential. Further north, are the pineapple fields in Magarini County that can provide large scale farming. Jatropha, aloe vera and vanilla grow well in the County and could be promoted for the production of bio-diesel, pharmaceuticals, cosmetics and food products.

4.6.3 Trade, Tourism and Industry

Tourism is one of the most important economic activities in the County. The major tourist attractions in the County are historic sites; topography; flora and fauna; water sports and recreation; cultural attractions and agro-tourism.

The industries in the County are manufacturing industries. Most of them are medium and small-scale enterprises. Small-scale Jua Kali cottage industries are also available in the County. Small-scale manufacturing industries have emerged and they manufacture goods such as Neem Soap and Wood Carvings.

Trading patterns in the County revolve around trading in agro-based goods, raw materials and other products from the manufacturing sector. In the County various types of trade such as retail, wholesale, distribution and hawking are carried out in a very elaborate way. The wholesale businesses are few and are located mainly in the major trading centres such as Kilifi and Malindi.

4.6.4 Mining and manufacturing

Kilifi County is rich in minerals; mainly titanium and iron ore, that have spurred extensive industrial mining activities. Other minerals extracted include barites, galena, rubies, pozzolana, gypsum and limestone. Salt mining and sand harvesting have been carried out over the years to take advantage of the sandy, salty waters. While these are economically lucrative, they are equally responsible for destruction of its mangrove forests. As for manufacturing sector there are:

- ✓ Two Cement factories in County (Mombasa Cement Limited and Athi River mining)
- ✓ Salt extracting companies in Malindi
- ✓ Milly fruit processing at Mtwapa
- ✓ Sandal factory in Kikambala
- ✓ Milk processing factory in Kilifi

4.6.5 Tourism

Tourism is very important for the County. It creates opportunities for employment in the service industries associated with it, such as transport, entertainment and advertising.

There has been an up-trend in tourism over the last few years and the County is well positioned to benefit from; local tourism, eco-tourism, pro-poor tourism, educational tourism, cultural tourism and sport tourism. All these trends offer opportunities for significant growth of the tourism sector in Kilifi County.

Main attractions

- ✓ Rabai Church
- ✓ Gede Ruins
- ✓ Vasco da Gama Pillar
- ✓ Mnarani Ruins
- ✓ Mangrove Forests
- ✓ Arubuko Sokoke Forest which hosts the Tsavo East National Park
- ✓ Indian Ocean
- ✓ Kafuloni
- ✓ Sabaki and Rare Rivers
- ✓ Marine parks of Malindi, Watamu and Mtwapa are a great tourist attraction.

4.7 Physical Infrastructure

The movement of people for socio-economic and cultural activities depends on good transport and communication system. A good road network provides access to the markets, health and other social facilities and also reduces incidences of insecurity.

The improvement of telephone services has made it easier to communicate within the County and other outside areas. This has improved efficiency in service delivery and decision making. The improvement in the communication system makes the communities who can contribute to their development.

4.7.1 Public Amenities

4.7.1.1 Health Facilities

The County has inadequate health facilities especially in the rural areas. Issues concerning mother and child care are not adequately addressed in most rural facilities. The same rural health facilities are also far from the community making them difficult to access. Also as a result of high poverty levels, women are discouraged from visiting facilities due to fee charges.

Has several healthcare facilities both private, missionary and public serving the residents.

Large county hospitals include;

- Kilifi District Hospital
- Malindi District Hospital
- Watamu Hospital.

Private Big hospitals include

- Tawfiq Hospital
- Star hospital
- Wananchi Medical
- St. Peters
- BOMU medical
- Khairat Medical

Missionary Hospitals include

- St. Lukes Hospital
- St. Benedicts

4.7.1.2 Education (Schools & Universities)

Has 252 primary schools, 64 secondary schools, 81 private primary schools, 5 private secondary schools and 2 international schools. Has a total of 8 higher learning institutions;

- Pwani university

- Mount Kenya University (Kilifi county campus)
- Kenya Utalii college (Kilifi county campus)
- Nairobi university (Kilifi county campus)
- Mombasa Aviation (Kilifi County campus)
- DALC education (Kilifi county Campus)
- Kenya school of flying (kilifi county center)

4.7.1.3 Social Halls

Commonly used in presiding of wedding extensions, business meetings, community meetings and many more. Some of the common halls are;

- Nidhamia muslim hall-malindi
- Kaloleni Social Hall

4.7.1.4 Recreational Parks & Stadia

Refreshment of strength and spirits not only meant for recreation but sightseeing too…experience the calm embrace blended with nature, heritage, and culture. These include;

- Uhuru Gardens - Malindi
- Mazeras , Mazingira Park - Kilifi

Stadiums

Local stadiums best ideal for sport activities and any related outdoor functions. Include;

- Karisa Maitha - Kilifi
- Malindi Municipal Ground

4.7.1.5 Petrol Stations & Garages

Based along the highway and are run by multinational oil firms stretching all the way from Mombasa county passing through kilifi county heading to Lamu county not only offering gas and mechanical services but food and washrooms. The prices are normally regulated by energy regulatory commission (ERC). These include;

- Shell Bp

- Total
- Kobil

And many more petrol stations and garages services situated within the vast county towns.

4.7.1.6 Public Toilets

Within Kilifi there exists public toilets in the following areas:

- Jua Kali Association, Kilifi North
- Green Town Movement, Kilifi North
- Water Gate Hotel, Kilifi North

4.8 Environment

Sound environment and natural resource management should contribute to poverty reduction, food security and sustainable livelihood, enhanced environmental equality and health, promotion of sustainable energy production, minimization of pollution and waste, improvement of shelter and habitats, promotion of eco-tourism and improved standards of living.

Socio-economic activities in the County are greatly influenced by climate and physiographic conditions. Deforestation, poor farming practices and settlement patterns have caused great environmental impact in the County. The major adverse environmental effects include land degradation, deforestation, sea erosion, and water pollution, dumping of commercial and domestic waste in town, marine pollution and soil erosion.

4.9 Human Resource Development

It is through education that the County ensures that its population has the right knowledge, attitude and skills to participate in the implementation of the development programmes of the County. By advocating against retrogressive cultural practices, the County ensures that local. Social and traditional institutions and cultural practices are not an obstacle to progress and development in the district.

4.10 Research Innovation and Technology

Use of Information, Communication and Technology (ICT) in the County has been very low. However the County is served by mobile phone service providers which include Safaricom, Airtel, Orange-Kenya and Yu-Mobile. However the services need to be expanded to cover the whole County. Access to email and internet services are not readily available especially in the rural areas. This makes communication in the County difficult thus hindering development, thus there is need to prioritize the establishment of cyber cafes and digital villages. Radio transmission is accessible to all areas in the County.

The ICT sector is important in ensuring that information on socio-economic issues is available, creation of employment opportunities, enhancing business opportunities through promotion of products in internet; creating efficient and effective services delivery as well as ensuring that users are educated, entertained and informed.

4.11 Governance, Justice, Law and Order

For any development to take place in the County, maintenance of law and order is very vital. Investors cannot invest in an environment of uncertainty. Therefore, this sector plays a crucial role in availing an enabling environment for investment.

Table 6: Roles of different stakeholders in maintaining Law and order in the County

Stakeholder	Roles
County Government	Provide conducive environment for all players to operate and creating peaceful environment for development.
Police	Maintain Law and order.
Central Bureau of statistics, civil Registration and Registration of persons	Collection of data for planning and decision making process
Private security firms	Supplementing police effort in maintaining security
Law firms	Providing legal services

4.11.1 Public Administration

Public administration plays a crucial role in availing an enabling environment for investment which is achieved through improved security, sound economic and financial management and development oriented administration. The County consists of the following administrative Sub-Counties:

- Ganze Sub-County
- Kaloleni Sub-County
- Kilifi Sub-County
- Magarini Sub-County
- Malindi Sub- County
- Rabai Sub-County

Apart from the County administration, other stakeholders are also involved in matters public administration, these are summarized in the table below:

Table 7: public administration

Stakeholder	Roles
Coast Development Authority and Planning Department	Co-ordination of development activities; providing planning of development projects and programmes services.
Central Bureau of Statistics, Civil Registration and Registration of Persons.	Collection of data for planning and decision making process.
Community	The community plays the role of providing information to the public administrators and initiating planning and implementation of development beside monitoring and evaluation. The community is also involved in community policing.

4.11.2 Special Programmes

Various efforts to enhance the community capacities for self-reliance and greater participation in the development process have been put in place in the County through community mobilizations as well as initiating and supporting community based development programmes targeting women, children, older persons, youth, people living with disabilities, the poor, and other minority groups. This has been done through social grants by the gender and social services department, the youth enterprise fund, community driven development and support to local development components of Arid Lands Resources Management Project.

On cultural and social services, the focus is on training and empowering local communities on participation in implementation of sports activities, preservation of cultural identity and heritage through cultural resources centres as well as carrying out flagship cultural and sports festivals and exhibitions.

The County is prone to disasters such as floods, drought, fires and Tsunami due to the harsh climatic conditions and the location of the County. Gender inequality in the County is deeply rooted in culture and traditions. Through the Youth Fund, Women Fund and other devolved funds, the youth and women in the County are being made to ensure that they are economically empowered.

4.12 Major Challenges and Cross Cutting Issues in the County

This section provides analysis of the major development challenges and cross cutting issues that are realized within the County. The major challenges that are addressed relate to landlessness which is then followed by analysis of the cross cutting issues including population growth, poverty, HIV/AIDS, disaster and Environmental Conservation & Management.

4.12.1 Landlessness

The available data which was obtained in the District from Welfare and Monitoring Survey 1997 showed that about 11.3% of the households in the County were landless where many of these people were squatters in private land. Although the Government adjudicated several schemes, the number of people settled was below target. Many people have no legal documents for land ownership where people own the land customarily. The absence of title deeds, has discouraged full utilization of land and as well led to low level of investment with no permanent structures in place.

4.12.2 Poverty

According to data contained in the Malindi District Poverty Assessment Report-2000, the County had a considerable number of persons considered to be in absolute poverty. This poor are defined as people who are unable to meet basic food and no-food requirements. The poor persons or households in the County are characterized by high disease incidences with high cost of drugs and treatment, food shortage, poor states of dwelling units (Shanties) both in rural and urban areas, over indulgence in consumption of local palm wine and drugs, poor sanitary conditions both in the urban and rural areas and lack of access to clean water. The poverty situation in the County has been exacerbated by the decline in the tourism industry, poor returns from agricultural produce and adverse weather conditions experienced in the recent past.

4.12.3 HIV/AIDS

According to the Ministry of Health, the County's HIV/AIDS prevalence rate is between 15-17 percent. The high prevalence rate in the County is caused by promiscuity, prostitution, drug addiction, and alcoholism, traditional practices such as wife inheritance, polygamy and belief in witchcraft. This trend has led to increased poverty levels in the County. The major challenges brought about by emergence of HIV/AIDS in the County include increase in number of children in need of special protection. The HIV/AIDS prevalence in the County is estimated at 15% implying that one in every seven adults is infected with the virus.

4.12.4 Gender inequality

Gender concerns in Kilifi County relate to the place of men and women in society, education, economic activities, land and other property ownership. In the County, women form the bulk subsistence of agricultural labour and are engaged in activities such as growing and marketing farm produce. Other chores include caring for children and other domestic chores. Many women in the County do not own land and other property and therefore cannot use land as collateral to get bank credit. In semi-arid areas such as many parts of Ganze Sub-County, women devote many more hours looking for water.

4.12.5 Water

Semi-Arid areas in the County have acute water problem. Women travel long distances looking for water for domestic use. This takes most of their time which they could have used elsewhere for productive and economic activities. The water quality in most areas is low hence exposing them to diseases.

4. 13 Environmental Conservation and Management

Climate and Physiographic conditions have a great influence on socio-economic activities in Kilifi County. Poor farming practices, deforestation and settlement patterns have caused great environmental impact in the County. The major adverse environmental impacts include land degradation, deforestation, sea erosion and air pollution, dumping of commercial and domestic waste in town and marine pollution.

4.13.1 Deforestation

Tree felling without replacement in non-gazetted forests have reduced the forest area in the County. These areas have been opened up for agriculture and settlement because they are viewed as a common resource by the community. The indigenous trees have been exploited for timber, poles and firewood. Such activities have greatly reduced the forest area in the County. The Mangrove forests in the estuaries have also been targeted for firewood, poles, salt and lime burning. These forests are a natural nursery for fish and migratory birds and uncontrolled exploitation is likely to affect the marine life.

4.13.2 Water Pollution

Water pollution within the County is common in Magarini Sub-County where sand harvesting is prevalent. These activities have increased water salinity and erosion. River Sabaki has also heavily polluted due to poor sanitation and human activities.

4.13.3 Soil Erosion and Degradation.

Sloping terrain and poor land use practices in parts of the County have increased vulnerability of these areas to soil erosion. The common practices include, slash and burn and shifting cultivation.

5. BASELINE ENVIRONMENTAL CONDITION OF THE PROPOSED PROJECT SITE

5.1 Vegetation at the proposed project site

5.1.1 Introduction

To understand and document the vegetation at the proposed project site, a vegetation survey was carried out. The vegetation survey employed the plot-less method developed by Hall and Swaine (1981) and used in modification by Mwachala, *et al.* (2004), this method was used to capture plant diversity in the various habitat types. The survey method involved random walks through the various habitats or patches. To ensure complete and representative observations, sampling will be stopped after considerable time, usually two hours or when the discovery of unrecorded species is less than one in two minutes. In addition, collections were recorded randomly where possible to cover the edges and other unique habitats. All the vascular plant species encountered were recorded in each of the habitat and specimens selectively collected in duplicate using standard methods (Foreman & Bridson, 1992). Any unidentified, difficulty and unique plant species encountered were confirmed at the East African Herbarium and specimens prepared for preservation. Species uniqueness (endemism, rarity, threat i.e. vulnerable, endangered) were determined through literature review, voucher specimens and databases at the EA Herbarium based on LEAP (Knox & Berghe, 1996) with input from other experienced botanical experts.

5.1.2 Vegetation communities

There were 3 distinct habitats: the secondary vegetation dominated by *Ricinus communis* and *Phyllanthus reticulatus*; the habitat near the shore line dominated by *Mimusops obtusifolia* and further into the quarry sites there were small patches of indigenous plants with few *Adansonia digitata* and *Cassytha filiformis* growing on *Azidiracta indica.*

5.1.3 Species richness

A total of 77 species were recorded with the grass family Gramineae being the most dominant with species like *Cenchrus cilliaris*, *Dactyloctenium aegyptium*, *Urochloa trichopus* and *Digitaria nuda* The Bean family or Leguminosae had species like *Senna didymobotrya*, *Indigofera tinctoria*, *Canavalia rosea*

Rocky outcrop habitat

Parasite(Cassytha filifomis)growing on *Azidiracta indica*

Plate 1: Vegetation communities at the proposed project site

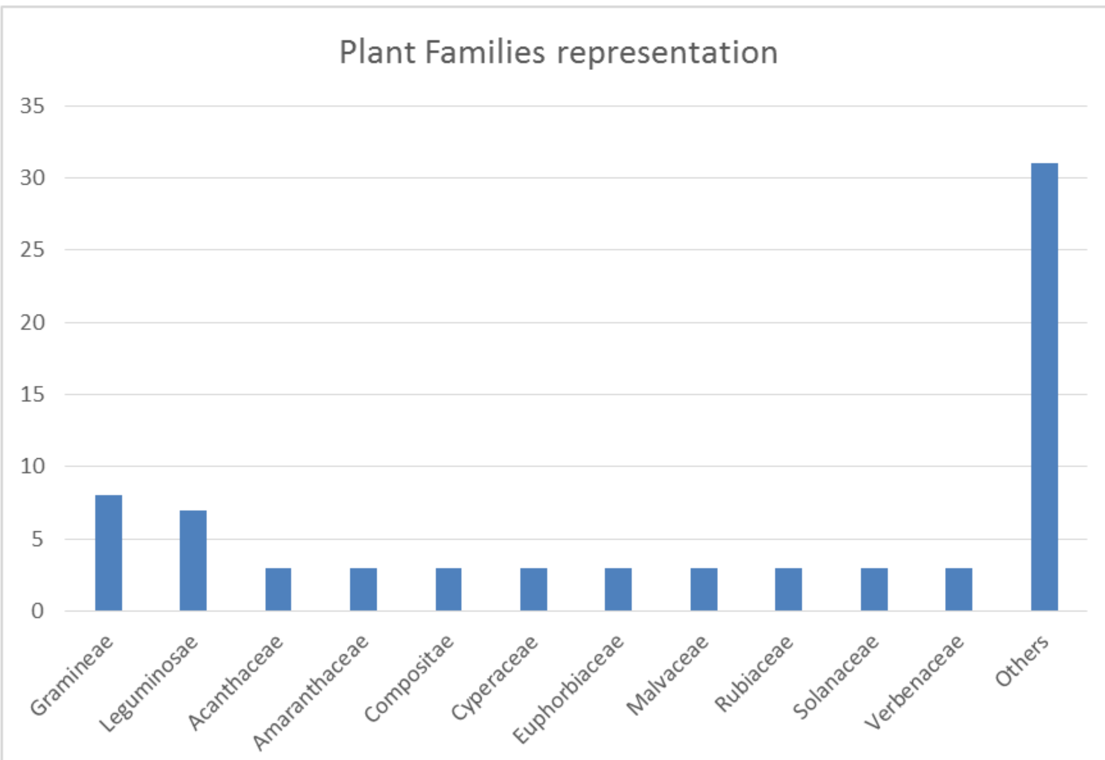


Figure 3: Plant family representation at the proposed project site

The herbaceous plants were the most dominant life form followed by shrubs and sedges and grasses, trees were very few with the least representation .Maritime scrub forest is scrub forest developed on coral rag with soils that tend to be shallow and so are more prone to desiccation than would be expected .Species like *Sideroxylon inerme*, *Capparis cartilaginea* and *Adansonia digitata* are some of the dominant species in the coral rag.

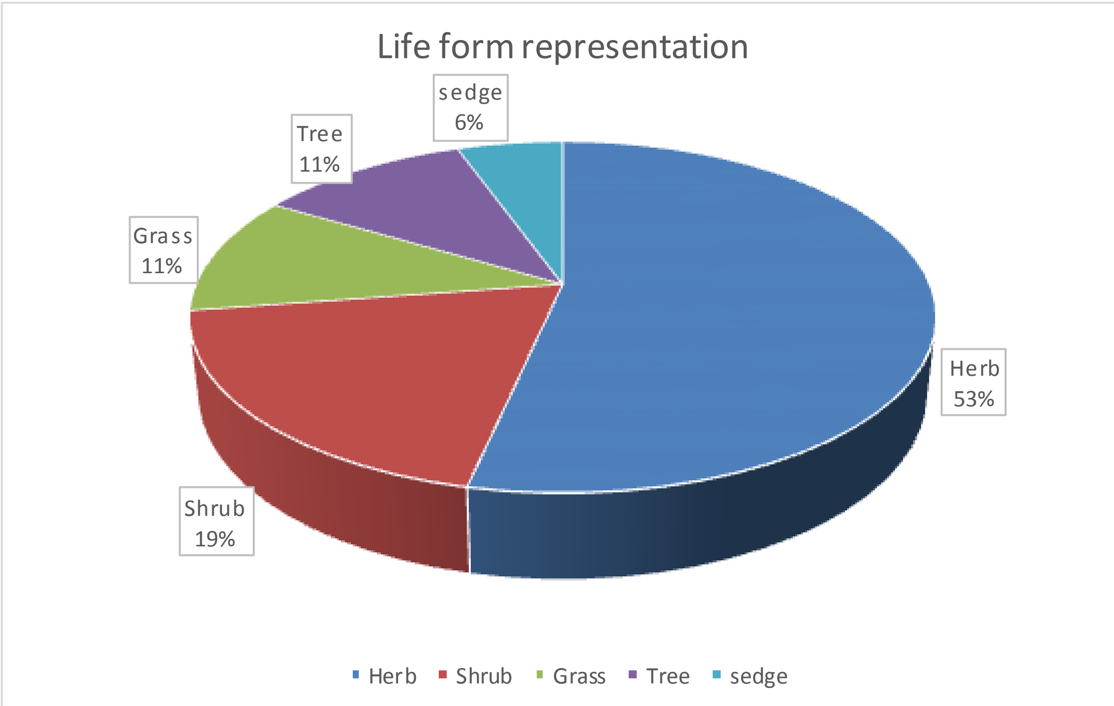


Figure 4: Life form presentation at he proposed project site

One of the species noted at the proposed project site is *Ricinus communis* or Castor Bean. This species is an invasive alien species can transform the structure and composition of an ecosystem by repressing or excluding native species either directly or by out competing them for resources, or indirectly by changing the way the nutrients are cycled through the system Itis a fast growing, evergreen herbaceous or semi-woody large shrub or small tree that reaches 5 meters tall and 4.5 m wide with poisonous seeds due to the presence of ricin protein .The geographic .*Ricinus communis* is originally native to northeastern Africa and the Middle East. It has escaped cultivation and become naturalized as a weed almost everywhere in the world that has a tropical or subtropical climate. Castor Bean grows wild on rocky hillsides, and in waste places, fallow fields, along road shoulders and at the edges of cultivated lands. *Plectranthus flaccidus*, *Indigofera tinctoria* were also dominant species. *Indigofera tinctoria* is a leguminous plant which is widespread across tropical regions around the globe, as it had been cultivated and highly valued for centuries as a main source of indigo dye, leading to its common names 'true indigo' and 'common indigo', before commercial synthetic indigo production came into use .it has the potential to invade native ecosystems and poses both a present and a future threat.

Ricinus communis **dorminated habitat**

Plate 2: *Ricinus communis* dominated habitat at the proposed project site

Plectranthus flaccidus

Indigofera tinctoria

Plate 3: Observed dominant species; *Plectranthus flaccidus* & *Indigofera tinctoria*

Canavalia rosea commonly known as the coastal jack bean inhabits upper beaches, cliffs, and dunes throughout the world's coastal tropics. It is highly salt-tolerant and prefers sandy soils. *Mormodica trifoliolata* is climber or trailer to 6 m long; stems herbaceous. The habitat is deciduous bushland and woodland; river banks and beds, and other seasonally inundated places in sandy saline soil; also in limestone scree

Canavalia rosea

Momordica trifoliolata

Plate 4: *Canavalia rosea* & *Mormodica trifoliolata* salt-tolerant & climber respectively

Capparis cartilaginea commonly known as the Cartilage Caper is a scrambling shrub which grows by spreading or scrambling over rocks whereas *Mimusops obtusifolia* is an East African range evergreen shrub perhaps only 150cm tall when growing close to the sea shore but more usually becomes a much-branched, spreading tree growing up to 20 meters tall. The tree is sometimes harvested from the wild as a local source of food and wood. The Fruit has a sweet-tasting flesh, it is usually eaten as a snack and the seeds discarded.

Capparis cartilaginea

Mimusops obtusifolia

Clerodendrum glabrum

Hewittia sublobata

Plate 5: Small deciduous tree species observed

Clerodendrum glabrum commonly known as the White Cats Whiskers is a small deciduous tree is, drought resistant and fast growing in the sun or semi-shade. It is useful for hedging/screening and it has non-aggressive roots. It is also useful as the leaves are rubbed onto the hands and face to repel bees when collecting honey. Another use is for poles for hut building. The medicinal properties are varied from treating intestinal parasites to binding the roots over snake bites. It is an ideal for a small garden.

Allophylus pervillei

Striga gesnerioides

Plate 6: Parasitic plants observed

Striga gesnerioides is commonly known as cowpea witch weed it is a parasitic plant that occur naturally in parts of Africa, Asia, and Australia. It is a serious pathogens of crop cereals, with the greatest effects being in savanna agriculture in Africa.

5.1.4 IUCN Conservation status

The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction i.e. those listed as Critically Endangered, Endangered and vulnerable. The IUCN Red List also includes information on plants that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants that are either close to meeting the threatened thresholds or that would be threatened were it not for an on-going taxon-specific conservation programme (i.e., are Near Threatened).

Out of the 74 plant species recorded none of them is critically endangered, endangered, vulnerable or rare.

Bearing in mind that the site of expansion was previously a sisal cultivation farm and subsequently weeds and invasive species have taken over, the original pristine vegetation is not exhibited in site further development of the area will have very minimal biodiversity impact .

Table 8: List of plant species observed at the proposed project site

Family	**Genus**	**Species**	**author**	**Life form**
Acanthaceae	*Hygrophila*	auriculata	(Schumach.) Heine	Herb
Acanthaceae	*Justicia*	gangetica		Herb
Acanthaceae	*Thunbergia*	alata	Bojer ex Sims	Herb
Amaranthaceae	*Achyranthes*	aspera	L.	Herb
Amaranthaceae	*Psilotrichum*	sericeum	(Roxb.) Dalziel	Herb
Amaranthaceae	*Aerva*	lanata	(L.) Juss	Herb
Amaryllidaceae	*Scadoxus*			Herb
Araceae	*Gonatopus*	boivinii	(Decne.) Engl.	Herb
Asparagaceae	*Asparagus*	racemosus	Willd.	Herb
Balanitaceae	*Balanites*			Shrub
Bombacaceae	*Adansonia*	digitata	L.	Tree
Burseraceae	*Commiphora*	edulis	(Klotzsch) Engl.	Shrub
Capparaceae	*Capparis*	cartilaginea	Decne.	Shrub
Commelinaceae	*Commelina*	mascsrenica		Herb
Commelinaceae	*Commelina*	africana	L.	Herb
Compositae	*Conyza*	sp		Herb
Compositae	*Launaea*	cornuta	(Hochst. Ex Oliv. & Hiern) C.Jeffre	Herb
Compositae	*Vernonia*	sp		Herb
Convolvulaceae	*Hewittia*	sublobata	(L.f.) Kuntze	Herb

Convolvulaceae	*Merremia*	ampelophylla	Hallier f.	Herb
Cucurbitaceae	*Coccinia*	grandiflora	Cogn.	Herb
Cucurbitaceae	*Momordica*	trifoliotata	Hook.f.	Herb
Cyperaceae	*Cyperus*	rotundus	L.	sedge
Cyperaceae	*Cyperus*	cyperoides	(L.) Kuntze	sedge
Cyperaceae	*Fimbristylis*	cymosa	R.Br.	sedge
Euphorbiaceae	*Ricinus*	communis	L.	Shrub
Euphorbiaceae	*Euphorbia*	hirta	L.	Herb
Euphorbiaceae	*Dalechampia*	scandens	L.	Herb
Gramineae	*Cenchrus*	ciliaris	L.	Grass
Gramineae	*Dactyloctenium*	aegyptium	(L.) Willd	Grass
Gramineae	*Enteropogon*	macrostachyus	K.Schum. ex Engl.	Grass
Gramineae	*Chloris*	gayana	Kunth	Grass
Gramineae	*Urochloa*	trichopus	(Hochst.) Stapf	Grass
Gramineae	*Digitaria*	nuda	Schumach.	Grass
Gramineae	*Bothriochloa*	insculpta	(A.Rich.) A.Camus	Grass
Gramineae	*Sporobolus*	vaginicus		Grass
Juncaceae	*Juncus*	sp		sedge
Lauraceae	*Cassytha*	filiformis	L	Herb
Labiatae	*Plectranthus*	flaccidus	Gürke	Herb
Labiatae	*Ocimum*	sp		Herb
Labiatae	*Hyptis*	suaveolens	Poit.	Herb
Leguminosae	*Indigofera*	tinctoria	L.	Herb

Leguminosae	*Senna*	didymobotrya	(Fresen.) Irwin & Barneby	Shrub
Leguminosae	*Acacia*	sp		Shrub
Leguminosae	*Tephrosia*	villosa	(L.) Pers.	Herb
Leguminosae	*Teramnus*	labialis	(L.f.) Spreng.	Herb
Leguminosae	*Canavalia*	rosea	(Sw.) DC.	Herb
Leguminosae	*Tephrosia*	pumila	(Lam.) Pers.	Herb
Malvaceae	*Hibiscus*	vitifolius	L.	Herb
Malvaceae	*Thespesia*	danis	Oliv.	Shrub
Malvaceae	*Sida*	ovata	Forssk.	Herb
Meliaceae	*Azidiracta*	indica		Tree
Moraceae	*Ficus*			Tree
Pedaliaceae	*Pedalium*	murex	L.	Herb
Plumbaginaceae	*Plumbago*	zeylanica	L.	Herb
Rhamnaceae	*Ziziphus*	mucronata	Willd.	Tree
Rubiaceae	*Psychotria*	punctata	Vatke	Shrub
Rubiaceae	*Diodia*	aulacosperma	K.Schum.	Herb
Rubiaceae	*Spermacoce*	laevis	Lam.	Herb
Rutaceae	*Zanthoxylum*	sp		Tree
Sapindaceae	*Allophylus*	pervillei	Blume	Tree
Sapotaceae	*Sideroxylon*	inerme	L.	Tree
Sapotaceae	*Mimusops*	obtusifolia		Tree
Scrophulariaceae	*Striga*	gesnerioides	(Willd.) Vatke ex Engl.	Herb
Simaroubaceae	*Harrisonia*	abyssinica	Oliv.	Shrub

Solanaceae	*Solanum*	incanum	L.	Shrub
Solanaceae	*Withania*	somnifera	L.Dunal	Shrub
Solanaceae	*Physalis*	peruviana	L.	Herb
Sterculiaceae	*Melhania*	ovata	(Cav.) Spreng.	Herb
Sterculiaceae	*Melhania*	ovata	(Cav.) Spreng.	Herb
Ulmaceae	*Trema*	orientalis	(L.) Blume	Shrub
Verbenaceae	*Lantana*	camara	L.	Herb
Verbenaceae	*Clerodendrum*	glabrum	E.Mey.	Shrub
Verbenaceae	*Premna*	resinosa	(Hochst.) Schauer	Shrub
Vitaceae	*Cyphostemma*	sp		Herb

5.2 Fauna at the proposed project site

Field survey was from conducted on the Terrestrial fauna; including insect pollinators, mammals, herpetiles (reptiles and amphibians) within the project footprint. The survey for reptiles and amphibians targeted areas where they can be observed easily in the morning. These include bare paths/roads, on stones/rocks, walls, on drainage features, near coastal shore and on tree stems. Local accounts were also used to populate list on herpetofauna in the area. Loose stones were turned over to find some species that prefers hiding under. Physical observation was used to assess the diversity of insect pollinators; comprising of the butterflies and bee families. Photographs of the species were acquired from the field as sample evidence.

5.2.1 Insect Pollinators (Butterflies and Bees)

The area has quite a significant number of butterfly species but low in bee diversity. Sampling was conducted during rainy seasons when the landscape vegetation is restored with ephemeral flowering plants that highly attract the insect pollinators. The survey recorded a total of 34 butterfly species and 4 bee species. Butterflies are very conspicuous in the landscape and do not escapes notice. They can quickly inform on the status of vegetation species without undertaking rigorous study. Three species of butterflies are common in the area and these include *Papilio* *demodocus*, *Junonia oenone* and. *Euphaedra neophron* normally prefers forest patches but its presence here indicates presence of shrubs or bushes within the area.

With regard to conservation status, the IUCN has no entries on butterflies probably implying no recorded threats yet.


Colotis protomedia


Eurema floricola


Junonia oenone


Pardopsis punctatissima


Leptotis pirithous


Acraea eponina


Colotis regina


Euphaedra neophron

Plate 7: Some of the butterfly species recorded at the proposed project site.

Table 9; List of Butterflies species recorded at the proposed project site

Species	**CONSERVATION STATUS**
Acraea eponina	Least Concern
Acraea insignis	Least Concern
Amauris niavius	Least Concern
Axiocerses harpax	Least Concern
Azanus jesous	Least Concern
Baliochila hildegarda	Least Concern
Belenois aurota	Least Concern
Belenois creona	Least Concern
Byblia anvatara	Least Concern
Byblia ilithyia	Least Concern
Catopsilia florella	Least Concern
Colitis daira	Least Concern
Colitis euippe	Least Concern
Colotis antevippe	Least Concern
Colotis danae	Least Concern
Colotis protomedia	Least Concern
Colotis vesta	Least Concern
Euphaedra neophron	Least Concern
Eurema brigitta	Least Concern

Eurema floricola	Least Concern
Eurema regularis	Least Concern
Eurytela dryope	Least Concern
Freyeria trochylus	Least Concern
Graphium angolanus	Least Concern
Hypolycaena philippus	Least Concern
Junonia hierta	Least Concern
Junonia natalica	Least Concern
Junonia oenone	Least Concern
Junonia orithya	Least Concern
Melanitis leda	Least Concern
Papilio demodocus	Least Concern
Pardopsis punctatissima	Least Concern
Phalanta phalantha	Least Concern
Zizula hylax	Least Concern

The most common species in the family was Honey bees, which is a subset of bees in the genus *Apis*. *Apis mellifera* was observed in project area. Stingless bees *Melliponula spp*. was common on flowering herbs and their occurrence was dependent on availability of the herb species. Stingless bees normally inhabit hollow trunks, tree branches, underground cavities and wall cavities. Carpenter bees derive their name from the fact that nearly all species build their nests in burrows in dead wood, bamboo or structural timbers. However, the genus *Proxylocopa* nests in the ground. They were observed mostly on flowering shrubs and trees. None of the bee species recorded in the traverse feature in the IUCN Red List data.

Table 10: List of species of bees encountered at the proposed project site v

Species	**Iucn Redlist Category**
Apis mellifera	No Entry Found
Melliponula spp.	No Entry Found
Proxylocopa	No Entry Found

5.2.2 Mammal Species

The area does not have conspicuous species of mammals; even the one recorded in this survey are merely an account from the local residents. Among species accounted for by the local residents include the African Savanna Hare (*Lepus microtis*), Four-toed elephant-shrew (*Petrodromus tetradactylus*), Red-legged sun squirrel (*Heliosciurus rufobrachium*) and Four-toed hedgehog (*Eraniceus albiventris*). The African Savanna Hare was common in the survey site observed through their droppings. Rats and moles were reported as freely occurring in the area. All the 5 mammal species recorded are accorded a Least Concern Category in the IUCN Red List.

5.2.3 Herpetofauna survey

The group is technically known as herptiles. They consist of reptiles snakes, lizards, geckos, and amphibians including frogs and toads. Local accounts mention presence of Puff Adder and Black Mamba. Other species of Lizards and Skinks were observed in the designated riparian rocky zones.

Table 11: Herpetofauna species observed

Common Name	Scientific Name	IUCN Redlist
Puff Udder	*Bitis arietans*	Least Concern
Speckled sand snake	*Psammophis punctulatus*	Least Concern
Black mamba	*Dendroaspis polylepis*	Least Concern
Variable ground skink	*Mabuya varia*	Least Concern
Long-tailed sand lizard	*Latastia longicaudata*	Least Concern
Day gecko	*Lygodactylus picturatus*	Least Concern
Black-lined plated lizard	*Gerrhosaurus nigrolineatus*	Least Concern

5.3 Avifauna species at the proposed project site

5.3.1 Background

Birds are very good barometers of the state of the environment, providing early warning systems of deteriorating environmental health and habitat loss and therefore good indicators of biological change. Birds occur in all types of habitats, everywhere in the world. They are highly visible, easy to monitor, and much research has been done on them. Monitoring bird populations is important – it allows us to monitor subtle environmental changes that could potentially affect biodiversity, or have socio-economic implications. According to Vielliard (2000), the structure of a bird community is a good indicator of biodiversity, particularly useful where biodiversity is high. According to BirdLife International, (2013), changes in bird populations can also provide a useful indication of broad environmental change. BirdLife International (2013) has demonstrated using ten reasons why birds are very good indicators for state of biodiversity (Appendix 8). The ornithological survey of the proposed project site was carried out to provide an up to date qualitative baseline survey of birds species currently found at the proposed project site as part of the Environmental Impact Assessment for the proposed expansion as well as for future implementation of the Environmental Management and Monitoring Plan.

5. 3.2 Avifauna species diversity

A total of 27 species were recorded at the site during the survey. The species comprised different assemblages of birds from various feeding guilds and families. These included grassland birds, wetlands birds, waterbirds, a few woodland birds either on passage or confined on woodland hedges and patches scattered especially in the north of the Cememnet plant. Birds associated with human dominated landscapes were also recorded especially near the cement plant (e.g. Little swifts, House sparrow and House crow).

Common and abundant species sighted during point counts include Winding cisticola (108 individuals and sighted in 28 of the 32 points). The homogenous habitat comprising of bushes and thickets interspersed with grass favoured this species. This was followed by House crow (42 individuals, recorded at 10 of the 32 points) and Ethiopian swallow (34 individuals recorded at 11 out of 32 points surveyed). A total of 25 Little swifts was recorded at only one sight near the proposed construction sight. This species has a propensity for built up environment as they roost and next in roofs and walls. Table 1 presents bird species recorded during the point counts including the conservation status based on the IUCN Red List status.

Table 12: Bird species recorded at proposed expansion site.

No.	Species	CommonName	Category	Species counts at 32 points (n/32)	Total individuals
1	*Cisticola galactotes*	Winding Cisticola	LC	28	108
2	*Corvus splendens*	House Crow	LC	10	42
3	*Hirundo aethiopica*	Ethiopian Swallow	LC	11	34
4	*Apus affinis*	Little Swift	LC	1	25
5	*Pycnonotus barbatus*	Common Bulbul	LC	14	19
6	*Anthus cinnamomeus*	Grassland Pipit	LC	11	15
7	*Vidua macroura*	Pin-tailed Whydah	LC	5	11

8	*Cypsiurus parvus*	African Palm-swift	LC	1	7
9	*Tchagra senegalus*	Black-crowned Tchagra	LC	6	7
10	*Hirundo smithii*	Wire-tailed Swallow	LC	7	7
11	*Centropus superciliosus*	White-browed Coucal	LC	5	5
12	*Milvus migrans*	Black Kite	LC	4	5
13	*Ardea melanocephala*	Black-headed Heron	LC	4	4
14	*Nicator gularis*	Eastern Nicator	LC	2	3
15	*Hirundo daurica*	Red-rumped Swallow	LC	2	3
16	*Charadrius tricollaris*	African Three-banded Plover	LC	2	3
17	*Caprimulgus pectoralis*	Fiery-necked Nightjar	LC	1	3
18	*Chrysococcyx caprius*	Diederik Cuckoo	LC	2	2
19	*Ploceus cucullatus*	Village Weaver	LC	1	2
20	*Serinus gularis*	Streaky-headed Seedeater	LC	1	2
21	*Passer domesticus*	House sparrow	LC	1	2
22	*Laniurius leucorhynchus*	Tropical boubou	LC	2	2
23	*Euplectes nigroventris*	Zanzibar Red Bishop	LC	2	2
24	*Onychognathus morio*	Red-winged Starling	LC	1	1
25	*Motacilla aguimp*	African Pied Wagtail	LC	1	1
26	*Burhinus vermiculatus*	Water Thick-knee	LC	1	1
27	*Ploceus subaureus*	African Golden Weaver	LC	1	1
					317

5.3.3 Avifaunal Importance and conservation status

Results from the field surveys show that the proposed area is important for different bird life and bird assemblages. The birds utilize the area for daily resource use and most important foraging by local resident species (grassland birds, bushland birds, wetlands birds and waterbirds). The study was conducted during a non-migration season and so it was not easy to assess the importance of the site as passage area for migrant birds.

In view of the homogeneity in habitat structure, the avifauna of the proposed cement production construction area is typically dominated by species that have a propensity for thickets/scrub and short vegetation. Its proximity to the ocean accounts for the few marine/aquatic species recorded. However, the use of the site by the aquatic species is not very prominent. This makes the sites insignificantly important form marine species.

Only one Afrotropical migrants (Ethiopian swallow) was recorded. The field visit was undertaken during non-migration season hence this explains why there are no palaearctic migrants and other afrotropical migrants on the list.

5.3.4 Description of the habitat verses bird abundance

The site is a classic example of a very homogenous landscape. The vegetation types were dominated by same species form expansive stands of vegetation community. Apart from the northern part of the site which had small patches of Neem trees (*Azadirachta indica*). Changes in biological diversity are correlated with several factors among them spatial heterogeneity of the sample area. In natural habitats, the more heterogeneous the environment, the more complex the communities and the higher the richness and diversity of species present at a particular place. This site is not heterogeneous. It is dominated by the same vegetation community and hence reducing the species diversity.

5.4 Dust emission from current operations

To establish the baseline dust levels before implementation of the proposed expansion, air quality monitoring was undertaken to establish exposure levels in the working environment due to current operations of MCL and to obtain data that can be used to form basis for planning the control measures to eliminate or minimize workers exposure and general environment Air quality levels measurements were taken at the following sites: quarry pit, shale limestone storage yard, clinker storage area, coal storage shed, coal furnace area, administration block, main store, white house, pentagon, kosovo, limestone yard, cement grinding area, central control room (CCR) area, power sub-station, diesel pump station, hoppers building, mechanical workshop, civil workshop, buffer workshop, main weighbridge, garage, shanty village, limestone crusher, rotary furnace area, motrex weighbridge, western boundary wall, gates, and eastern boundary wall. From the dust measurement results, the dust levels at all the sections surveyed is below the recommended threshold limit values (TLV). Appendix 17 gives detailed results of dust survey measurements from all the stated sections. is the detailed

5. 5 Gaseous (stuck) emission from current operations

To establish the current stuck emission from operations of the MCL factory measurements of stack emissions from the coal furnace (raw mill), chimney stack (kiln cooler), and chimney stack (cold mill) and at the ambient air quality at central control room area was carried out The following tables 13- 16 are an extract of tabulation of the findings from the detailed stack emission report appended in appended in appendix 18.

Table 13: Emission measurement results from the Coal Furnace (Raw Mill)

Parameter being monitored	**Findings**		
	Arithmetic mean of the readings	**WHO Air Quality guidelines**	**Remarks**
Oxygen (O_2) percentage (%)	21.6%		
Carbon monoxide (CO) mg/m^3	11.1 mg/m^3	500mg/m^3 (450PPM)	The low level of CO
Carbon dioxide (CO_2)	3.3ppm	500mg/m^3	Within the recommended range
Hydrocarbons (C_xH_y)	Below detectable limit	20mg/m^3	Within the recommended limit
Nitrogen dioxide (NO_2)	Below detectable limit	460mg/m^3	Within the recommended limit
Sulphur dioxide (SO_2)	Within the recommended limit	2000mg/m^3 (800ppm)	SO_2 Emission is low

Table 14: Emission measurement results from the kiln cooler chimney stuck

Parameter	**Arithmetic mean of the readings**	**WHO Air Quality guidelines**	**Remarks**
Carbon monoxide (CO)	Below detectable limit	500mg/m^3 (450PPM)	The low level of CO
Carbon dioxide (CO_2)	0.01ppm	500mg/m^3	Within the recommended range
Hydrocarbons (C_xH_y)	Below detectable limit	20mg/m^3	Within the recommended limit
Nitrogen dioxide (NO_2)	Below detectable limit	460mg/m^3	Within the recommended limit
Sulphur dioxide (SO_2)	Below detectable limit	2000mg/m^3 (800ppm)	SO_2 emission islow

Table 15: Emission measurement results from the coal mill chimney stuck

Parameter	**Arithmetic mean of the readings**	**WHO Air Quality guidelines**	**Remarks**
Carbon monoxide (CO) mg/m^3	Below detectable limit	500mg/m^3 (450PPM)	The low level of CO
Carbon dioxide (CO_2)	0.6mg/m^3	500mg/m^3	Within the recommended range
Hydrocarbons (C_xH_y)	Below detectable limit	20mg/m^3	Within the recommended limit
Nitrogen dioxide (NO_2)	Below detectable limit	460mg/m^3	Within the recommended limit

Sulphur dioxide (SO_2)	Below detectable limit	2000mg/m^3 (800ppm)	SO_2 emission is low

Table 16: Ambient air quality at the central control room (CCR)

Parameter	**Arithmetic mean of the readings**	**WHO Air Quality guidelines**	**Remarks**
Oxygen (O_2) percentage	20.9%		
Carbon monoxide (CO) mg/m^3	Below detectable limit	• 100mg/m^3 (90PPM) for 15 minutes • 60mg/m^3 (50PPM) for 30 minutes • 30mg/m^3 (25PPM) for 1 hour • 10mg/m^3 (10PPM) for 8 hours	The low level of CO emission shows a complete combustion of the fuel
Carbon dioxide (CO_2) *milligram per cubic meter (mg/m^3)*	0.0025%	0.5%	Within the recommended range
Hydrocarbons (C_xH_y) *milligram per cubic meter (mg/m^3)*	Below detectable limit	70ppm	Within the recommended limit
Nitrogen dioxide (NO_2) *milligram per*	Below detectable	Annual exposure 80ug/m^3 24 hours exposure 150ug/m^3	No_2 not detected

cubic meter mg/m³	limit		
Sulphur dioxide (SO_2) mg/m^3 *milligram per cubic meter* mg/m^3	Below detectable limit	$125ug/m^3$ for 24 hours $50ug/m^3$ annual average	SO_2 emission islow

5.6 Noise levels from current operations

To establish the current noise level from the ongoing operations of MCL, noise measurements were taken in the following areas/points at the coal mill blower, cold mill, gate 2, main gate, eastern boundary wall middle, limestone yard, cement grinding area, and diesel pump area. Measurement results at all the areas examined were within the recommended limits except at the cement grinding area, the mines bulldozer and at the raw mill. Appendix 19 is the detailed noise measurement report.

5.7 Traffic flow Baseline

To have an indication on traffic flow along Mombasa Kilifi Road at the junction of Mombasa Cement Vipingo , monitoring of traffic at this junction was carried out in a period of five days. Data obtained is important baseline information on traffic flow at this junction and will be used to determine changes in traffic flow at the said junction in future after the implementation of the proposed expansion of MCL Vipingo clinker and Cement plant. Traffic was classified into seven categories as follows: Motorcycles/Tricycles, Passenger Cars, Minibuses/Vans, Buses, Light Trucks/Pick-Up Trucks, Medium Size Trucks 7-15 tons with 1-2 rear axles and Heavy Commercial Vehicles. Study time frame was 9hrs per day (0800hrs to 1700hrs) on the following dates 11th, 12th, 13th, 14th and 18th of May 2015. Table 17 to 22 Is a tabulation of hourly traffic floor of the seven categories of traffic monitored for the five day period.

Table 17: Traffic volume tabulation at the junction of the road entering into Mombasa Cement Limited-Vipingo premises and Mombasa-Malindi highway on 11th May 2015

TIME	TYPE OF TRAFFIC						
	Motorcycle/Tricycle	**Passenger cars**	**Minibuses/Vans**	**Buses**	**Light trucks/Pick-up trucks**	**Medium size trucks (7-15 tones with 1-2 axles)**	**Heavy commercial vehicles**
8.00-9.00 am	8	55	63	10	9	20	12
9.00-10.00 am	8	79	61	2	14	35	5
10.00-11.00 am	11	60	62	2	20	50	15
11.00-12.00 pm	12	94	79	4	28	27	13
12.00-1.00 pm	10	71	73	1	27	14	16
1.00-2.00 pm	19	100	81	3	30	57	14
2.00-3.00 pm	9	96	70	4	26	34	18
3.00-4.00 pm	10	76	99	15	23	48	10
4.00-5.00 pm	6	94	46	10	21	39	10
Sub total	**93**	**725**	**634**	**51**	**198**	**324**	**113**
Total Volume	**2138**						

Table 18: Traffic volume tabulation at the junction of the road entering into Mombasa Cement Limited-Vipingo premises and Mombasa-Malindi highway on 12th May 2015

TIME	**TYPE OF TRAFFIC**						
	Motorcycle/Tricycle	**Passenger cars**	**Minibuses/Vans**	**Buses**	**Light trucks/Pick-up trucks**	**Medium size trucks (7-15 tones with 1-2 axles)**	**Heavy commercial vehicles**
8.00-9.00 am	11	110	82	6	34	25	7
9.00-10.00 am	15	97	59	6	26	41	19
10.00-11.00 am	13	104	46	5	22	49	11
11.00-12.00 pm	7	93	72	4	19	39	16
12.00-1.00 pm	3	83	59	4	29	41	20
1.00-2.00 pm	5	78	64	0	29	47	14
2.00-3.00 pm	2	91	59	4	28	27	16
3.00-4.00 pm	9	82	64	13	28	44	6
4.00-5.00 pm	7	101	73	4	20	48	14
Sub total	**72**	**839**	**578**	**46**	**235**	**361**	**123**
Total Volume	**2254**						

Table 19: Traffic volume tabulation at the junction of the road entering into Mombasa Cement Limited-Vipingo premises and Mombasa-Malindi highway on 13th May 2015

TIME	**TYPE OF TRAFFIC**						
	Motorcycle/Tricycle	**Passenger cars**	**Minibuses/Vans**	**Buses**	**Light trucks/Pick-up trucks**	**Medium size trucks (7-15 tones with 1-2 axles)**	**Heavy commercial vehicles**
8.00-9.00 am	11	110	69	2	33	29	9
9.00-10.00 am	13	97	59	6	54	15	10
10.00-11.00 am	6	100	68	8	54	14	18
11.00-12.00 pm	13	108	68	2	46	13	11
12.00-1.00 pm	1	74	52	2	40	20	8
1.00-2.00 pm	15	92	58	6	31	52	6
2.00-3.00 pm	5	99	65	5	28	59	14
3.00-4.00 pm	9	102	59	10	32	41	12
4.00-5.00 pm	16	127	75	3	35	42	11
Sub total	**89**	**909**	**573**	**44**	**353**	**285**	**99**
Total Volume	**2352**						

Table 20: Traffic volume tabulation at the junction of the road entering into Mombasa Cement Limited-Vipingo premises and Mombasa-Malindi highway on 14th May 2015

TIME	TYPE OF TRAFFIC						
	Motorcycle/Tricycle	**Passenger cars**	**Minibuses/Vans**	**Buses**	**Light trucks/Pick-up trucks**	**Medium size trucks (7-15 tones with 1-2 axles)**	**Heavy commercial vehicles**
8.00-9.00 am	3	105	70	6	23	21	16
9.00-10.00 am	4	101	77	7	31	10	19
10.00-11.00 am	11	122	68	4	17	21	14
11.00-12.00 pm	9	104	60	2	44	10	19
12.00-1.00 pm	12	108	57	1	66	11	17
1.00-2.00 pm	17	64	66	2	63	25	10
2.00-3.00 pm	15	110	75	5	48	23	15
3.00-4.00 pm	8	90	65	6	32	21	19
4.00-5.00 pm	16	117	68	7	41	18	14
Sub total	**95**	**921**	**606**	**40**	**365**	**160**	**143**
Total Volume	**2330**						

Table 21: Traffic volume tabulation at the junction of the road entering into Mombasa Cement Limited-Vipingo premises and Mombasa-Malindi highway on 18th May 2015

TIME	**TYPE OF TRAFFIC**						
	Motorcycle/Tricycle	**Passenger cars**	**Minibuses/Vans**	**Buses**	**Light trucks/Pick-up trucks**	**Medium size trucks (7-15 tones with 1-2 axles)**	**Heavy commercial vehicles**
8.00-9.00 am	10	105	71	4	34	7	9
9.00-10.00 am	17	107	80	2	33	11	14
10.00-11.00 am	14	122	61	2	40	8	11
11.00-12.00 pm	29	98	64	4	53	13	8
12.00-1.00 pm	14	73	63	3	39	10	12
1.00-2.00 pm	9	81	67	1	59	18	8
2.00-3.00 pm	16	101	70	1	52	20	6
3.00-4.00 pm	12	89	58	4	44	16	13
4.00-5.00 pm	13	106	81	6	59	10	8
Sub total	134	882	615	27	413	113	89
Total Volume	**2273**						

Table 22: Cumulative volumes of traffic recorded over the five days period

Traffic Categories/Monitoring dates	**Monday 11th May 2015**	**Tuesday 12th May 2015**	**Wednesday 13th May 2015**	**Thursday 14th May 2015**	**Monday 18th May 2015**	**TOTALS PER CATEGORY**
Motorcycle/Tricycle	93	72	89	95	134	**483**
Passenger Cars	725	839	909	921	882	**4,276**
Minibuses/Vans	634	578	573	606	615	**3,006**
Buses	51	46	44	40	27	**208**
Light trucks/ Pick-up trucks	198	235	353	365	413	**1,564**
Medium size trucks (7-15 tones with 1-2 axles)	324	361	285	160	113	**1,243**
Heavy Commercial vehicles	113	123	99	143	89	**567**
Total traffic volume per day	**2138**	**2254**	**2352**	**2330**	**2273**	

Grand Total Traffic Count over the 5 day perid	**11,347**

5.7.1 Traffic volume

The results of the traffic volume show that;-

- ✓ 37.3% (4,276) of the total traffic volume recorded (11,347) was passenger cars. Heavy Commercial vehicles counted over the five day period represented 5.0% of the total traffic count.
- ✓ Peak flow times for the traffic were 1.00pm to 2.00pm on the first day; 8.00am to 9.00am on the second day; 4.00pm to 5.00pm on the third day; 2.00pm to 3.00pm on the fourth day and 4.00pm to 5.00pm to the fifth day.
- ✓ 32.5% of the total traffic (3686) was recorded on the morning hours between 8.00 am and 11.00 am; 32.7% of the total traffic (3710) was recorded on the afternoon hours between 11.00 am and 2.00 pm; 34.8% of the total traffic volume (3951) was recorded in the late afternoon and evening hours between 2.00 pm and 5.00pm.

5.7.2 Hourly traffic flow

Combined hourly traffic flow for the first three days of monitoring is plotted in the figure below:

Figure 5: Combined hourly traffic flow for the seven categories studied in the first three days

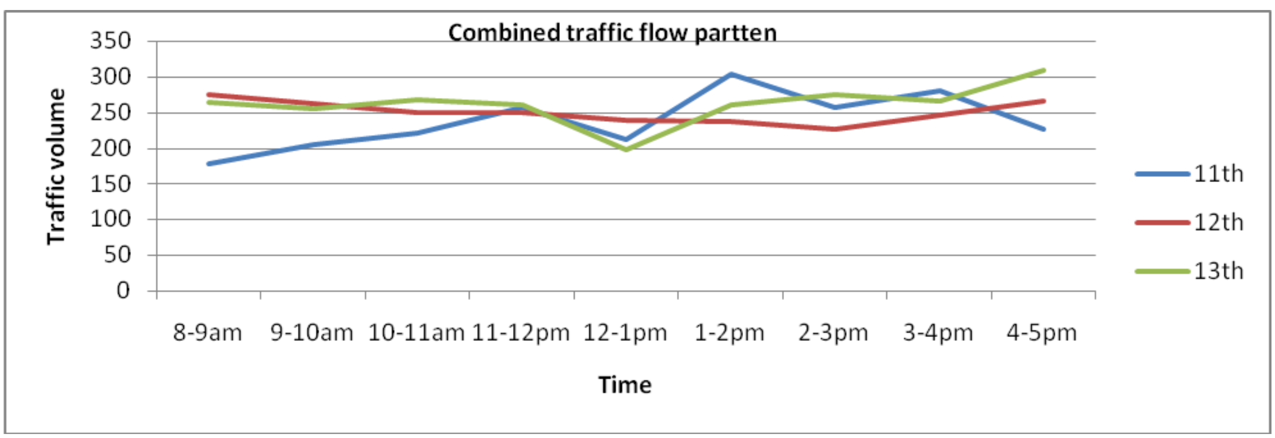


Figure 6: Nine hours of flow of Passenger cars on each of the 11th 13th and 18th

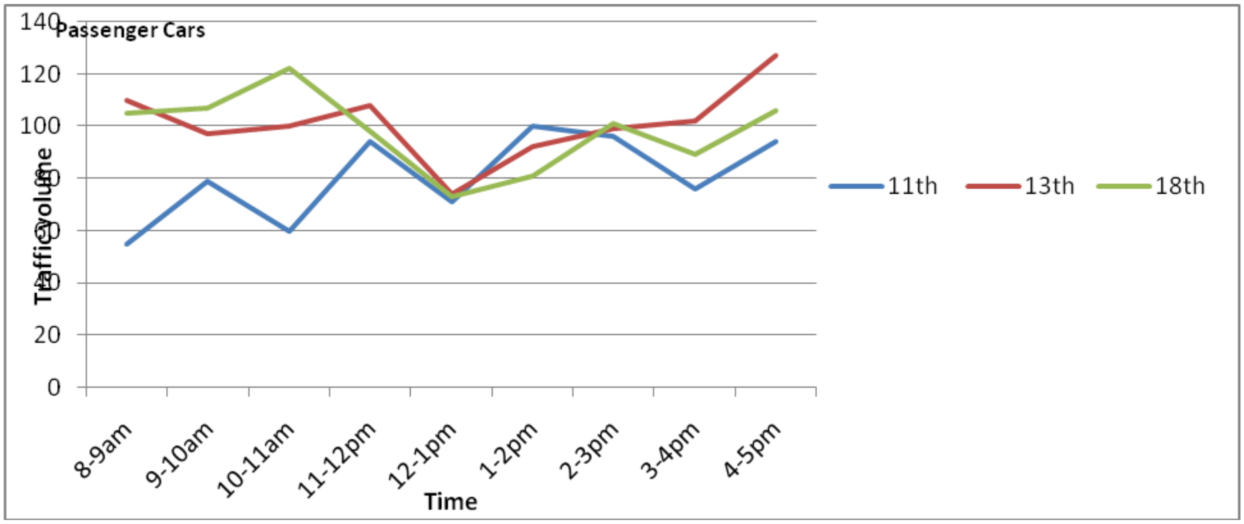
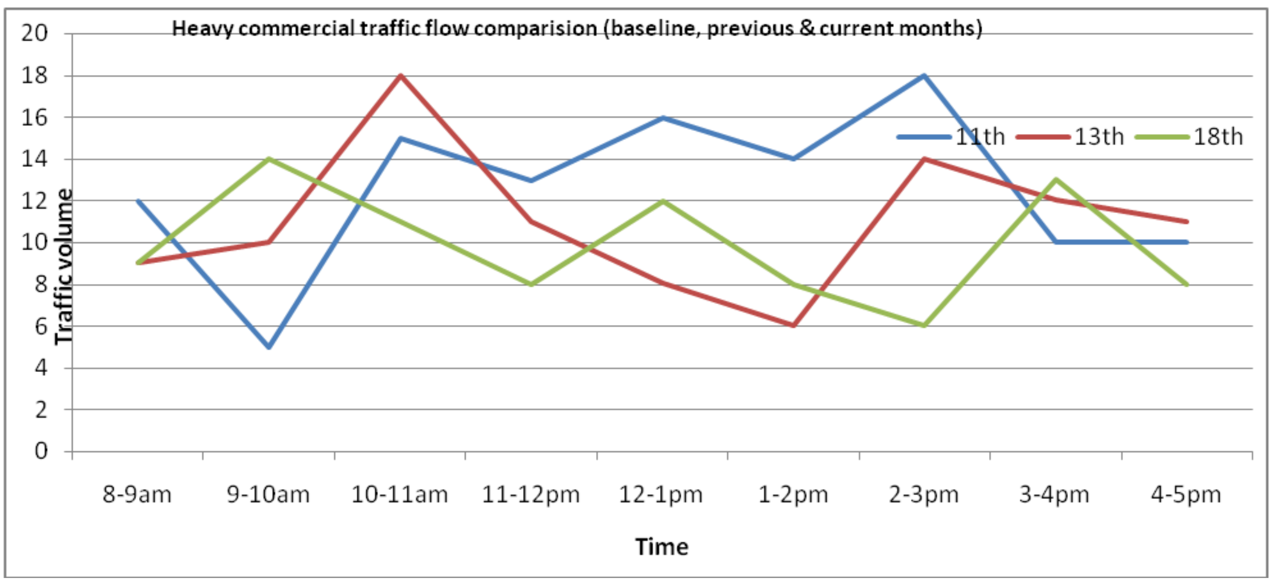


Figure 7: Nine hours **of flow** of Heavy Commercial Vehicles on each of 11th, 13th and 18th



5.7.3 Discussion

- ✓ The data collected suggests that passenger cars are the highest users of the road as recorded at the junction of the road entering into Mombasa Cement Limited-Vipingo premises and Mombasa-Malindi highway. This implies that as the proponent plans to deliver construction equipment and materials to the project site, the drivers of the vehicles that will be delivering the equipment and materials must be informed and sensitized that the road has a high number of passenger cars and that the drivers should strictly observe the highway code ,exercise care on this road to avoid accidents with the motorcycles/tricycles.

- ✓ The traffic volume flow was noted to be almost uniformly spread across the day with 32.5% of traffic flow recorded between 8.00am and 11.00am, 32.7% of traffic recorded between 11.00am and 2.00pm and 34.8% recorded between 2.00pm and 5.00pm. this means that vehicles entering and leaving the proposed project site should be distributed uniformly across the day.

6. BACKGROUND TO CEMENT PRODUCTION

6.1 Introduction

Cement is a finely ground, non-metallic, inorganic powder when mixed with water forms a paste that sets and hardens (Japan Cement Association, 1996). This hydraulic hardening is primarily due to the formation of calcium silicate hydrates as a result of the reaction between mixing water and the constituents of the cement. In the case of aluminous cements hydraulic hardening involves the formation of calcium aluminate hydrates. Cement is a basic material for building and civil engineering construction.

The cement industry is an energy intensive industry with energy typically accounting for 30-40% of production costs (i.e. excluding capital costs). Traditionally, the primary fuel used is coal. A wide range of other fuels are also used, including petroleum coke, natural gas and oil.

The emissions from cement plants which cause greatest concern are nitrogen oxides (NOx), sulphur dioxide (SO_2) and dust. Other emissions to be considered are carbon oxides (CO, CO_2), volatile organic compounds (VOCs), polychl ordinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs), metals, and noise.

6.2 Cement production methods

The basic chemistry of the cement manufacturing process begins with the decomposition of calcium carbonate ($CaCO_3$) at about 900 °C to leave calcium oxide (CaO, lime) and liberate gaseous carbon dioxide (CO_2); this process is known as calcination. This is followed by the clinkering process in which the calcium oxide reacts at high temperature (typically 1400-1500 °C) with silica, alumina, and ferrous oxide to form the silicates, aluminates, and ferrites of calcium which comprise the clinker. The clinker is then ground or milled together with gypsum and other additives to produce cement. There are four main process routes for the manufacture of cement; the dry, semi-dry, semi-wet and wet processes.

- In the **dry process**, the raw materials are ground and dried to raw meal in the form of a flowable powder. The dry raw meal is fed to the preheater or pre-calciner kiln or, more rarely, to a long dry kiln.

- In the **semi-dry process** dry raw meal is pelletised with water and fed into a grate preheater before the kiln or to a long kiln equipped with crosses.
- In the **semi-wet process** the slurry is first dewatered in filter presses. The filter cake is extruded into pellets and fed either to a grate preheater or directly to a filter cake drier for raw meal production.
- In the **wet process**, the raw materials (often with high moisture content) are ground in water to form a pumpable slurry. The slurry is either fed directly into the kiln or first to a slurry drier.

Figure 1 shows an overview of a dry process pre-calciner route.

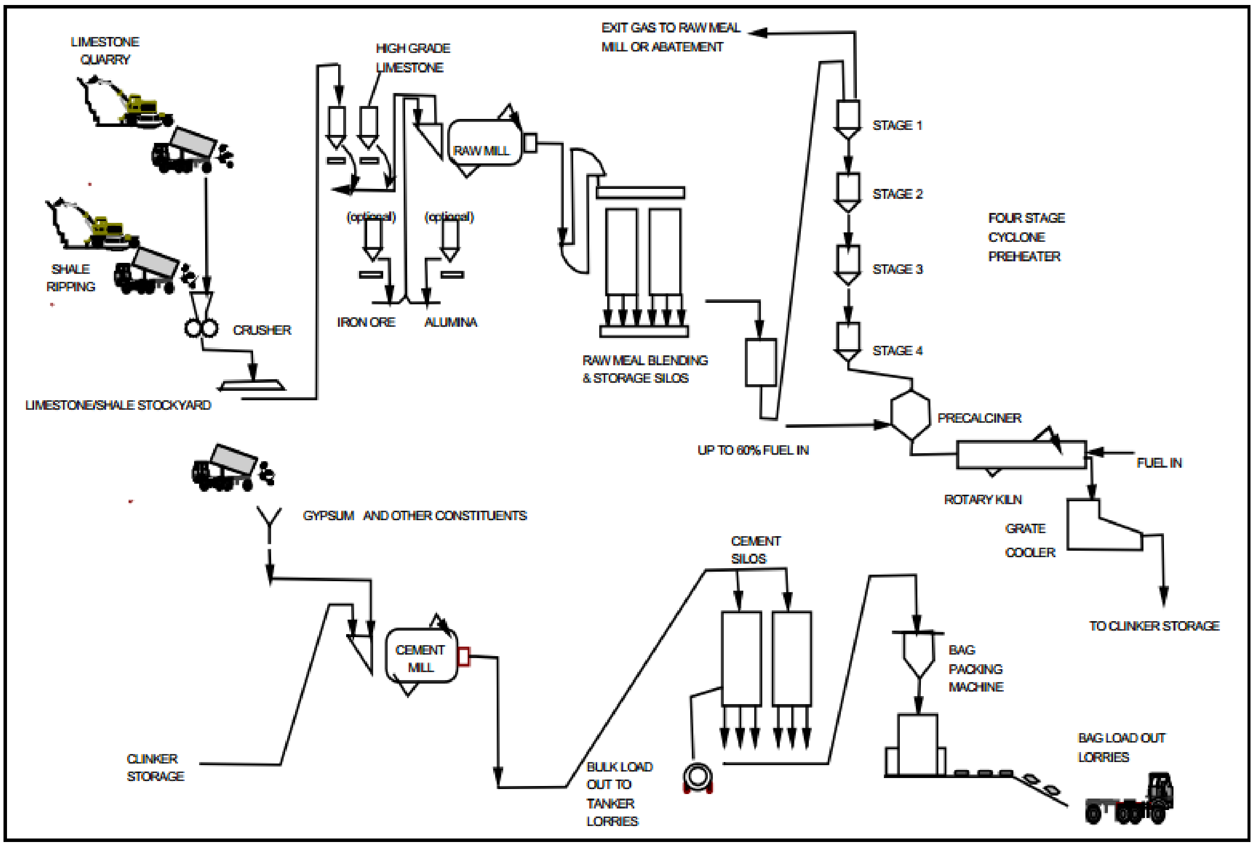


Figure 8: Typical pre-calciner dry process. Based on figure in [UK IPC Note, 1996]

The choice of process is to a large extent determined by the state of the raw materials (dry or wet). Wet processes are more energy consuming, and thus more expensive. Plants using semi-dry processes are likely to change to dry technologies whenever expansion or major improvement is required (Cembureau report, 1997).

Cement manufacturing is pyro-processing process. Pyro-processing is a process in which materials are subjected to high temperatures (typically over 800 °C) in order to bring about a chemical or physical change. Pyro-processing includes such terms as ore-roasting, calcination and sintering. Equipment for pyro-processing includes kilns, electric arc furnaces and reverberatory furnaces. The raw material mix (raw mill) is fed to a kiln where pyro-processing takes place. As with most industries, pyro-processing is the most energy-intensive part of the industrial process. The four different processes that are used in the cement industry to accomplish the cement pyro-processing step are:

- The wet process,
- The dry process (long dry process),
- The preheater process,
- The pre-calciner.

The processes vary with respect to equipment design, method of operation, and fuel consumption. Generally, fuel consumption decreases in the order of the processes listed. Below, these processes are briefly described, starting with the wet process and then noting differences in the other processes.

6.2.1 The Wet Process

In the wet process, all of the pyro-processing activity occurs in the rotary kiln. Kilns have length-to-diameter ratios in the range of 15:1 to 40:1. (See figure 2 below). While some wet process kilns may be as long as 210 m, many wet process kilns are shorter. Wet process systems consist solely of the simple rotary kiln. Usually, a system of chains is provided at the feed end of the kiln in the preheat zones to improve heat transfer from the hot gases to the solid materials. As the kiln rotates, the chains are raised and exposed to the hot gases. Further kiln rotation causes the hot chains to fall into the cooler materials at the bottom of the kiln, thereby transferring the heat to the load.

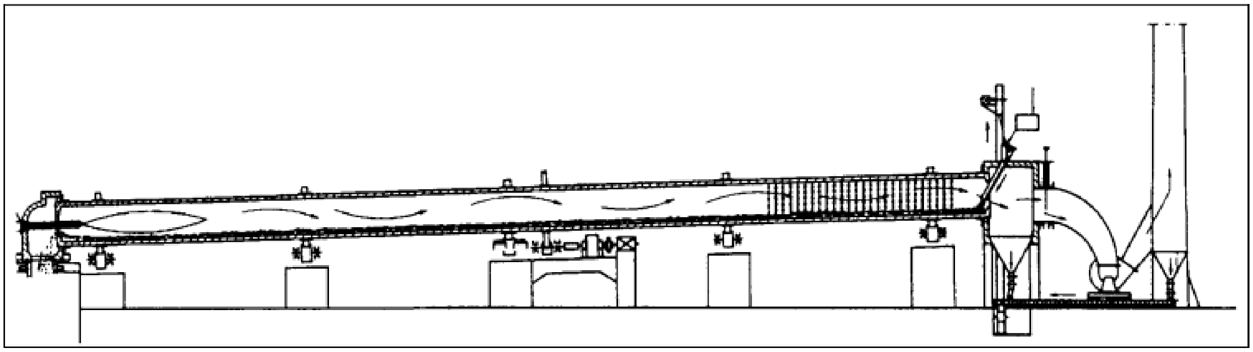


Figure 9: Long wet rotary kiln with chains. [Cembureau report, 1997]

6.2.2 The long dry process

Just like in the wet process, in long dry process all of the pyro-processing activity occurs in the rotary kiln also. Kilns also have length-to-diameter ratios in the range of 15:1 to 40:1. All dry process kilns are shorter than 210m. Long dry process pyro-processing systems consist solely of the simple rotary kiln. Usually, a system of chains is provided at the feed end of the kiln in the drying zones to improve heat transfer from the hot gases to the solid materials. As the kiln rotates, the chains are raised and exposed to the hot gases. Further kiln rotation causes the hot chains to fall into the cooler materials at the bottom of the kiln, thereby transferring the heat to the load.

6.2.3 The preheater process

Dry process pyro-processing systems have been improved in thermal efficiency and productive capacity through the addition of one or more cyclone-type preheater vessels in the gas stream exiting the rotary kiln. This system is called the preheater process. The vessels are arranged vertically, in series, and are supported by a structure known as the preheater tower. Hot exhaust gases from the rotary kiln pass counter-currently through the downward-moving raw materials in the preheater vessels. Compared to the simple rotary kiln, the heat transfer rate is significantly increased, the degree of heat utilization is greater, and the process time is markedly reduced by the intimate contact of the solid particles with the hot gases. The improved heat transfer allows the length of the rotary kiln to be reduced. The hot gases from the preheater tower are often used as a source of heat for drying raw materials in the raw mill. Because the catch from the mechanical collectors, fabric filters, and/or electrostatic precipitators (ESP) that follow the raw mill is returned to the process, these devices are considered to be production machines as well as pollution control devices.

6.2.4 Pre-calciner process

In this process, additional thermal efficiencies and productivity gains are achieved by diverting some fuel to a calciner vessel at the base of the preheater tower. This system is called the preheater/pre-calciner process. While a substantial amount of fuel is used in the pre-calciner, at least 40% of the thermal energy is required in the rotary kiln. The amount of fuel that is introduced to the calciner is determined by the availability and source of the oxygen for combustion in the calciner. Calciner systems sometimes use lower-quality fuels (e. g., less-volatile matter) as a means of improving process economics.

Preheater and pre-calciner kiln systems often have an alkali bypass system between the feed end of the rotary kiln and the preheater tower to remove the undesirable volatile constituents.

6.3 Cement production sub-processes

All the cement production processes have the following sub-processes in common:

- Winning of raw materials
- Raw materials storage and preparation
- Fuels storage and preparation
- Clinker burning
- Cement grinding and storage
- Packing and dispatch

6.3.1 Winning of raw materials

Naturally occurring calcareous deposits such as limestone, marl or chalk provide the source for calcium carbonate. Silica, iron oxide and alumina are found in various ores and minerals, such as sand, shale, clay and iron ore. Winning of nearly all of the natural raw materials involves quarrying and mining operations. The materials are most often obtained from open surface quarries. The operations necessary include rock drilling, blasting, excavation, hauling and crushing. Main raw materials, like limestone, chalk marl and shale or clay, are extracted from quarries. In most cases the quarry is close to the plant. After primary crushing the raw materials are transported to the cement plant for storage and further preparation. Limestone is the main raw material for the production of cement. Limestone is a sedimentary rock consisting of more than 50% calcium carbonate (calcite - $CaCO_3$). There are many different types of limestone formed through a variety of processes;

- Non-clastic, chemical or inorganic limestone: - Limestone precipitated from water.
- Biochemical limestone: - Limestone secreted by marine organisms such as algae and coral.
- Bio-clastic limestone: - Limestone formed from the shells of Dead Sea creatures.
- Clastic limestone: - Limestone formed from the cementation of sand and / or mud by calcite and this often has the appearance of sandstone or mudstone.

6.3.2 Raw material storage and preparation

Preparation of the raw material is of great importance to the subsequent kiln system both in getting the chemistry of the raw feed right and in ensuring that the feed is sufficiently fine.

6.3.3 Raw materials storage

The raw material fed to a kiln system needs to be as chemically homogeneous as practicable. This is achieved by controlling the feed into the raw grinding plant. When the material from the quarry varies in quality, initial pre-blending can be achieved by stacking the material in rows or layers along the length (or around the circumference) of the store and extracting it by taking cross-sections across the pile. When the material from the quarry is fairly homogeneous, simpler stacking and reclaiming systems can be used. Raw materials used in relatively small quantities, mineral additions for example, may alternatively be stored in silos or bunkers

6.3.4 Grinding of raw materials

Accurate metering and proportioning of the mill feed components by weight is important for achieving a consistent chemical composition. This is essential for steady kiln operation and a high-quality product. Metering and proportioning is also an important factor in the energy efficiency of the grinding system. The predominant metering and proportioning equipment for raw material feed to mills is the apron feeder followed by the belt weigh feeder.

6.3.5 Grinding of raw materials, dry and semi-dry kiln systems

The raw materials, in controlled proportions, are ground and mixed together to form a homogeneous blend with the required chemical composition. For dry and semi-dry kiln systems, the raw material components are ground and dried to a fine powder, making use mainly of the kiln exhaust gases and/or cooler exhaust air. For raw materials with relatively high moisture content, and for start-up procedures, an auxiliary furnace may be needed to provide additional heat.

Typical dry grinding systems used are:

- Tube mill, centre discharge;
- Tube mill, air-swept;
- Vertical roller mill
- Horizontal roller mill.

Other grinding systems are used to a lesser extent. These are:

- Tube mill, end discharge in closed circuit;
- Autogenous mill;
- Roller press, with or without crusher drier.

The fineness and particle size distribution of the product leaving a raw grinding system is of great importance for the subsequent burning process. The target given for these parameters is achieved by adjusting the separator used for classifying the product leaving the grinding mill. For dry classification, air separators are used. The rotor cage type separators, have several advantages. These are:

- Lower specific energy consumption of the grinding system (less over-grinding),
- Increased system throughput (efficiency of particle separation), and
- More favorable particle size distribution and product uniformity.

6.3.6 Grinding of raw materials, wet or semi-wet kiln system

Wet grinding is used only in combination with a wet or semi-wet kiln system. The raw material components are ground with added water to form a slurry. To achieve the slurry fineness required, in order to comply with modern quality demands, closed circuit milling systems are the main option. The wet process is normally preferred whenever the raw material has a moisture content of more than 20% by weight. Raw materials such as chalk, marl or clay, which are sticky and of high inherent moisture content, are soft and as a first stage of preparation they may be ground in a wash mill. Water and crushed material are fed to the wash mill and broken down into slurry by shearing and impact forces imparted by the rotating harrows. When sufficiently fine, the material passes through screens in the wall of the wash mill and is pumped to storage. To achieve the required slurry fineness further grinding in a tube mill is usually required, especially if an additional raw material such as sand is to be added. To reduce kiln fuel consumption, water addition during the raw material grinding is controlled so that the amount used is the minimum necessary to achieve the required slurry flow and pumpability characteristics (32 to 40% w/w water). Chemical additives may act as slurry thinners permitting the water content to be reduced.

6.3.7 Raw meal or slurry homogenisation and storage

Raw meal or slurry leaving the raw grinding process requires further blending/homogenization to achieve optimum consistency of the raw mix prior to being fed to any type of kiln system. The raw meal is homogenised and stored in silos, the raw slurry in either tanks or silos. For raw meal transport to storage silos pneumatic and mechanical systems are used. Mechanical conveyors normally require a higher investment cost but have much lower operating costs than pneumatic conveying systems. A combination of air-slide or screw/chain conveyors with a belt bucket elevator is nowadays the most commonly used conveying system.

6.3.8 Fuel storage and preparation

Various fuels can be used to provide the heat required for the process. Three different types of fuels are mainly used in cement kiln firing; in decreasing order of importance these are:

- Pulverised coal and petcoke;
- (Heavy) fuel oil;
- Natural gas.

The main ash constituents of these fuels are silica and alumina compounds. These combine with the raw materials to become part of the clinker. This needs to be allowed for in calculating the raw material proportion and so it is desirable to use fuel with a consistent, though not necessarily low, ash content. The main fuels used in the cement industry are petcoke and coal (black coal and lignite). Cost normally precludes the use of natural gas or oil, but the selection of fuels depends on the local situation (such as availability of domestic coal). In order to keep heat losses at minimum, cement kilns are operated at lowest reasonable excess oxygen levels. This requires highly uniform and reliable fuel metering and fuel presentation in a form allowing easy and complete combustion. These conditions are fulfilled by all liquid and gaseous fuels. For pulverised solid fuels, good design of hoppers, conveyors and feeders is essential to meet these conditions.

6.3.8.1 **Storage of fuels**

Raw coal and petcoke are stored similarly to raw materials; thus, in many cases, in covered stores. Outside storage in large, compacted stockpiles is used for long-term stocks. Such stockpiles may be seeded with grass to prevent rainwater and wind erosion. Drainage to the ground from outside storage has shown to be a problem. However, sealed concrete floors under the stockpiles make it possible to collect and clean the water that drains off. Normal good practice in terms of compaction and stockpile height needs to be observed when storing coal of relatively high volatile-matter content in order to avoid the risk of spontaneous ignition when stored for long periods.

Pulverised coal and petcoke are stored exclusively in silos. For safety reasons (i.e. the danger of explosions being triggered by smouldering fires and static electricity spark-overs) these silos have to be of the mass flow extraction type and have to be equipped with standard safety devices.

Fuel oil is stored in vertical steel tanks. These are sometimes insulated to help keep the oil at pumpable temperature (50 to 60 °C). They may also be equipped with heatable suction points to maintain the oil at the correct temperature locally.

6.3.8.2 **Preparation of fuels**

Solid fuel preparation (crushing, grinding and drying) is usually carried out on site. Coal and petcoke are pulverised to about raw meal fineness in grinding plants using equipment similar to the raw-material grinding plants. The fineness of the pulverised fuel is important, too fine and flame temperatures can be excessively high, too coarse and poor combustion can occur. Low volatility or low volatiles content solid fuel will need finer grinding. If sufficient hot air for drying is not available from the kiln or from the cooler, an auxiliary furnace may be needed. Special features have to be incorporated to protect the equipment from fires and explosions.

Three main types of coal milling and grinding systems are used:

- **Tube mill, air-swept**

The air-swept mill only has one grinding compartment. The ground material is discharged pneumatically from the mill and carried in the gas stream to the high-efficiency separator.

Air-swept mills are used for grinding very moist materials, which requires a large flow rate of low-temperature gas through the drying chamber.

Grinding plants using air-swept mills have the advantage of simple design and low capital expenditure.

- **Vertical roller or ring-ball mill**

This type of mill consists of two types of rings separated by a series of large balls, like a thrust bearing. The lower ring rotates, while the upper ring presses down on the balls via a set of spring and adjuster assemblies, or pressurized rams. The material (coal) to be pulverized is introduced into the center or side of the pulverizer (depending on the design). As the lower ring rotates, the balls to orbit between the upper and lower rings, and balls roll over the bed of coal on the lower ring. The pulverized material is carried out of the mill by the flow of air moving through it. The size of the pulverized particles released from the grinding section of the mill is determined by a classifier separator. If the coal is fine enough to be picked up by the air, it is carried through the classifier. Coarser particles return to be further pulverized.

- **Impact mill**

Impact Mills are screen less, high-speed beater mills for pulverising and micro-pulverising. The product to be processed is fed to the mill centrally via an inlet box at the top and is pre-crushed by primary beater tools when reaching the top of the rotor. The beaters also accelerate the product, moving it into the milling zone proper, at the side of the rotor. There the grinding stock fluidized in the air flow is comminuted by the grinding tools (rotor, stator). The stator is formed by a cover enclosing the rotor. The inside of this cover is provided with toothed grooves running vertical, i.e. crosswise to the sense of rotation of the rotor. The outside of the rotor is covered by numerous U-shaped sections which form a deep cassette-type structure. This geometry creates extreme air whirls in the rotor's grinding zone which induce intense secondary commination processes due to the particles crashing into each other and due to friction and shearing forces. The final particle size can be adjusted over a wide range by changing the grinding rotor clearance, air flow and rotor speed.

In addition to (micro) pulverization in the < 100 µm range, the Impact Mill has proven to be very reliable and efficient in removing fibers from organic substances (paper, paperboard, cellulose, etc.), grinding-coating, cryogenic grinding, combined grinding/blending and grinding/drying. Ground solid fuel may be fired directly into the kiln, but in modern installations it is usually stored in silos to allow the use of more thermally efficient burners (indirect firing) using low primary air. Solid fuel grinding, storage and firing systems have to be designed and operated so as to avoid the risk of explosion or fire. The primary requirements are to control air temperatures properly, and to avoid the accumulation of fine material in dead spots exposed to heat.

6.3.9 **Clinker burning**

This part of the process is the most important in terms of emission potential and of product quality and cost. In clinker burning, the raw mill (or raw mill slurry in the wet process) is fed to the rotary kiln system where it is dried, pre-heated, calcined and sintered to produce cement clinker. The clinker is cooled with air and then stored. In the clinker burning process it is essential to maintain kiln charge temperatures of between 1400 to 1500 °C and gas temperatures of about 2000 °C. Also, the clinker needs to be burned under oxidising conditions. Therefore an excess of air is required in the sintering zone of a cement clinker kiln. Since the rotary kiln was introduced around 1895 it has become the central part of all modern clinker producing installations. The first rotary kilns were long wet kilns, as shown in Figure 2 above, where the whole heat consuming thermal process takes place in the kiln itself. With the introduction of the dry process, optimisation led to technologies which allowed drying, preheating and calcining to take place in a stationary installation rather than in the rotary kiln.

The rotary kiln consists of a steel tube with a length to diameter ratio of between 10:1 and 38:1. The tube is supported by two to seven (or more) support stations, has an inclination of 2.5 to

4.5% and a drive rotates the kiln about its axis at 0.5 to 4.5 revolutions per minute. The combination of the tube's slope and rotation causes material to be transported slowly along it. In order to withstand the very high peak temperatures the entire rotary kiln is lined with heat resistant bricks (refractories). All long and some short kilns are equipped with internals (chains, crosses, lifters) to improve heat transfer.

Transient buildups of material can occur around the inner surface of the kiln depending on the process and raw materials etc. These are known as rings and can occur at the feed end (gypsum rings), near the sintering zone (clinker rings) or the product exit end (ash rings). The latter two types can break away suddenly and cause a surge of hot, poor quality material to leave the kiln which may be reprocessed or have to be rejected as waste. The cyclones and grates of preheater kilns may also be subject to build up of material which can lead to blockages.

6.3.9.1 **Kiln firing**

The fuel introduced via the main burner produces the main flame with flame temperatures around 2000 °C. For process-optimisation reasons the flame has to be adjustable within certain limits. In a modern indirectly fired burner, the flame is shaped and adjusted by the primary air (10-15% of total combustion air).

Potential feed points for supplying fuel to the kiln system are:

- Via the main burner at the rotary kiln outlet end;
- Via a feed chute at the transition chamber at the rotary kiln inlet end (for lump fuel);
- Via secondary burners to the riser duct;
- Via pre-calciner burners to the pre-calciner;
- Via a feed chute to the pre-calciner (for lump fuel);
- Via a mid-kiln valve in the case of long wet and dry kilns (for lump fuel).

Coal/petcoke firing plants are of both indirect- and direct-firing types. Direct-firing plants operate without fine-coal storage and fine-coal metering. The pulverised fuel is blown directly into the kiln with the mill sweeping air acting as carrier and as (flame shaping) primary air. Direct firing plants have a number of drawbacks. In particular kiln-system heat losses are around 200-250 MJ/tonne clinker (6 to 8% higher on modern kiln systems). Thus direct firing is seldom installed nowadays. Fuel oil is, at adequate viscosity and pressure, discharged via an atomiser nozzle into the kiln in order to form e.g. the main flame. Flame shaping is mainly accomplished via multi-primary air channel burners with the oil atomiser head in a central location. Kiln burners for natural gas, too, are designed according to the multi-channel principle, the gas thereby replacing not only coal or fuel oil, but also primary air.

6.3.9.2 **Long rotary kilns**

Long rotary kilns can be fed with slurry, crushed filter cakes, nodules or dry meal and are thus suitable for all process types. The largest long kilns have a length-to-diameter ratio of 38:1 and can be more than 200 m long. These huge units produce around 3600 tonnes/day using the wet process. Long rotary kilns are designed for drying, preheating, calcining and sintering, so that only the feed system and cooler have to be added. The upper part of the long kilns is equipped with chain curtains and fixed installations to improve heat transfer.

Wet process kilns, used since 1895, are the oldest type of rotary kilns in use for producing cement clinker. Wet raw material preparation was initially used because homogenisation was easier with liquid material. Wet kiln feed typically contains 32 to 40% water. This is necessary to maintain the liquid properties of the feed. This water must then be evaporated in the specially designed drying zone at the inlet section of the kiln where a significant portion of the heat from fuel combustion is used. This technology has high heat consumption with the resulting emission of high quantities of combustion gas and water vapour.

6.3.9.3 **Rotary kilns equipped with preheaters**

Rotary kilns equipped with preheaters have a typical length-to-diameter ratio of between 10:1 and 17:1. There are two types of preheaters:

- Grate preheaters; and
- Suspension preheaters.

6.3.9.3.1 Grate preheater technology

Grate preheater technology, perhaps better known as the Lepol kiln, was invented in 1928. It represented the first approach to letting part of the clinkering process take place in a stationary installation outside the kiln. This allowed the rotary kiln to become shorter and so reduced the heat losses and increased energy efficiency. In the grate preheater (see Figure 3) nodules made from dry meal on a noduliser disc (semidry process) or from wet slurry filter cakes in an extruder (semi-wet process) are fed onto a horizontal travelling grate which travels through a closed tunnel. The tunnel is divided into a hot gas chamber and a drying chamber by a partition with an opening for the grate. A fan draws the exhaust gas from the rotary kiln into the top of the preheater, through the nodules layer in the hot gas chamber, and then through the cyclones of the intermediate dust collector. In these cyclones large dust particles, which would otherwise cause wear to the fan, are removed. The next fan then draws the gas into the top of the drying chamber, through the moist layer of nodules, and finally pushes it out into the dust collector. In order to achieve optimum thermal efficiency, the semi-wet grate preheaters can be equipped with triple-pass gas systems, and cooler waste air is used for raw material drying. The maximum unit size to have been built is 3300 tonnes/day for a semi-wet kiln system.

The rotary kiln exhaust gas enters the preheater with a temperature of 1000-1100°C. As it flows through the layer of material in the hot gas chamber, the exhaust gas cools down to 250- 300°C, and it leaves the drying chamber at 90-150°C. The material to be burnt reaches a temperature of about 150oC in the drying chamber and 700-800°C in the heating chamber.

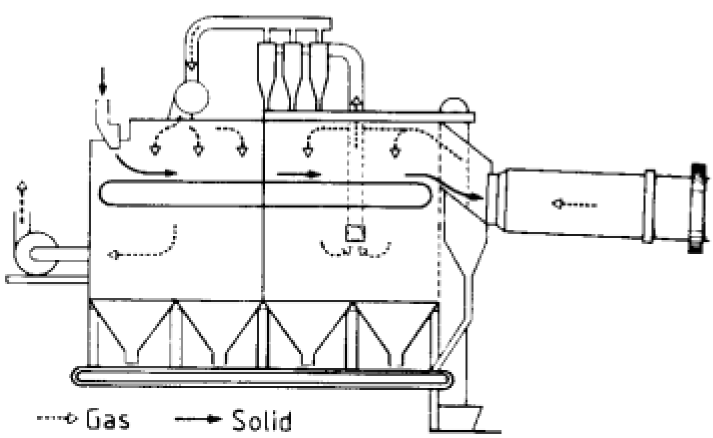


Figure 10: Grate preheater. [Ullmann's, 1986]

6.3.9.3.2 Suspension preheater technology

The invention of the suspension preheater in the early 1930s was a significant development. Preheating and even partial calcination of the dry raw meal (dry/semi-wet processes) takes place by maintaining the meal in suspension with hot gas from the rotary kiln. The considerably larger contact surface allows almost complete heat exchange, at least theoretically. Various suspension preheater systems are available. They usually have between four and six cyclone stages, which are arranged one above the other in a tower 50-120 m high. The uppermost stage may comprise two parallel cyclones for better dust separation. The exhaust gases from the rotary kiln flow through the cyclone stages from the bottom upward. The dry powdery raw material mixture is added to the exhaust gas before the uppermost cyclone stage. It is separated from the gas in the cyclones and rejoins it before the next cyclone stage. This procedure repeats itself at every stage until finally the material is discharged from the last stage into the rotary kiln. This alternate mixing, separation, and remixing at higher temperature is necessary for optimal heat transfer.

6.3.9.3.3 Shaft preheaters

A considerable number of shaft preheaters were built following the introduction of suspension preheater technology, given its theoretically superior heat exchange properties. However, the difficulty of ensuring an even distribution of meal to gas meant that actual performance was far worse than expected, and technology using shaft stages alone was eventually abandoned in favour of hybrid systems with cyclone stages or pure multi-stage cyclone preheaters. Some of those hybrids are still in operation, however most of them have been converted to pure cyclone preheaters. A shaft stage is considerably less sensitive to build-up problems than a cyclone stage, which can be an advantage for the bottom stage in cases where excessive quantities of circulating elements (chlorides, sulphur, and alkalis) are present. Hybrid preheaters with a bottom shaft stage are still available for new plants. Typical capacities of shaft preheater kilns were up to 1500 tonnes/day, whereas hybrid systems can produce 3000 tonnes/day or more.

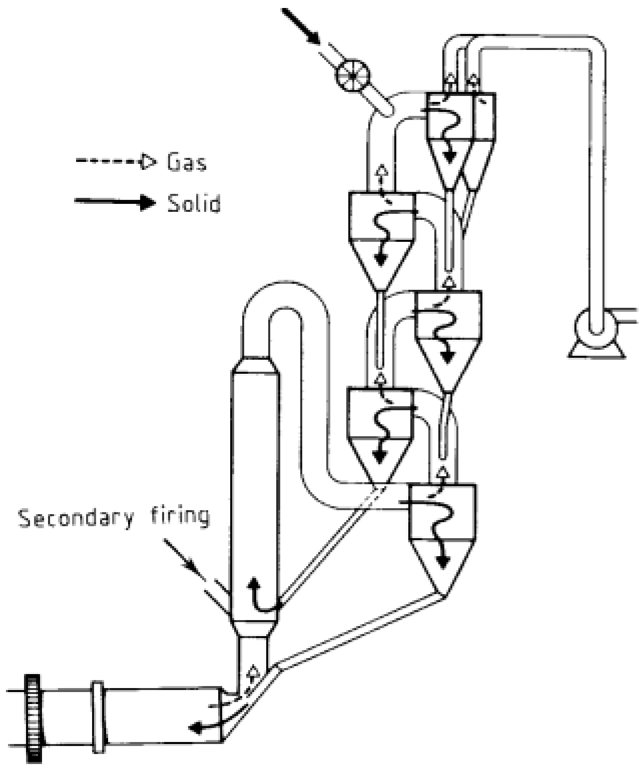


Figure 11: Suspension preheater with pre-calciner. [Ullmann's, 1986]

5.3.9.3.4 Four stage cyclone preheater

The four-stage cyclone preheater kiln system (see Figure 5) was standard technology in the 1970s when many plants were built in the 1000 to 3000 tonnes/day range. The exhaust gas, which has a temperature of around 330 °C is normally used for raw material drying. When the meal enters the rotary kiln, calcination is already about 30% completed. Severe problems have in the past been encountered with four stage preheaters in cases where inputs of circulating elements (chlorides, sulphur, and alkalis) from the feed and/or fuel were excessive.

Highly enriched cycles of these elements lead to build-ups in cyclone and duct walls, which frequently cause blockages and kiln stops lasting several days. Kiln gas bypass, i.e. extraction of part of the particulate laden gas stream leaving the kiln so that it bypasses the cyclone system, is a frequently used solution to the problem. This bypass gas is cooled to condense the alkalis and then passed through a dust collector before discharge. Whilst in some regions it is necessary, for the control of clinker alkali levels, to send the bypass dust and part of the kiln dust to landfill, in all other cases it is fed back into the production process.

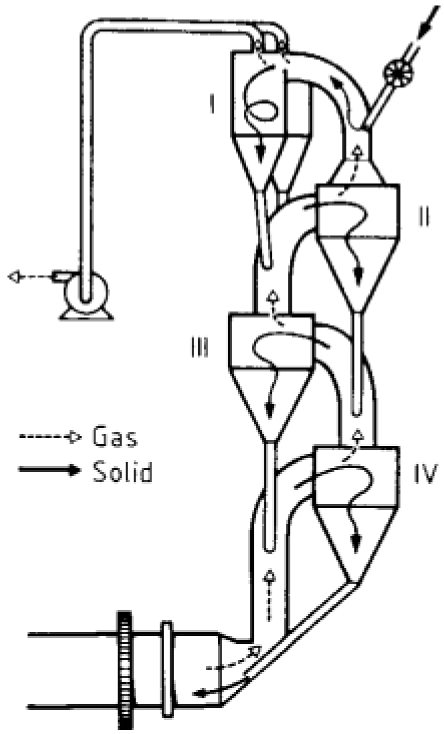


Figure 12: Suspension preheater. [Ullmann's, 1986]

6.3.9.4 Rotary kilns with preheater and pre-calciner

The pre-calcination technique has been available to the cement industry since about 1970. In this procedure the heat input is divided between two points. Primary fuel combustion occurs in the kiln burning zone. Secondary burning takes place in a special combustion chamber between the rotary kiln and the preheater. In this chamber up to 60% of the total fuel can be burnt in a typical pre-calciner kiln. This energy is basically used to calcine the raw meal, which is almost completely calcined when it enters the kiln. Hot air for combustion in the calciner is ducted from the cooler. Material leaves the calciner at about 870 ºC.

Figure 4 shows this procedure applied to a kiln with a suspension preheater. In principle, secondary burning can also be applied in a kiln with a grate preheater. For a given rotary kiln size pre-calcining increases the clinker capacity. Kiln systems with five cyclone preheater stages and pre-calciner are considered standard technology for new dry process plants. Earlier pre-calciner systems had only four preheater stages with accordingly higher exhaust gas temperature and fuel consumption. Where natural raw material moisture is low, six-stage preheaters can be the preferred choice, particularly in combination with bag-filter dedusting.

Where excessive inputs of circulating elements are present, a kiln gas bypass is required to maintain continuous kiln operation. However, due to the different gas flow characteristics, a bypass in a pre-calciner kiln is much more efficient than in a straight preheater kiln. In spite of the fact that the meal enters the kiln 75 to 95% calcined, most pre-calciner kilns are still equipped with a rotary kiln with a calcining zone, i.e. with an L/D ratio of 13:1 to 16:1 as in the case of the straight preheater kilns.

6.3.9.5 **Shaft kilns**

A few shaft kilns are used for cement production. Kilns of this type consist of a refractory-lined, vertical cylinder 2-3 m in diameter and 8-10 m high. They are fed from the top with raw meal pellets and fine grained coal or coke. The material being burnt travels through a short sintering zone in the upper, slightly enlarged part of the kiln. It is then cooled by the combustion air blown in from the bottom and leaves the lower end of the kiln on a discharge grate in the form of clinker. Shaft kilns produce less than 300 tonnes/day of clinker. They are only economic for small plants, and for this reason their number has been diminishing.

6.3.9.6 **Kiln exhaust gases**

In all kiln systems the exhaust gases are finally passed through an air pollution control device (electrostatic precipitator or bag filter) for separation of the dust before going to the main stack. In the dry processes the exhaust gases can be at a relatively high temperature and may provide heat for the raw mill when it is running (compound operation). If the raw mill is not running (direct operation), the gases are normally cooled with water sprays in a conditioning tower before going to the dust collector, both to reduce their volume and to improve their precipitation characteristics.

6.3.9.6.1 Carbon Oxide-trips

Carbon monoxide can arise from any organic content in the raw materials and, occasionally, due to the incomplete combustion of fuel. The contribution from the raw materials, due to preheating, will be exhausted with the kiln gases. Control of CO levels is critical in cement (and lime) kilns when Electrostatic Precipitators (EPs) are used for particulate abatement, to ensure concentrations are kept well below the lower explosive limit. If the level of CO in the EP rises (typically to 0.5% by volume) then the electrical system is tripped (switched off) to eliminate the risk of explosion. This leads to unabated particulate releases from the kiln. CO trips can be caused by unsteady state operation of the combustion system. This sometimes occurs when feeding solid fuels, so solid-fuel feeding systems must be designed to prevent surges of fuel into the burner. The moisture content of solid fuels is a particularly critical factor in this respect and must be carefully controlled to prevent hold ups or blockages in the fuel preparation and feeding systems.

6.3.9.6.2 **Clinker coolers**

The clinker cooler is an integral part of the kiln system and has a decisive influence on performance and economy of the pyro-processing plant. The cooler has two tasks:

- To recover as much heat as possible from the hot (1450 °C) clinker so as to return it to the process; and
- To reduce the clinker temperature to a level suitable for the equipment downstream.

Heat is recovered by preheating the air used for combustion in main and secondary firing as close to the thermodynamic limit as possible. However, this is hindered by high temperatures, the extreme abrasiveness of the clinker and its wide granulometric range. Rapid cooling fixes the mineralogical composition of the clinker to improves the grindability and optimise cement reactivity. Typical problems with clinker coolers are thermal expansion, wear, incorrect air flows and poor availability, which work against the above requirements. There are two main types of coolers: rotary and grate.

6.3.9.6.3 **Rotary coolers**

The tube cooler

The tube cooler uses the same principle as the rotary kiln, but for reversed heat exchange. Arranged at the outlet of the kiln, often in reverse configuration, i.e. underneath the kiln, a second rotary tube with its own drive is installed. After kiln discharge, the clinker passes a transition hood before it enters the cooler, which is equipped with lifters to disperse the product into the air flow. Cooling air flow is determined by the air required for fuel combustion. Apart from the speed, only the internals can influence the performance of the cooler. Optimisation of lifters must consider heat exchange (dispersion pattern) versus dust cycle back to the kiln.

The planetary (or satellite) cooler

The planetary (or satellite) cooler is a special type of rotary cooler. Several cooler tubes, typically 9 to 11, are attached to the rotary kiln at the discharge end. The hot clinker enters through openings in the kiln shell arranged in a circle at each point where a cooler tube is attached. The quantity of cooling air is determined by the air required for fuel combustion and enters each tube from the discharge end, allowing counter-current heat exchange. As for the tube cooler, internals for lifting and dispersing the clinker are essential. There are no variable operating parameter. High wear and thermal shock, in conjunction with dust cycles, mean high clinker exit temperatures and sub-optimum heat recovery are not unusual. Clinker exit temperature can only be further reduced by water injection into the cooler tubes or onto the shell.

Because it is practically impossible to extract tertiary air, the planetary cooler is not suitable for pre-calcination. Secondary firing with up to 25% fuel in the kiln riser area is possible, however.

6.3.9.6.4 Grate coolers

Cooling in grate coolers is achieved by passing a current of air upwards through a layer of clinker (clinker bed) lying on an air-permeable grate. Two ways of transporting the clinker are applied: travelling grate and reciprocating grate (steps with pushing edges). Since the hot air from the after-cooling zone is not used for combustion, it is available for drying purposes, e.g. raw materials, cement additives or coal. If not used for drying, this cooler waste air must be properly de-dusted.

Travelling grate coolers

In this type of cooler, clinker is transported by a travelling grate. This grate has the same design features as the preheater grate (Lepol). Cooling air is blown by fans into compartments underneath the grate. Advantages of this design are an undisturbed clinker layer (no steps) and the possibility of exchanging plates without a kiln stop. Due to its mechanical complexity and poor recovery resulting from limited bed thickness (caused by the difficulty of achieving an effective seal between the grate and walls), this design ceased to be used in new installations around 1980.

Reciprocating grate cooler, conventional

Clinker transport in the reciprocating grate cooler is effected by stepwise pushing of the clinker bed by the front edges of alternate rows of plates. Relative movement of front edges is generated by hydraulic or mechanical (crankshaft) drives connected to every second row. Only the clinker travels from feed end to discharge end, but not the grate. The grate plates are made from heat resistant cast steel and are typically 300 mm wide and have holes for the air to pass through them. Cooling air is insufflated from fans via compartments located underneath the grate. These compartments are partitioned from one another in order to maintain the pressure profile. Two cooling zones can be distinguished:

- The recuperation zone, from which the hot cooling air is used for combustion of the main burner fuel (secondary air) and the pre-calciner fuel (tertiary air);
- The after-cooling zone, where additional cooling air cools the clinker to lower temperatures.

The largest units in operation have an active surface of about 280 m2 and cool 10000 tonnes/day of clinker. Typical problems with these coolers are segregation and uneven clinker distribution leading to air-clinker imbalance, fluidisation of fine clinker and also build ups and less than ideal life of plates.

Reciprocating grate cooler, modern

Introduction and development of modern technology reciprocating grate coolers started around 1983. The design aimed to eliminate the problems with conventional coolers thus coming a step closer to optimum heat exchange and also more compact coolers using less cooling air and smaller de-dusting systems. Key features of modern cooler technology are (depending on supplier):

- Modern plates with built-in, variable or permanent, pressure drop, permeable to air but not clinker;
- Forced plate aeration via ducts and beams;
- Individually adjustable aeration zones;
- Fixed inlet;
- Fewer and wider grates;
- Roller crusher;
- Heat shields.

6.3.9.6.5 Vertical coolers

A dust free after-cooler called a Gravity cooler or G-cooler has been developed to be installed after a planetary cooler or short grate recuperator/cooler. The cooling air never comes into contact with the clinker as heat exchange is affected by the clinker descending over transverse steel tubes in the clinker bed, which in turn are cooled by air blown through them.

6.3.10 **Cement grinding and storage**

6.3.10.1 **Clinker storage**

Clinker and other cement components are stored in silos or in closed sheds. Larger stocks can be stored in the open if the necessary precautions against dust formation are taken.

The most common clinker storage systems are:

- Longitudinal store with gravity discharge (limited live-stock);
- Circular store with gravity discharge (limited live-stock);
- Clinker storage silo (high live stock; problems with ground vibrations can occur during clinker withdrawal from the silo at certain silo levels);
- Clinker storage dome (limited live-stock).

6.3.10.2 **Cement grinding**

Cement is produced by inter-grinding cement clinker and sulphates such as gypsum and anhydrite. In blended cements (composite cements) there are other constituents, such as granulated blast furnace slag, natural or artificial pozzolanas, limestone, or inert fillers. These will be inter-ground with the clinker or may need to be dried and ground separately. (Grinding plants may be at separate locations from clinker production plants.) The kind of cement grinding process and the plant concept chosen at a specific site depend on the cement type to be produced. Of special importance are the grindability, the humidity and the abrasive behaviour of the compounds of the cement type produced. Most mills work in a closed circuit, that is, they can separate cement with the required fineness from the material being ground and return coarse material to the mill.

6.3.10.2.1 Metering and proportioning of the mill feed

The accuracy and reliability of metering and proportioning of the mill feed components by weight is of great importance for maintaining a high energy efficiency of a grinding system. The predominant metering and proportioning equipment for the material feed to mills is the belt weigh feeder.

6.3.10.2.2 Grinding of cement

Due to the variety of cement types required by the market, latest-generation grinding systems equipped with a dynamic air separator predominate. Commonly used finish grinding systems are:

- Tube mill, closed circuit (mineral addition is rather limited, if not dry or pre-dried);
- Vertical roller mill (best suited for high mineral additions due to its drying capacity, best suited for separate grinding of mineral addition);
- Roller press (mineral addition is rather limited, if not dry or pre-dried).

Other finish grinding systems used are:

- Tube mill, end discharge in open circuit;
- Tube mill, end discharge in closed circuit with mechanical air separator or cyclone air separator of older generations;
- Horizontal roller mill.

The working principle of vertical roller mills is based on the action of 2 to 4 grinding rollers supported on hinged arms and riding on a horizontal grinding table or grinding bowl. It is suited especially for simultaneous grinding and drying of cement raw materials or slag since vertical roller mills can handle relatively high moisture contents in the mill feeds. The transition time for materials through the mill is short enough to prevent pre-hydration of the cement clinker, e.g. in the case of slag cement grinding.

The high-pressure twin roller mill still needs a comparatively high degree of maintenance. High-pressure twin roller mills are often used in conjunction with ball mills. A more recent development in cement grinding is the horizontal roller mill. This consists of a short horizontal shell supported on hydrodynamic or hydrostatic bearings. The shell is rotated via a girth gear. Inside the shell is a horizontal roller which is free to rotate and can be pressed hydraulically onto the shell. The material to be ground is fed into one or both ends of the shell, and passes between the roller and the shell several times. The crushed material leaving the mill is transported to a separator, the oversize fraction being returned to the mill.

6.3.10.2.3 Grinding of mineral additions

Mineral additions are usually ground together with the clinker and gypsum. The decision to grind them separately basically depends upon the following factors:

- The percentage of mineral additives in the final product and in cement production as a whole;
- Whether a spare mill system is available;
- Whether there is a considerable difference in the grindability of the clinker and mineral additives;
- The moisture content of the mineral additives.

If pre-drying of mineral additives is required, drier systems can be employed using either kiln exhaust gases and/or cooler exhaust air or an independent hot gas source.

Inter-grinding systems

Any of the grinding systems mentioned for the dry/semi-dry grinding of raw materials can be used for inter-grinding mineral additives with clinker and gypsum. However, most systems place limits on the moisture content of the feed mixture - 2% maximum or 4% if a hot gas source is used. For higher moisture contents the systems require pre-drying of the mineral additives in a drier. An exception is the vertical roller system, which is capable of handling moisture contents up to 20%, but still requires a hot gas source.

Separate Grinding

For separate grinding of mineral additives the systems for the dry/semi-dry grinding of raw materials can be used. However, the same applies for the systems with regard to the moisture content of the additives mixture, and pre-drying may be required.

6.3.10.2.4 Separation by particle size distribution

The particle size distribution of the product leaving the cement grinding system is of great importance for the cement quality. The specification of these parameters is achieved by adjusting the separator. Latest generation separators of the rotor cage type have several advantages over previous designs, such as:

- Lower specific energy consumption by the system (less overgrinding);
- Increase of system throughput (efficiency);
- Possibility of product cooling;
- Higher flexibility for adjustments in product fineness;
- Better control of particle size distribution, better product uniformity.

6.3.10.2.5 **Storage of cement**

Both pneumatic and mechanical conveying systems can be used for cement transport to storage silos. Mechanical systems normally have a higher investment cost but a much lower operating cost than pneumatic transport. A combination of air-slide or screw/chain conveyors with a chain bucket elevator is nowadays the most commonly used conveying system. Different cements are stored separately in silos. Usually various silos are required for the storage of cements. However, new silo designs allow the storage of more than one type of cement in the same silo. The silo configurations currently used for cement storage are:

- Single-cell silo with discharge hopper
- Single-cell silo with central cone
- Multi-cell silo
- Dome silo with central cone

Compressed air is used to initiate and maintain the cement discharge process from these silos via aeration pads located at the bottom of the silo.

6.3.11 **Packing and dispatch**

Cement is normally transferred from the silos either directs into bulk road or tankers, or to a bag packing station.

7. BACKGROUND TO RAW MATERIALS USED IN CEMENT PRODUCTION

Raw materials used in the manufacture of cement are;-

- ✓ Limestone
- ✓ Pozzolana
- ✓ Bauxite
- ✓ Gypsum
- ✓ Iron ore
- ✓ Shale

7.1 Limestone

Limestone is a sedimentary rock composed primarily of calcium carbonate ($CaCO_3$) in the form of the mineral calcite. It most commonly forms in clear, warm, shallow marine waters. It is usually an organic sedimentary rock that forms from the accumulation of shell, coral, algal and fecal debris. It can also be a chemical sedimentary rock formed by the precipitation of calcium carbonate from lake or ocean water (Folk, 1974).

7 .1.1 Limestone-Forming Environment

7.1.1.1 Limestone-Forming Environment - Marine

Most limestones form in shallow, calm, warm marine waters. That type of environment is where organisms capable of forming calcium carbonate shells and skeletons can easily extract the needed ingredients from ocean water. When these animals die their shell and skeletal debris accumulate as a sediment that might be lithified into limestone. Their waste products can also contribute to the sediment mass. Limestones formed from this type of sediment are biological sedimentary rocks. Their biological origin is often revealed in the rock by the presence of fossils.Some limestones can form by direct precipitation of calcium carbonate from marine or fresh water. Limestones formed this way are chemical sedimentary rocks. They are thought to be less abundant than biological limestones.

7.1.1.2 Limestone-Forming Environment – Evaporative

Limestone can also form through evaporation. Stalactites, stalagmites and other cave formations (often called "speleothems") are examples of limestone that formed through evaporation. In a cave, droplets of water seeping down from above enter the cave through fractures or other pore spaces in the cave ceiling. There they might evaporate before falling to the cave floor. When the water evaporates, any calcium carbonate that was dissolved in the water will be deposited on the cave ceiling. Over time this evaporative process can result in an accumulation of icicle-shaped calcium carbonate on the cave ceiling. These deposits are known as **stalactites**. If the droplet falls to the floor and evaporates there a stalagmite could grow upwards from the cave floor. The limestone that makes up these cave formations is known as "travertine" and is a chemical sedimentary rock.

7.1.2 Composition of Limestone

Limestone is by definition a rock that contains at least 50% calcium carbonate in the form of calcite by weight. All limestones contain at least a few percent other materials. These can be small particles of quartz, feldspar, clay minerals, pyrite, siderite and other minerals. It can also contain large nodules of chert, pyrite or siderite.

7.1.3 Varieties of Limestone

There are many different names used for limestone. These names are based upon how the rock formed, its appearance or its composition and other factors (Dunham, 1962). Here are some of the more commonly used:

Chalk: A soft limestone with a very fine texture that is usually white or light gray in color. It is formed mainly from the calcareous shell remains of microscopic marine organisms such as foraminifers or the calcareous remains from numerous types of marine algae.

Coquina: A poorly-cemented limestone that is composed mainly of broken shell debris. It often forms on beaches where wave action segregates shell fragments of similar size.

Fossiliferous Limestone: A limestone that contains obvious and abundant fossils. These are normally shell and skeletal fossils of the organisms that produced the limestone.

Lithographic Limestone: A dense limestone with a very fine and very uniform grain size that occurs in thin beds that separate easily to form a very smooth surface.

Oolitic Limestone: A limestone composed mainly of calcium carbonate "oolites", small spheres formed by the concentric precipitation of calcium carbonate on a sand grain or shell fragment.

Travertine: A limestone that forms by evaporative precipitation, often in a cave, to produce formations such as stalactites, stalagmites and flowstone.

Tufa: A limestone produced by precipitation of calcium-laden waters at a hot spring, lake shore or other location.

7.1.4 Uses of Limestone

Limestone is a rock with an enormous diversity of uses. It could be the one rock that is used in more ways than any other (Dunham, 1962).

- Most limestone is crushed and used as a construction material.
- It is used as a crushed stone for road base and railroad ballast.
- It is used as an aggregate in concrete.
- It is fired in a kiln with crushed shale to make cement.

Some additional but also important uses of limestone include:

- Dimension Stone: Limestone is often cut into blocks and slabs of specific dimensions for use in construction and in architecture. It is used for facing stone, floor tiles, stair treads, window sills and many other purposes.
- Roofing Granules: Crushed to a fine particle size, crushed limestone is used as a weather and heat-resistant coating on asphalt impregnated shingles and roofing. It is also used as a top coat on built-up roofs.
- Flux Stone: Crushed limestone is used in smelting and other metal refining processes. In the heat of smelting, limestone combines with impurities and can be removed from the process as a slag.
- Portland cement: Limestone is heated in a kiln with shale, sand and other materials and ground to a powder that will harden after being mixed with water.

- AgLime: Calcium carbonate is one of the most cost-effective acid neutralizing agents. When crushed to sand-size or smaller particles limestone becomes an effective material for treating acidic soils. It is widely used on farms throughout the world.
- Lime: If calcium carbonate (CaC03 is heated to high temperature in a kiln the products will be a release of carbon dioxide gas (CO_2) and calcium oxide (CaO). The calcium oxide is a powerful acid neutralization agent. It is widely used as a soil treatment agent (faster acting than aglime) in agriculture and as an acid neutralization agent by the chemical industry.
- Animal Feed Filler: Chickens need calcium carbonate to produce strong egg shells so calcium carbonate is often offered to them as a dietary supplement in the form of "chicken grits". It is also added to the feed of some dairy cattle who must replace large amounts of calcium lost when the animal is milked.
- Mine Safety Dust: Also known as "rock dust". Pulverized limestone is a white powder that can be sprayed onto exposed coal surfaces in an underground mine. This coating improves illumination and reduces the amount of coal dust that activity stirs up and releases into the air. This improves the air for breathing and it also reduces the explosion hazard produced by suspended particles of flammable coal dust in the air.

7.2 Pozzolana

Pozzolana, also known as pozzolanic ash (*pulvis puteolanus* in Latin), is a siliceous or siliceous and aluminous material which reacts with calcium hydroxide in the presence of water at room temperature (pozzolanic reaction). The designation pozzolana is derived from one of the primary deposits of volcanic ash. Nowadays the definition of pozzolana encompasses any volcanic material (pumice or volcanic ash), predominantly composed of fine volcanic glass, that is used as a pozzolan (Mehta, 1981).

7.2.1 Geochemistry and mineralogy

The major pozzolanically active component of volcanic pumices and ashes is a highly porous glass. The mineralogical composition of unaltered pyroclastic rocks is mainly determined by the presence of phenocrysts and the chemical composition of the parent magma. The major component is volcanic glass typically present in quantities over 50% weight. Pozzolana containing significantly less volcanic glass, such as a trachyandesite from Volvic with only 25% of the weight are less reactive.

7.2.2 Uses

Pozzolana is abundant in certain locations and is extensively used as an addition to Portland cement. Compared to industrial by-product pozzolans they are characterized by larger ranges in composition and a larger variability in physical properties. The application of pozzolana in Portland cement is mainly controlled by the local availability of suitable deposits and the competition with the accessible industrial by-product supplementary cementitious materials.

7.2.3 Pozzolanic reaction

The pozzolanic reaction is the chemical reaction that occurs in Portland cement containing pozzolans. At the basis of the pozzolanic reaction stands a simple acid-base reaction between calcium hydroxide, also known as Portlandite, or ($Ca(OH)_2$), and silicic acid (H4SiO4, or Si(OH)4). Simply, this reaction can be schematically represented as follows:

Ca(OH)2 + H4SiO4 → Ca2+ + H2SiO42− + 2 H2O → CaH2SiO4 · 2 H2O

Or summarized in abbreviated notation of cement chemists:

CH + SH → C-S-H

The product of general formula (CaH2SiO4 · 2 H2O) formed is a calcium silicate hydrate, also abbreviated as C-S-H in cement chemist notation, the hyphenation denotes the variable stoichiometry.

5.3 Bauxite

Bauxite is not a mineral. It is a rock formed from a laterite soil that has been severely leached of silica and other soluble materials in a wet tropical or subtropical climate. It is the primary ore of aluminum. Almost all of the aluminum that has ever been produced has been extracted from bauxite (Bárdossy, 1990).

5.3.1Bauxite's Composition

Bauxite does not have a specific composition. It is a mixture of hydrous aluminum oxides, aluminum hydroxides, clay minerals and insoluble materials such as quartz, hematite, magnetite, siderite and goethite. The aluminum minerals in bauxite can include: gibbsite $Al(OH)_3$, boehmite AlO(OH), and, diaspore, AlO(OH).

5.3.2 Physical Properties of Bauxite

Bauxite is typically a soft , white to grey to reddish brown material with a pisolitic structure, earthy luster and a low specific gravity (SG: 2.0-2.5). These properties are useful for identifying bauxite; however, they have nothing to do with bauxite's value or usefulness. This is because bauxite is almost always processed into another material with physical properties that are distinctly different from bauxite.

Table 23: Physical properties of bauxite

Physical Properties of Bauxite	
Chemical Classification	**Description**
Color	white, grey, sometimes stained yellow, orange red, pink, brown or yellow by iron or included iron minerals
Streak	usually white but iron stain can discolor
Luster	dull, earthy
Diaphaneity	opaque
Cleavage	none
Mohs Hardness	1 to 3
Specific Gravity	2 to 2.5
Diagnostic Properties	often exhibits pisolitic structure, color
Chemical Composition	variable but always rich in aluminum oxides and aluminum hydroxides
Crystal System	n/a
Uses	primary ore of aluminum, also used as an

	abrasive

5.4 Gypsum

Gypsum is an evaporite mineral most commonly found in layered sedimentary deposits in association with halite, anhydrite, sulfur, calcite and dolomite (Anthony et al, 2003). Gypsum ($CaSO4.2H2O$) is very similar to Anhydrite ($CaSO4$). The chemical difference is that gypsum contains two waters and anhydrite is without water. Gypsum is the most common sulfate mineral.

Table 24: Physical properties of gypsum

Physical Properties of Gypsum	
Chemical Classification	sulfate
Color	clear, colorless, white, gray, yellow, red, brown
Streak	white
Luster	vitreous, silky, sugary
Diaphaneity	transparent to translucent
Cleavage	perfect
Mohs Hardness	2
Specific Gravity	2.3
Diagnostic Properties	cleavage, specific gravity, low hardness
Chemical Composition	hydrous calcium sulfate, $CaSO4.2H2O$
Crystal System	monoclinic

Uses	Use to manufacture dry wall, plaster, joint compound. An agricultural soil treatment.
Chemical Classification	sulfate

7.4.1 Uses of Gypsum

Gypsum uses include: manufacture of wallboard, cement, plaster of Paris, soil conditioning, a hardening retarder in Portland cement. Varieties of gypsum known as "satin spar" and "alabaster" are used for a variety of ornamental purposes, however their low hardness limits their durability.

7.5 Iron Ore

Earth's most important iron ore deposits are found in sedimentary rocks. They are formed from chemical reactions that combined iron and oxygen in marine and fresh waters. The two most important minerals in these deposits are iron oxides: hematite (Fe_2O_3) and magnetite (Fe_3O4).

7.5.1 Formation of Iron Ore

Nearly all of Earth's major iron ore deposits are in rocks that formed over 1.8 billion years ago. At that time Earth's oceans contained abundant dissolved iron and almost no dissolved oxygen. The iron ore deposits began forming when the first organisms capable of photosynthesis began releasing oxygen into the waters. This oxygen immediately combined with the abundant dissolved iron to produce hematite or magnetite. These minerals deposited on the sea floor in great abundance, forming what are now known as the "banded iron formations." The rocks are "banded" because the iron minerals deposited in alternating bands with silica and sometimes shale. The banding might have resulted from seasonal changes in organism activity (Kato et al, 1969).

7.5.2 Iron Ore Uses

The primary use of iron ore is in the production of iron. Most of the iron produced is then used to make steel. Steel is used to make automobiles, locomotives, ships, beams used in buildings, furniture, paper clips, tools, reinforcing rods for concrete, bicycles, and thousands of other items. It is the most-used metal by both tonnage and purpose.

7.6 Shale

Shale is a fine-grained sedimentary rock that forms from the compaction of silt and clay-size mineral particles that we commonly call "mud". This composition places shale in a category of sedimentary rocks known as "mudstones". Shale is distinguished from other mudstones because it is fissile and laminated. "Laminated" means that the rock is made up of many thin layers. "Fissile" means that the rock readily splits into thin pieces along the laminations (Herbert,1996).

7.6.1Uses of Shale

Some shales have special properties that make them important resources. Black shales contain organic material that sometimes breaks down to form natural gas or oil. Other shales can be crushed and mixed with water to produce clays that can be made into a variety of useful objects.

7.6.2 Shale Used to Produce Cement

Cement is another common material that is often made with shale. To make cement, crushed limestone and shale are heated to a temperature that is high enough to evaporate off all water and break down the limestone into calcium oxide and carbon dioxide. The carbon dioxide is lost as an emission but the calcium oxide combined with the heated shale makes a powder that will harden if mixed with water and allowed to dry.

8. BACKGROUND TO FUELS USED IN CEMENT PRODUCTION

Fuels that are used for primary firing in cement production include:

- Coal
- Petroleum coke
- Heavy fuel oil
- Natural gas
- Landfill off-gas
- Oil refinery flare gas

8.1 Coal

Coal is a fossil fuel and is the altered remains of prehistoric vegetation that originally accumulated in swamps and peat bogs. The energy we get from coal today comes from the energy that plants absorbed from the sun millions of years ago. All living plants store solar energy through a process known as photosynthesis. When plants die, this energy is usually released as the plants decay. Under conditions favourable to coal formation, the decaying process is interrupted, preventing the release of the stored solar energy. The energy is locked into the coal (International Energy Annual, 2006).

8.1.1 Coal formation

Coal formation began during the Carboniferous Period - known as the first coal age - which spanned 360 million to 290 million years ago. The build-up of silt and other sediments, together with movements in the earth's crust - known as tectonic movements - buried swamps and peat bogs, often to great depths. With burial, the plant material was subjected to high temperatures and pressures. This caused physical and chemical changes in the vegetation, transforming it into peat and then into coal (EIA International Energy Statistics, 2012).

8.1.2 Coalification

The quality of each coal deposit is determined by:

- varying types of vegetation from which the coal originated
- depths of burial

- temperatures and pressures at those depths
- length of time the coal has been forming in the deposit

The degree of change undergone by a coal as it matures from peat to anthracite is known as **coalification**. Coalification has an important bearing on coal's physical and chemical properties and is referred to as the 'rank' of the coal. Ranking is determined by the degree of transformation of the original plant material to carbon. The ranks of coals, from those with the least carbon to those with the most carbon, are lignite, sub-bituminous, bituminous and anthracite.

8.1.3 Types of Coal

- **Lignite or 'brown coal':** Initially the peat is converted into lignite or 'brown coal' - these are coal-types with low organic maturity. In comparison to other coals, lignite is quite soft and its colour can range from dark black to various shades of brown.
- **Sub-bituminous coals:** Over many more millions of years, the continuing effects of temperature and pressure produces further change in the lignite, progressively increasing its organic maturity and transforming it into the range known as 'sub-bituminous' coals.
- **Bituminous or 'hard coals':** Further chemical and physical changes occur until these coals became harder and blacker, forming the 'bituminous' or 'hard coals'.
- **Anthracite:** Under the right conditions, the progressive increase in the organic maturity can continue, finally forming anthracite.

In addition to carbon, coals contain hydrogen, oxygen, nitrogen and varying amounts of sulphur. High-rank coals are high in carbon and therefore heat value, but low in hydrogen and oxygen. Low-rank coals are low in carbon but high in hydrogen and oxygen content.

8.1.4 Uses of Coal

Coal has many important uses worldwide. The most significant uses of coal are in electricity generation, steel production, cement manufacturing and as a liquid fuel.

Different types of coal have different uses e.g.;

- Steam coal - also known as thermal coal - is mainly used in power generation.
- Coking coal - also known as metallurgical coal - is mainly used in steel production.

Coal is also an essential ingredient in the production of specialist products:

- Activated carbon - used in filters for water and air purification and in kidney dialysis machines.
- Carbon fibre - an extremely strong but light weight reinforcement material used in construction, mountain bikes and tennis rackets.
- Silicon metal - used to produce silicones and silanes, which are in turn used to make lubricants, water repellents, resins, cosmetics, hair shampoos and toothpastes.

8.2 Natural Gas

Natural gas is a fossil fuel formed when layers of buried plants, gases, and animals are exposed to intense heat and pressure over thousands of years (Michael et al 2011). The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in natural gas. Natural gas is a non-renewable resource because it cannot be replenished on a human time frame. Natural gas is a hydrocarbon gas mixture consisting primarily of methane, but commonly includes varying amounts of other higher alkanes and sometimes a usually lesser percentage of carbon dioxide, nitrogen, and/or hydrogen sulfide. Natural gas is an energy source often used for heating, cooking, and electricity generation. It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals. Natural gas is found in deep underground rock formations or associated with other hydrocarbon reservoirs in coal beds and as methane clathrates.

8.3 Petroleum coke

Petroleum coke (often abbreviated pet coke or petcoke) is a carbonaceous solid delivered from oil refinery coker units or other cracking processes (Stockman, et al 2013). Coking processes that can be employed for making petcoke include contact coking, fluid coking, flexicoking and delayed coking. Other coke has traditionally been delivered from coal. Petcoke is over 90 percent carbon and emits 5 to 10 percent more carbon dioxide (CO_2) than coal on a per-unit-of-energy basis when it is burned. As petcoke has a higher energy content, petcoke emits between 30 and 80 percent more CO_2than coal per unit of weight. The difference between coal and coke in CO_2 production per unit energy produced depends upon the moisture in the coal (increases the CO_2

per unit energy -- heat of combustion) and volatile hydrocarbon in coal and coke (decrease the CO_2 per unit energy).

8.4 Heavy fuel oil

Fuel oil is a fraction obtained from petroleum distillation, either as a distillate or a residue. Broadly speaking fuel oil is any liquid petroleum product that is burned in a furnace or boiler for the generation of heat or used in an engine for the generation of power, except oils having a flash point of approximately 40 °C (104 °F) and oils burned in cotton or wool-wick burners. In this sense, diesel is a type of fuel oil. Fuel oil is made of long hydrocarbon chains, particularly alkanes, cycloalkanes and aromatics.

8.4.1 Classes

There are basically six fuel grades. The boiling point and carbon chain length of the fuel increases with fuel oil number. Viscosity also increases with number, and the heaviest oil has to be heated to get it to flow (World Resources Institute, Washington, DC).

- Number 1 fuel oil is a volatile distillate oil intended for vaporizing pot-type burners. It is the kerosene refinery cut that boils off right after the heavy naphtha cut used for gasoline. Older names include coal oil, stove oil and range oil.
- Number 2 fuel oil is distillate home heating oil. Trucks and some cars use similar diesel fuel with a cetane number limit describing the ignition quality of the fuel. Both are typically obtained from the light gas oil cut. Gas oil refers to the original use of this fraction in the late 19th and early 20th centuries - the gas oil cut was used as an enriching agent for carburetted water gas manufacture.
- Number 3 fuel oil was distillate oil for burners requiring low-viscosity fuel. ASTM merged this grade into the number 2 specification, and the term has been rarely used since the mid-20th century.
- Number 4 fuel oil is commercial heating oil for burner installations not equipped with preheaters. It may be obtained from the heavy gas oil cut.
- Number 5 fuel oil is residual-type industrial heating oil requiring preheating to 170 – 220 °F (77 – 104 °C) for proper atomization at the burners. This fuel is sometimes known as Bunker

B. It may be obtained from the heavy gas oil cut, or it may be a blend of residual oil with enough number 2 oil to adjust viscosity until it can be pumped without preheating.

- Number 6 fuel oil is a high-viscosity residual oil requiring preheating to 220 – 260 °F (104 – 127 °C). Residual means the material remaining after the more valuable cuts of crude oil have boiled off. The residue may contain various undesirable impurities including 2 percent water and one-half percent mineral soil. This fuel may be known as residual fuel oil (RFO), by the Navy specification of Bunker C, or by the Pacific Specification of PS-400.

8.5 Landfill gas

Landfill gas is a complex mix of different gases created by the action of microorganisms within a landfill.

8.5.1 Production

Landfill gas production results from chemical reactions and microbes acting upon the waste as the putrescible materials begins to break down in the landfill. The rate of production is affected by waste composition and landfill geometry, which in turn influence the microbial populations within it, chemical make-up of waste, thermal range of physical conditions, and the biological ecosystems co-existing simultaneously within most sites. This heterogeneity, together with the frequently unclear nature of the contents, makes landfill gas production more difficult to predict and control than standard industrial bioreactors for sewage treatment (Brosseau, 1994). Landfill gas is approximately forty to sixty per cent methane, with the remainder being mostly carbon dioxide. Landfill gas also contains varying amounts of nitrogen and oxygen gas, water vapour, hydrogen sulphide, and other contaminants.

8.5.2 Landfill gas use

The gases produced within a landfill can be collected or flared off. Once collected, the gas has several different pathways it can take. The landfill gas can be utilized directly on site by a boiler or any type of combustion system. This provides raw heat for processes. Electricity can also be generated on site through the use of micro turbines, steam turbines, or fuel cells. The landfill gas can also be sold off site and sent into natural gas pipelines. This requires the gas to be processed into pipeline quality by removing the water, carbon dioxide, nitrogen, hydrogren, oxygen and any other trace contaminants. Once in the general supply of natural gas, it can be used at power plants producing electricity or in home boilers. Landfill gas can also be used to evaporate leachate, another byproduct of the landfill process. This displaces another fuel that was previously used for the same thing.

8.6 Oil Refinery flare gas

A gas flare, alternatively known as a flare stack, is a gas combustion device used in industrial plants such as petroleum refineries, chemical plants, and natural gas processing plants as well as at oil or gas production sites having oil wells, gas wells, offshore oil and gas rigs and landfills. (Kayode 2007). In industrial plants, flare stacks are primarily used for burning off flammable gas released by pressure relief valves during unplanned over-pressuring of plant equipment. During plant or partial plant startups and shutdowns, flare stacks are also often used for the planned combustion of gases over relatively short periods.

A great deal of gas flaring at many oil and gas production sites has nothing to do with protection against the dangers of over-pressuring industrial plant equipment. When petroleum crude oil is extracted and produced from onshore or offshore oil wells, raw natural gas associated with the oil is produced to the surface as well. Especially in areas of the world lacking pipelines and other gas transportation infrastructure, vast amounts of such associated gas are commonly flared as waste or unusable gas. The flaring of associated gas may occur at the top of a vertical flare stack (as in the adjacent photo) or it may occur in a ground-level flare in an earthen pit. Preferably, associated gas is re-injected into the reservoir, which saves it for future use while maintaining higher well pressure and crude oil producibility.

9. PROJECT DESCRIPTION AND DESIGN

9.1 Design components

The components of the proposed expansion of MCL Vipingo factory will consist of limestone crusher, limestone pre-blending stockpile, additive storages, raw material hoppers, raw mill building & bag house, blending silo, kiln feed, preheater tower, rotary kiln, clinker cooler building, clinker transport conveyer, clinker storage, gypsum storage, pozzolana storage, coal stockpile, coal mill building, cement mill hoppers, cement mill building, cement silos, cement packing plant, cement loading for dispatch, clinker dispatch station, main sub-station, central control room, laboratories, engineering offices, stores, weighbridges, dispatch offices, water reservoirs and water treatment plant

9.2 Raw material acquisition

MCL will use the following raw materials in clinker production.

- ✓ Coral limestone
- ✓ Shale
- ✓ Iron ore

The mix of these three raw materials in required proportion grinding them and burning them in a kiln in a clinkerization process will produce clinker.

Production of cement will require the following materials,

- ✓ Clinker
- ✓ Pozzolana
- ✓ Gypsum

9.2.1 Source of Limestone to be used

The limestone that will be used in clinker production will be coral limestone also known as chalk. This limestone is the main raw material that will be used. This limestone will be sourced from existing limestone deposits that MCL is currently extracting for use in clinker and cement production for the existing plant. These limestone quarries are at close proximity to the existing plant and the proposed one and are located at Takaungu/Mavueni within Kilifi County. MCL has an EIA licence for extracting these limestone deposits namely application reference number

EIA/217 (registration number 0000337) and application reference number CP/PR.0495 (registration number 0007709). Appendix 9 is copies of the two EIA licences for limestone quarries.

9.2.2 Source of Shale

Shale that will be used in clinker production will be sourced from existing shale quarry owned by MCL at Vyambani within Kilifi County. MCL has an EIA licence for the shale quarry application reference number CP/PR/0682 (registration number 0007707). Appendix 10 is copy of the EIA licence for shale quarrying.

9.2.3 Source of Iron ore

Iron ore that will be used in clinker production will be bought from people/companies operating iron ore quarries as currently is the case.

9.2.4 Source of Pozzolana

Gypsum that will be used in cement production will be bought from people/companies operating pozzolana quarries as currently is the case. The details of the current suppliers of pozzolana to MCL are in appendix 11 the same suppliers will continue supplying required pozzolana for the proposed expansion.

9.2.5 Source of Gypsum

Gypsum that will be used in cement production will be imported. Currently MCL imports the gypsum used in cement production from Oman. It is anticipated that for the proposed expansion the gypsum that will be used will still be imported from Oman.

9.3 Limestone crushing

Limestone from limestone quarries will be transported to the limestone crusher for crushing and screening. Crushing of limestone will involve reduction of limestone to the required size. The limestone crusher that will be installed be double impact type with the following components hopper, uproar feeder, impact bars and blades, crusher chute, belt conveyors bag filters for dust collection. Once the limestone is crushed to the required size it will be conveyed to the limestone pre-blending stockpile where it will be pilled longitudinally.

9.4 Pre-blending and weigh feeders

The crushed limestone will be stacked in multiple layer fashion in pre blending stock piles to attain homogeneity. The limestone will then be reclaimed by bridge type stacker reclaimer and transferred to raw mill hopper weigh feeders by means of a closed conveyor belt. Two additives namely iron ore and shale will also conveyed to the weigh feeders in readiness for proportionate release and feeding into raw mill for grinding.

9.5 Raw mill

In the raw mill grinding and separation of calcareous, siliceous, argillaceous, and ferriferous raw materials i.e. limestone, shale, iron ore and bauxite to raw meal will be done using a central discharge ball mill with grinding media of 90mm-30mm. The mill will have two separators one dynamic and the other rotating with three dynamic separator fun, raw mill fun and bag house fun. Hot gases will be generated using heavy fuel to heat the material. Dynamic separators with four cyclones will extract fine materials while centre separator will extract rejected materials and redirect it back to the raw mill for reprocessing. Extracted fine materials from separator cyclones will then move by air slides to the blending silo.

9.5.1 Dust extraction system at the raw mill

The specification of the dust extraction system at the raw mill raw mill will be like that of the existing one. The specification of the existing one include a ten chamber bag house de-dusting system, with each chamber containing 250 bags, two funs the raw mill fun sucking dust from the raw mill and the pre-heater fun sucking dust from the pre-heater. The sucked dust will be held by the bags in the bag house. The reversible fun which sucks air reversed back to the bag house will result in release of the dust material held by the bags, which will be dropped and directed to ten rotary air locks from the air locks the dust is then directed to a chain conveyor and into the blending silo.

9.6 Blending silo

The blending silo that will be constructed will consist of silo aeration system, mixing bin, bag filter system for dust collection, bag filter fan, chimney for venting out air and silo top material distribution system from bucket elevator. Discharge into the blending silo will be from the top while blending of the raw mill will be done in the mixing bin by aid of four aeration blowers.

Once blending is complete the raw mill will be extracted from the bottom of the silo by aid of ten air slides and will be delivered to a pre-heater bucket elevator.

9.6.1 Dust collecting system at the blending silo

The blending silo will have two bag filters (for dust collection) one at 10m and the other at the top of the silo each of the bag filters will have 73 bags. The bag filter fan will suck dust from the blending process the sucked dust will be held by the bags in the bag house before release back into the silo.

9.7 Pre-heater

The pre-heater that will be constructed will be a 5-stage cyclone pre-heater with upper twine cyclone. Raw mill from the blending silo will be received at the pre-heater bucket elevator, the raw mill will then be moved by aid of air slide to the rotary airlock from where it will then be moved to the pre-heater and then to the pre-calciner for first burning. Subsequently, the raw meal will undergo a process of calcination in a pre-calcinator (in which the carbonates present are reduced to oxides) energy source at the pre-calciner will be coal; temperatures at the pre-calciner are between 850^0C-900^0C. After the pre-calcination, the pre-heated raw mill will then be fed into the kiln for burning.

9.7.1 Dust extraction system at pre-heater

Dust extraction system at the pre-heater will be bag filters

9.8 Coal mill

The coal mill that will be constructed will be the closed circuit type. In the coal mill, coal will be ground into fine material before charging the fine coal into the pre-calciner and rotary kiln for clinker burning.

9.8.1 Dust collection at the coal mill

The coal mill will have bag filters for dust collecting, the bag filters will be located at the raw coal hopper, fine coal hopper, weigh feeders and at the four chamber bag house.

9.9 Rotary kiln

A horizontal rotary kiln will be installed, in this kiln the pre-heated raw mill after the pre-calcination will be fed into the kiln, also fine coal from the coal mill is also fed into the kiln. Temperatures in the kiln will be raised to between 1,450°C and 1,500°C. Burning of the pre-heated raw mill from the calcination and clinkerization reactions will be completed in the horizontal rotary kiln. Combustion will causes a chemical reaction called decarbonation which will result in release of the CO_2 contained in the limestone. The fired materials take the form of hard granules called clinker.

9**.10 Clinker crusher**

A hammer type clinker crusher will be installed, the clinker formed at the rotary kiln will be cooled and conveyed to the clinker crusher for size reduction.

9.10.1 Dust collection system at the clinker crusher

Dust collection system at the clinker crusher will be by use of electrostatic precipitators.

9.11 Clinker shed

The cooled clinker of the required size will be conveyed into the clinker shed for storage. It is from the clinker storage shed that the clinker will be feed into the cement mill on site for production of cement.

9.11.1 Dust collection system at the clinker shed

Dust collection system at the clinker storage shed will be bag filters

9.12 Cement mill

In the cement mill cement production will be carried out by grinding of clinker, gypsum and pozzolana and packaging of the resulting cement. The process will involve three main activities namely:-

- ✓ Conveying of raw material from one point to another using various equipment.
- ✓ Grinding of material by equipment like ball mill, and, roll press.

- ✓ Separation of product from ground material and recycling of the coarse material back to grinding equipment.

The cement mill operation will be divided into the following steps:

i) Conveying the product to silo from separator.

ii) Conveying and separation of product with desired quality and recirculation of the unqualified product for further grinding.

iii) Grinding of the feed and recirculation material in ball mill.

iv) Mill lubrication and circulation system.

v) Controlled conveying of fresh feed to mill from hoppers.

vi) Raw material filling to hoppers from storage area.

9.12. 1 Cement grinding system

The equipment for the grinding system will be divided into the following groups according to function and positioning.

a) Silo transport group

b) Mill out let group

c) Mill lubrication group

d) Bag filter group

e) Mill group

f) Hopper and feeding group

9.12.1.1 Silo transport group

The equipment from silo top bag filter to the separator cyclone discharge air slide blowers will sequentially be included in this group, in reverses of the material flow. The sequence will be as follows; silo top bag filter fan- sequential timer for bag filter purging, discharge air slide blower, main drive motor, air slide blower, twin blowers for the long conveying air slide and the blowers for the parallel air slides below the cyclones. There will be two large silos for storing different types of cement and for bagged and bulk packaging. There will be two BE installed in the silo feeding system and will be facilitated to feed any of the silos. A pneumatic operated diverter will guide material flow to the elevators.

9.12.1.2 Mill out let group

The mill outlet group will include equipment for the recirculation, separation and separator feeding according to the material flow. There sequence will be separator bag filter, bag filter fan sequential timer for bag filter purging, blower for the air slide carrying separator reject to the mill through the solid flow meter, separator lubrication pump, separator drive, separator fun drive, separator air slide nib trap blower, separator feed air slide blower, mill out let, and mill discharge air slide blower.

9.12.1.3 Mill lubrication group

The mill lubrication group will consist of mill inlet and outlet slide shoe, high pressure or pre - jacking pumps, mill inlet and outlet slide shoe bearing lubrication pumps (low pressure), axial guide pump, mill gear boxes 1&2 gear box lubricating pumps and the mill girth gear grease spray system. Mill gear boxes will have two independent lubricating pumps; which run as per the selection from central control room. The pumps system will be provided with pressure and flow switches, to monitor the conditions, reporting in central control room. Various bearing and oil temperature as per the requirement for machinery safety will be monitored and reporting to central control room.

9.12.1.4 The bag filter group

The bag filter group will consist of the separator de-dusting bag filter, bag filter fan, and sequential timer for bag filter purging. The bag filters will be fixed in different locations. The capacity of the bag filters will ranges from 5,000m^3 to 55,000m^3 while the filter area will range from 60m^2 to 730m^2. The number of bags per location will range from 42 to 510.

9.12.1.5 The Mill Group

The cement mill will have two main drives of 1900KW and two motor cooling fans on each motor

9.12.1.6 Mill feed group

Each cement mill will have mill feed belt conveyor, reversible belt conveyor feeding to mill belt conveyor below weigh feeders, de-dusting bag filter, bag filter fan, sequential timer for bag filter purging and weigh feeders for Clinker, gypsum and pozzolana.

9.12.1.7 Hopper feeding group

This group will constitute three hoppers for clinker, gypsum and pozzolana filling and extraction from the storage area. There will be a motorized diverter at the main feeding belt which will serve to divert clinker to clinker hopper when it is open to the direct chute to clinker hopper and closed to the gypsum/pozzolana hopper feeding reversible belt conveyor, gypsum feeding condition when the diverter closes to direct chute/ open to belt conveyor side running forward to gypsum hopper and pozzolana hopper when filled as the diverter closes to direct chute/open to belt conveyor running reverse to pozzolana hopper.

The sequence of this group will be hopper top diverter to the position as per selection, hopper top de-dusting bag filter, bag filter fan sequential timer for bag filter purging, belt conveyor running as per selection, belt conveyor below the clinker storage area or belt conveyor below the gypsum/ pozzolana storage area. The plant will be operated and controlled through programmed logic control system from the Central Control Room. The various process control parameters will be monitored and adjusted as per the conditions.

9.12.2 Products

Two types of cement will be produced from the cement mill namely Portland Pozzolana Cement (PPC) and Ordinary Portland Cement (OPC).

9.12.3 Packaging

Packaging of cement will be of two types bagged packaging in50kg bags which will be done by Rotor Packer and bulk packaging for cement tanker from an overhead chute .

9.13 Project cost

The proposed expansion of Mombasa Cement Vipingo Unit by constructing two new plants is estimated to cost KSH 7, 360,000,000.00 (seven billion, three hundred and six million Kenya Shillings only). On submission of the Project report, the project proponent paid to the National Environment Management Authority 0.1% of this project cost i.e. KSH 7,360,000 (seven million three hundred and sixty thousand Kenya Shillings only) this being EIA processing and licensing fees as provided for in the Environmental (Impact Assessment and Audit) Regulations, 2003. Appendix 12 is a copy of the NEMA receipt acknowledging of payment of the 0.1%of the project cost.

10. PROJECT ALTERNATIVES

Analysis of the cement plant expansion project focused on the following:-

- ✓ The "Yes' and "No" project alternative
- ✓ Project site alternatives
- ✓ Technology alternatives
- ✓ Alternative sources of raw materials
- ✓ Alternative raw materials
- ✓ Alternative clay additives
- ✓ Alternative energy sources

10.1 The "Yes" and "No" Project alternatives

The "Yes" project alternatives means the proposed cement plant expansion project at the Mombasa Cement Vipingo plant be implemented as currently proposed without any alterations. On the other hand the "No" project alternative means that the proposed cement plant expansion project as currently proposed be rejected in its entirety with no alterations. The pros and cons of this alternative include the following;

- ✓ The EIA Study seeks to expand the cement plant.
- ✓ Noting that Mombasa Cement contributes to the revenue of the country and creates jobs to the local community for their benefit, the yes project alternative is consistent with this objective.
- ✓ Construction industry rely on cement as one of the main construction material, cement from this expansion of Mombasa Cement Limited Vipingo serve both the Kenyan market and beyond boarders.
- ✓ The no alternative if implemented will deprive the local community of more job opportunities hence denying them an economic opportunity to improve their livelihoods.
- ✓ The no project alternative will mean that cement in the country will remain in short supply and that the deficit will have to be sourced from elsewhere..

10.2 Alternative location

There are a number of key factors determining the location of a cement factory. These include but not limited to:

- ✓ Availability of raw material, key of which is coral limestone
- ✓ The availability of key infrastructure in the particular location
- ✓ Availability of market or linkages to market of the product
- ✓ Availability of land space to site the project
- ✓ Consideration on proximity to location of other cement plants.

These factors are briefly discussed below:-

10.2.1 Availability of Raw Materials

Limestone forms the bulk of the materials used in the production of Portland cement. For a cement plant to be economically viable, it is important that limestone sources be close to the processing plant. This is because owing to large contribution in the raw material content, bulk transportation cost will form a major factor in determining cost of cement. To minimize unit cost of the finished product, the location of the plant should be convenient enough relative to the source of limestone. In the proposed project, limestone will be obtained onsite which is most convenient.

10.2.2 Infrastructure

Close proximity to developed infrastructure such as good road network, railway line, and adequate sources of electricity and availability of water for industrial use (cooling) is also a key factor determining choice of site for a cement plant. The proposed project site is located close to a tarmac road, linkage to a railway line is available at Mombasa only 45 km away, a 33KV electrical line is on site and water is also available on site from existing boreholes.

10.2.3 Water supply

The Cement plant uses large quantities of water as a coolant and for dust suppression. The plant therefore must be located where a dependable supply of water is available.

10.2.4 Power supply

Electrical supply requirement is a basic requirement for the production of cement. For the proposed project, a 33KV electrical line is on site.

10.2.5 Transportation consideration

Availability of a good transport network in one of the requirement for consideration when locating a cement industry. As a general rule, it is most economical to have the plant located where there is a well-established transport network this need is met for the proposed expansion.

10.2.6 Markets

The project site is linked to Mombasa, a vital Coastal county. A large fraction of the cement produced in the country is consumed in Mombasa. Mombasa is also well connected to other local towns and neighbouring countries by both road and railway. Therefore, the proposed cement plant will be well linked to markets for its products.

10.2.7 Availability of land

A cement plant requires a large area of land in order to effectively accommodate its different operations. This need is met for the proposed expansion.

10.2.8 Location of other cement plants

Mombasa Cement Limited proposes to expand an existing cement production factory. Bamburi Cement Company, one of the leading producers of cement in Kenya is located in Mombasa. One of Bamburi Cement’s quarries lies only 10 km away from the project site. Athi River mining, another cement producer, is situated at Kaloleni, some 40km north-west of Mombasa. Therefore, cement production is not new in the locality of the proposed project area.

10.3 Technology alternatives

Alternative technologies in the proposed project can be discussed in terms of:

- ✓ The main process route for the manufacture of cement
- ✓ The choice of kiln for making clinker

10.3.1 The process route

Mombasa Cement Limited Vipingo employs the dry process of cement production where the raw materials are ground to raw meal in the form of a flowable powder. The dry raw meal which is first sent into the raw mill silo for blending is then extracted from blending silo and fed to the preheater with pre-calciner for pre-heating before it is fed into the rotary kiln for clinkerization.. After the clinker emerges from the kiln it is cooled before adding gypsum and pozzolana in readiness to grind them to produce cement. The blended mixture is then fed into a cement mill and is crushed into the fine powder cement. The cement is stored in cement silo from where it discharged for packaging.

Other alternative process routes for manufacture of cement: - semi-dry, wet and semi-wet processes.

- ✓ In the semi-dry process, dry raw meal is pelletized with water and fed into a grate pre-heater in front of the kiln or into a long kiln equipped with crosses.
- ✓ In the wet process, the raw materials (often with high moisture content) are ground in water to form a pumpable slurry. The slurry is either fed directly into the kiln or first to a slurry dryer.
- ✓ In the semi-wet process, the slurry is first dewatered in filter presses. The filter cake is either extruded into pellets and fed to a grate pre-heater or fed directly to a filter cake dryer for raw meal production.

These alternative processes are more energy consuming, and thus more expensive comparative to the dry process route..

10.3.2 Similarities of all the four process routes

All the cement production processes have the following sub-processes in common:

- ✓ Winning of raw materials
- ✓ Raw materials storage and preparation
- ✓ Fuels storage and preparation
- ✓ Clinker burning
- ✓ Cement grinding and storage
- ✓ Packing and dispatch

10.3.3 Why the Dry Process Route is preferred

Mombasa Cement Limited opted for the dry process route for making clinker and cement in the proposed project for three reasons. These are:

- ✓ The production will be based on dry processes due to the availability of dry raw materials. Plants using wet or semi wet processes normally only have access to moist raw materials
- ✓ Semi-dry, semi-wet and wet processes are more energy consuming, compared to dry processes
- ✓ Plants using semi dry processes are likely to change to dry technologies whenever expansion or major improvement is required

10.4 Choice of kiln for making clinker

Cement kilns are used for the pyro-processing stage of manufacture of Portland cement, in which calcium carbonate reacts with silica-bearing minerals to form a mixture of calcium silicates. Cement kilns are the heart of this production process: their capacity usually defines the capacity of the cement plant.

A typical process of manufacture consists of three stages:

- Grinding a mixture of limestone and clay or shale to make a fine "raw mix";
- Heating the raw mix to sintering temperature (up to 1450 °C) in a cement kiln;
- Grinding the resulting clinker to make cement.

In the second stage, the raw mix is fed into the kiln and gradually heated by contact with the hot gases from combustion of the kiln fuel.

In broad terms, there are two types of kilns for making clinker. These are;

- Rotary Kilns
- Vertical shaft Kilns

10.4.1 The rotary kiln

The rotary kiln consists of a tube made from steel plate, and lined with firebrick. The tube slopes slightly (1–4°) and slowly rotates on its axis at between 30 and 250 revolutions per hour. Raw mix is fed in at the upper end, and the rotation of the kiln causes it gradually to move downhill to the other end of the kiln. At the other end fuel, in the form of gas, oil, or pulverized solid fuel, is blown in through the "burner pipe", producing a large concentric flame in the lower part of the kiln tube. As material moves under the flame, it reaches its peak temperature, before dropping out of the kiln tube into the cooler. Air is drawn first through the cooler and then through the kiln for combustion of the fuel. In the cooler the air is heated by the cooling clinker, so that it may be 400 to 800 °C before it enters the kiln, thus causing intense and rapid combustion of the fuel.

Salient features of this type of kiln are:

- ✓ They have been in use since 1895
- ✓ They have become a central part of all modern clinker producing installations
- ✓ They are of various improved forms, allowing much room for appropriate choice to be made

10.4.2 Vertical shaft Kilns

The Vertical Shaft Kiln or VSK is the first type of kiln that was used and it can be traced back to the 5th century A.C. in Greece, when they were used for limestone calcining (Reiter, AC, 11/1997, p. 23). In the 20th century, they have been largely replaced by rotary kilns, which were implemented for the first time in 1885.

10.4.3 The Pros and Cons of the two types of Kilns

Rotary Kiln	**Vertical Shaft Kiln**
Pros	*Pros*
High quality and uniform cement production	Lower initial investment
Low production costs	
Less environmental pollution due to optimized combustion	
Low heat consumption	
Reduced number of personnel	

Low percentage of free lime	
Possibility of using alternative fuels	
Dynamic production process since the material is always agitated	
Cons	*Cons*
Higher initial investment	Low-grade cement unsuitable for large structures or infrastructure such as bridges, airports, etc. inappropriate for export
	High production costs
	High environmental pollution and difficult to adapt to modern dedusting systems
	Higher heat consumption and therefore higher fuel costs
	More personnel needed
	Higher percentage of free lime
	Unable to use alternative fuels such as waste

Of the two types, Mombasa Cement Limited has chosen to use a rotary horizontal kiln.

10.5 Raw material source alternatives

The main raw materials of Mombasa Cement Limited Vipingo, coral limestone is quarried close to the factory. The coral lime stone is transported by dumper trucks to the crushing plant. Other raw material for cement production is pozzolana and gypsum which are added in little quantities compared to limestone. Gypsum required is importanted from Oman through the port of Mombasa while pozzolana is sourced from Athi River and Kajiado areas.

10.6 Raw material sources and alternatives

The raw material used for the production of clinker at Mombasa Cement Limited is coral limestone and clays mainly shale and iron ore. The limestone to be used will be sourced from site where the plant will be located. Alternative Sources of limestone that can be used include from Eastern parts of Kenya including Kitui area and the Rift valley area including West Porkot areas. These alternative sources will be far away from the location of the plant and hence will result in very high costs in raw material transportation costs. Mombasa Cement Limited prefers uses coral limestone because it is found in bulk onsite. This makes clinker production cost effective.

10.7 Proffered additives clays and alternatives

Shale and iron ore are used by MCL as an additive for its clinker production. The Shale and iron ore are to be sourced from Vyambani area and Jaribuni areas respectively of Kilifi County, the source areas are relatively close to the location of the plant. Alternative areas of shale and iron ore include Mwatate areas for iron ore which could be far from the site which will increase cost of transportation to the plant.

10.8 Preferred fuel and alternatives

MCl will use coal as the primary fuel for firing the kiln for clinker burning. This coal will be imported as is the case currently. Alternative fuels that can be used in clinker burning include petroleum coke, heavy fuel oil, natural gas, landfill off-gas and oil refinery flare gas.

11. OCCUPATIONAL SAFETY AND HEALTH

11.1 Introduction

Occupational Safety and Health (OSH) is of paramount importance in all working environment, in this case operations of MCL Vipingo. It is always important for mechanisms to be put in place to predict potential risks, incidents and hazards in the said working environment. This is because the occupational environment directly affects employees involved in operations, the neighbourhood, visitors, contractors, sub-contractors and the general public. Therefore during the operation of all activities of MCL Vipingo, a number of safety measures have are in place to ensure the safety of employees, neighbour s and the general public. Employees and visitors to the departments may be exposed to a variety of personal health and safety risks. The type and level of exposure is generally related to factors controlled by the employer. Such factors include design, equipment, tools, work procedures, and employee training. Occupational health and safety risks that must be considered by the employer arise from normal functions and operations and during unusual circumstances such as accidents and incidents.

MCL Vipingo is responsible for OSH requirements at the proposed expansion of the clinker and cement production plant and all associated facilities. The company has to put in place required OHS measures that include the following:-

- Implementation of appropriate national and internal recognised OSH standards, codes and guidelines.
- Inclusion of meaningful participation of employees in implementation and maintenance of procedures and processes.
- Implementation of a programme to change employee involved in operation culture and altitudes regarding health and safety.
- Planning, implementing and monitoring programs and systems required to ensure OSH at the workplace.
- Maintenance at workplaces, equipment, tools and machinery and organise work so as to eliminate or control hazardous ambient work factors.
- Provision of adequate personal protective equipments to all employees at no cost to employees.

- Recording and reporting of occupational injuries and illness to the Directorate of Occupational Safety and Health.

MCL Vipingo will have to develop and documented an elaborate Occupational Health and Safety Policy. The policy will seek to ensure that the workplace is safe and that workers are protected against accidents and injuries. Some of the features to be captured in the policy may include work safety procedures, machines safety, chemical safety, use of personal protective equipments, reporting of injuries, accidents, alcohol and drug use at the workplace, housekeeping practices safety committee and safety training and safe work practices.

11.2 Employee safety

In addressing requirements and needs to ensure employee safety, the following will need to be addressed: -

- ✓ Provision of adequate personal protective equipment.
- ✓ Servicing of plant and equipment as per manufacturer's specification and schedule.
- ✓ Hiring of experienced and competent plant and equipment operators.
- ✓ Continues training of employees on emerging technologies relevant to the operations of the company.
- ✓ Provision of appropriate welfare facilities to the workers.
- ✓ Putting measures in place to minimise noise, dust and other emission to the stipulated legal limits.
- ✓ Pre- medical examinations for new employees before hiring them and annual medical examination thereafter to tract employee health.

11.3 Machine Use and Electrical Safety

Machinery and equipment for the proposed expansion will include, hoppers, conveyors, bucket elevators, pumps, such as lubricating pumps, pre-jacking pumps, axial guide pump, electric motors, clinker burning and cement grinding equipment such as rotary kiln, ball mill and roll press, lifting equipments such as forklift truck, overhead travelling electric cranes, chain blocks, hydraulic cylinder jacks and bucket excavators, air receivers, electrical equipments such as welding machines, cutting machines, electrical generators

In regard to electrical safety, the following should be observed

- ✓ All lifting equipments and pressure vessels to always undergone statutory examination and certification by a registered OSH Inspector before use.
- ✓ Installation and fitting of proper electrical system to enable supply of electrical energy to utility point.
- ✓ All electrical installations and fittings to be done according to electrical safety rules.
- ✓ All electrical wires to be appropriately and safely insulated
- ✓ Sockets and other electrical outlets must be securely fitted
- ✓ Appliances to be properly earthed

11,4 Chemical safety

MCL will operate a laboratory where the quality of the various raw materials to be used will be tested and the quality of the products will be monitored. In doing this some chemical reactions may be necessitated that will require the use of acids and bases. To address the requirement of chemical safety for the users of the laboratory chemicals the following will be necessary.

- ✓ Hire trained and experienced chemists to man the laboratory.
- ✓ Provide appropriate laboratory equipment necessary for the required chemical reactions
- ✓ Provided appropriate laboratory reagents in required concentrations.
- ✓ Provide appropriate laboratory first aid equipment including eye wash station
- ✓ Ensure every reagent used has the appropriate Material Safety Data Sheets (MSDS) available.

11.5 Fire Safety

With regard to fire safety at the workplace, the following among others will have to be taken into consideration; emergency exits, housekeeping, fire fighting appliances, fire detection system, fire audit, emergency evacuation procedures, ventilation and overcrowding.

- ✓ Appropriate fire exits to be provided in all sections and be appropriately labelled.
- ✓ Sound housekeeping practices to be embraced and upheld at all times.
- ✓ Appropriate fire warning system to be installed.
- ✓ Appropriate serviceable fire fighting appliances to be installed.

- ✓ A fire marshal team to be trained and appropriately equipped.
- ✓ Ventilation at the workplace to be sufficient.
- ✓ No overcrowding at any workstation.
- ✓ Safe passages to be provided for.
- ✓ Appropriate signage to be displayed.

12. STAKEHOLDERS CONSULTATION

Consultation with stakeholders that are likely to be affected and those that are likely to have an interest in the proposed project was conducted as provided for in Regulation 17 of the Environmental (Impact Assessment and Audit) Regulations, 2003. The consultation was vital and served to:-

- Inform local community especially those drawn from the proposed project site of the proposed development within their locality.
- Explain to the local community the nature of the proposed project, its objectives and scope.
- Give local community especially those drawn from the proposed project site an opportunity to present their views, concerns and issues regarding the proposed.
- Obtain suggestions from the local community and other stakeholders on possible ways potential negative impacts can be effectively mitigated and how the local community can be part of the proposed project.

The consultation was twofold, namely;

- Questionnaire survey
- Public Baraza

12.1 Questionnaire survey

A detailed questionnaire survey was carried out that targeted to reach out to primary stakeholders at the grass root. This included political leaders, local administration, community based organizations, local learning institutions, local faith based institutions, local medical institutions, opinion leaders and business community (appendix 13).

12.1.1 Questionnaire Survey for Political Leaders

One political leader Hon. Muhambi G. Kahindi –M.C.A Mnarani Ward, Kilifi County respondent to the questionnaire. The following is a summary of his responses.

Economic activities & livelihood of the catchment area of the proposed project include the following.

- ✓ Quarrying
- ✓ Fishing
- ✓ Small scale trading
- ✓ Coconut production
- ✓ Selling of firewood
- ✓ Commercial farming

Issues of concern regarding the proposed expansion of MCL are:-

- ✓ Employment opportunities should be prioritized for the local people from within the area when the project is implemented.
- ✓ Local people to be employed on merit.
- ✓ Top Management should inculcate sound managerial skills and good public relationships with co-workers while eliminating a culture of looking down on others.
- ✓ The workers to the proposed project should be given proper tools and equipment for the assigned jobs.

Expected positive impacts from the proposed expansion if undertaken may include:-

- ✓ It will create employment opportunities.
- ✓ It will foster infrastructural development like road construction.
- ✓ The people's lifestyle will be improved.
- ✓ Insecurity problem in the area will decline.
- ✓ Corporate social responsibility from MCL is expected to be scaled up.

Expected negative impacts

- ✓ Dust emission.
- ✓ The crop production will be affected if environmental sanity is not observed.
- ✓ The proposed project will affect the community's grazing grounds hence the impact on livestock production in the area.
- ✓ People's health shall be affected as a result of the industrial production process.
- ✓ Small scale quarry miners will lose out their livelihood.

Suggestions in regard to the proposed development

- ✓ The project implementers should observe all the environmental laws to the latter.
- ✓ The management should observe all the labour laws
- ✓ The local people should be given a priority when it comes to opportunities that may arise like employment

- ✓ A culture of co-existence and good relationship between the investors and community around should be cultivated.

Recommendations on the proposed development project

- ✓ The project should be implemented.
- ✓ The local people should be considered for the employment opportunities that shall arise when the project implementation is initiated.
- ✓ The organized women and youth groups should be facilitated in various ways so as to develop themselves.
- ✓ The areas bordering the beach/ocean should be reserved i.e. should not be developed.
- ✓ Roads/paths passing-by schools should be tarmacked.
- ✓ The company should invest more in infrastructural development of the area like road construction and borehole construction.

12.1.2 Questionnaire survey for local administrative leaders

Six administrators from two locations and their sub-locations responded to the questionnaire. These were:-

- ➢ Raphael B. Karisa-Mavueni/Takaungu Area Sr. Chief
- ➢ David Kahindi -Junju Location Chief
- ➢ Anzazi C. Charo -Takaungu Sub-Location Sr. Asst. Chief
- ➢ NgalaChome –Mkomani/Mkwajuni Asst. Chief
- ➢ Joseph ChengoNdurya -Kiriba/Wangwana Sub-Location
- ➢ RunyaMwalimuRunya -Kuruwitu (Junju) Sub-Location

The following is a summary of their responses.

Economic activities & livelihood of the area include:-

- ✓ Farming
- ✓ Livestock keeping
- ✓ Commercial/Trading/Business activities
- ✓ Fishing
- ✓ General labour as casuals or permanent employment
- ✓ Tapping of wine (Mnazi)
- ✓ Home craft –weaving/basketry with makuti

Issues & concerns regarding the proposed expansion project

- ✓ Environmental degradation due to air pollution.
- ✓ Dust pollution.
- ✓ Land issues
- ✓ The insecurity problem will be addressed as more idle persons will absorbed in the company operations.
- ✓ The project may result in employment creation
- ✓ The project implementation will be able to address the un employment problem within the region priority being given to the natives**.**
- ✓ The project implementers should respect the people and their socio-cultural diversities and practices

Expected positive include:-

- ✓ The proposed project is bound to create employment opportunities for people in the area.
- ✓ The living standards of the people will be improved since more people will get employment that will translate to good life for those employed and their dependants.
- ✓ The raw material that is sourced from the area like Vyambani area will have an immediate market.

Expected negative impacts may include:-

- ✓ Increased air pollution from dust
- ✓ The health of the people will generally deteriorate as a result of the dust emitted to the environment.
- ✓ Ecological set up of the area shall be disturbed.
- ✓ There will general environmental degradation.

Suggestions in regard to the proposed development

- ✓ The project is good because it is an investment and therefore it should be implemented.
- ✓ The proposed project is good as it will create employment to the community and also result to increased revenue for both the County and National Governments and thus improved economy.
- ✓ The project implementation should not discriminate any region or area within the project catchment area but should ensure it benefits everyone especially when they are giving back to the society

- ✓ Plant Casuarina /neem trees along the fence and the areas where the company is harvesting limestone/corals to curb the dust problem.
- ✓ Rehabilitate all the quarries after their usefulness.
- ✓ The company should put cabros or tarmac the quarry roads to minimize dust into the air.
- ✓ Respect local people despite their social standing in the society.
- ✓ Respect the cultural practices of the local people like gods-‘MIZIMU’ and ‘KAYAs’ and other ancestral beliefs.

Recommendations on the proposed development project

- ✓ The proposed project should be implemented but the management should observe all environmental laws and best conservation practices.
- ✓ The company should employ local people.
- ✓ The youths within the project catchment areas should be given first priority whenever the job opportunities arise.
- ✓ Quarry rehabilitation to be undertaken.
- ✓ Put proper mechanism to curb the dust.
- ✓ Plant trees like neem and Casuarinas to aid in curbing the dust .
- ✓ The company should also ensure that the road network in the neighbourhood is taken care and not just some few ‘reserved’ roads in Takaungu area.
- ✓ Corporate Social Responsibility to be scaled up.
- ✓ The company should enhance their relationship with the local community

12.1.3 Questionnaire survey for learning institutions

The following learning institutions respondent to the questionnaire

- ✓ Mkwajuni Youth Polytechnic
- ✓ Bahari Girls National School
- ✓ Kilifi High Vision Secondary School
- ✓ Takaungu Secondary School
- ✓ Mnarani Secondary School
- ✓ Dindiri Secondary School
- ✓ Takaungu Primary School

- ✓ Mavueni Primary School
- ✓ Mkomani Primary School
- ✓ Kadzinuni Primary School
- ✓ Vuma Primary School
- ✓ Mkwajuni Primary School
- ✓ ShauriMoyo Primary School
- ✓ Kapecha Primary School
- ✓ Dindiri Primary School
- ✓ Kiriba Primary School
- ✓ Kaole Primary School
- ✓ Makata Primary School
- ✓ Madrasa-TulAnswarIsamiya

Economic activities & livelihood of the area

- ✓ Commerce/trade (small scale/micro-businesses)
- ✓ Fishing
- ✓ Crop production -both cash crop e.g. sisal as a cash crop and subsistence crop production for crops like maize, cassava coconuts and vegetables.
- ✓ Animal keeping.
- ✓ Quarrying and block making
- ✓ Transport service e.g. bodaboda operations
- ✓ Employment in government and firms/farms around like sisal plantations.
- ✓ Tapping palm wine.
- ✓ Handcraft industry.

Issues & concerns regarding the proposed expansion project

- ✓ Environmental pollution e.g. air pollution, water pollution, noise pollution and soil pollution.
- ✓ Land degradation.
- ✓ Stunted growth of vegetation due dust.
- ✓ Land ownership rights and conflict between the company and the locals.

- ✓ Displacement of persons leaving them as squatters and new places to resettle displaced individuals may not be readily available.
- ✓ The expansion is likely to increase the pollution rate because of heavy machines to be involved.
- ✓ Decline in agricultural production since agriculture needs large tracts of land to support the existing population which will be taken by the company in terms of raw material sourcing as well as quarrying for the farms they have acquired.
- ✓ Lack of grazing lands.
- ✓ Increased motor vehicular operations on the road leading to traffic jams and accidents.
- ✓ The land which has been lying fallow because of its unsuitability for farming shall be put into use.
- ✓ The health of the people shall be affected.
- ✓ The proposed project may increase volatile relationship between the company and community especially on the alleged unhealthy impacts that may emanate from the wastes from the plant construction and operation on the living and non-living things.

Expected positive

- ✓ The project will create a lot of employment opportunities for people.
- ✓ The insecurity problem will scale down since the idle people will be busy as most of them will be absorbed in the cement production activities and the company will enhance its security system in the area.
- ✓ The raw material that is sourced from the area like Vyambani area will have an immediate market.
- ✓ The local production of cement from near the source of the raw material is bound to incur fewer expenses hence the price of the final product is bound to reduce.
- ✓ The proposed project is likely to improve the economic standards of the area and the regions as a whole since the areas around have very few companies/factories hence the poverty level will be highly reduced.
- ✓ The company and in partnership with other parties will aid in infrastructural development such as schools, hospitals, roads and water provisions and thus opening up the area for more development.

- ✓ The project is likely bound to create competition in the working sector.
- ✓ The project when implemented is likely to spur other business opportunities in the area.
- ✓ The project if implemented will uplift the living standards of the people.
- ✓ The social amenities in the area will be improved.
- ✓ Individual talents will be developed.
- ✓ Increased cement production will translate to more funding to facilities in the area like schools, health facilities and other social centres within and outside the community as the company has been always doing through its corporate social responsibility obligations.
- ✓ The implementation of the proposed project will translate to more revenue to the County Government and the county's economy as a whole.
- ✓ The company is likely to promote education, health, technology, business among others through its awareness program or in partnership.

Expected negative impacts

- ✓ Dust emanating from the cement production and motor vehicle movement will affect the residents and their neighbourhood.
- ✓ Increased motor vehicular operations in the area are likely to disrupt learning in institutions in the area.
- ✓ Stunted plants/vegetation or death of plants and crops.
- ✓ Crop failure which will affect the livelihood of the people.
- ✓ The expansion is likely to increase the pollution rate because of heavy machines to be involved.
- ✓ The proposed plant will require a lot of raw material which means a lot of land shall be acquired to sustain the company's production hence loss of agricultural lands for grazing and cultivation.
- ✓ The people's health shall be affected due to dust and environmental pollutione.g. increased diseases and their related problems among the people and in the environment.
- ✓ There will be general environmental degradation.
- ✓ The proposed project is likely to increase injuries and accidents to the people involved in the construction of the proposed expansion project, those during the operation and neighbours especially when there is increased motor vehicular operation in the area.

Suggestions in regard to the proposed development

- ✓ An amicable solution should be reached out between the company and locals on the land ownership to avoid future conflicts while creating a peaceful co-existence.
- ✓ The proposed project is a well thought plan which if implemented will create employment opportunities while at the same time addressing the insecurity problems in the neighbourhood.
- ✓ The planned project is a nice development project which if the management numerate the workers well will eradicate poverty in the area given the massive job opportunities that will be on offer.
- ✓ The proposed expansion project should be implemented but bearing in mind the negative effects and their solutions.
- ✓ The quarries created to support the proposed project should be environmentally safe and after their lifespan, they should be rehabilitated to productive state.
- ✓ The company and community around should cultivate a mutual understanding to avoid wrangles/conflicts which hamper the progress of the parties involved.
- ✓ The company should develop more institution in the area of the Mtwapa Complex caliber which the company has heavily invested in.

Recommendations on the proposed development project

- ✓ The company should go ahead with the proposed development project which will drastically reduce the poverty level of the area e.g. through the employment opportunities.
- ✓ The company should put in place a management that will be able to address the company's needs, provide a conducive working environment for workers e.g. by remunerating them well and the neighbouring communities' needs.
- ✓ The company should instill sound environmental measures in the cement production to protect the environment and the health of the people e.g. use of dust arrestors and fixing machines with sound silencers.
- ✓ The quarries created to support the proposed project should be environmentally safe and after their lifespan, they should be rehabilitated to productive state.

- ✓ The company should always consider the local community first whenever the opportunities arise like job opportunities before outsourcing to aid in building the community and enhancing the interrelationship.
- ✓ The company should support the children within the neighbourhood with bursaries that they may later benefit from the opportunities that will be available on from the company as well as enhancing good relationship/co-existence.
- ✓ The management of the company through the directors should support the development of local facilities like schools and health centres with building materials and other need tools and equipment.
- ✓ The company should put up a health facility to meet the needs of the workers as well as the neighbours who will be affected by the company's operations.
- ✓ The company should develop and or enhance a tree planting program especially on roads used by the company trucks to minimize dust to the atmosphere.
- ✓ Put road and safety signs as well as constructing road bumps especially near learning institutions and public areas like market centres for drivers to observe.
- ✓ Protect the rights of the local community.
- ✓ The company should develop modern rental houses to house staff and other interested persons.
- ✓ The corporate social responsibility should be an obligation of the company it is highly investing especially in matters of education that is more valuable to the community members.

12.1.4 Questionnaire Survey For Health/Medical Institution

The following medical institutions responded to the questionnaire.

- ✓ Kadzinuni Dispensary
- ✓ Rayman Medical Clinic
- ✓ Takaungu Dispensary

Economic activities & livelihood of the area

- ✓ Farming
- ✓ Fishing
- ✓ Small scale businesses

- ✓ Transportation –bodaboda
- ✓ Employment in public and private sectors
- ✓ Mining –Excavation of coral blocks
- ✓ Casual and labourers/wages

Issues & concerns regarding the proposed expansion project

- ✓ The proposed project is likely to result into rapid environmental degradation and exhaustion of natural resources where the materials originate.
- ✓ Eruption of air borne illness as a result of flue gases and heavy dust that will be emanating from the ever busy cement factories.
- ✓ Poor agricultural production due to air pollution –Crops will not be productive as before due to dusty environment which will affect respiration and the processes of photosynthesis.
- ✓ Insecurity and licentious activities are likely to increase as more people flock Takaungu area to seek employment and when they thus fail to secure the jobs they might turn to be thieves, conmen as well as prostitutes.
- ✓ Land and general environmental pollution may likely result if no proper waste disposal mechanisms are instituted e.g. disposal solid and liquid wastes.
- ✓ Pressure on the existing infrastructural and social amenities when more people come in the area.
- ✓ Accidents and injuries may increase in the area when the proposed project is inaugurated.
- ✓ The local community may loose their only grazing grounds in the area.

Expected positive

- ✓ The proposed project will increase employment opportunities in the area.
- ✓ The area will witness a lot of infrastructural developments to meet the needs of increased population and thus the growth of the trading centres into urban areas.
- ✓ The proposed project will facilitate the growth of new business opportunities in the area e.g. saloons, cybercafé, mini to supermarkets in the area to meet the available demands of the population and thus the economic development of the area.
- ✓ The living standards of the people will generally improve.
- ✓ The means of transport in the area will generally improve to meet desires of the diverse community.

Expected negative impacts

- ✓ There is likelihood of environmental degradation as a result of pollution.
- ✓ The people's health is likely to deteriorate given that the negative resultants are not checked.
- ✓ The cement production process is likely to result into poor agricultural production as the dust generated may hinder the plants growth.
- ✓ The project is likely to have impacts on the livestock and marine life.
- ✓ The project is likely to cause landlessness in the community especially around the proposed project.
- ✓ The community is likely to loose the grazing grounds.
- ✓ The proposed project is likely to increase accidents and injuries in the area.
- ✓ Overpopulation due to influx of the job seekers and other clientele may way down on the existing infrastructural and social amenities.

Suggestions in regard to the proposed development

- ✓ The company should carry out periodic monitoring and evaluation on the negative effects.
- ✓ The management should instill proper mechanism to address the negative impacts that may occur.
- ✓ The local community should be among the key beneficiaries of the proposed project.
- ✓ The factory management should work hand in hand with all the line agencies/ministries.
- ✓ The returns of the proposed project should not at the expense of human sufferings.
- ✓ The management should ensure good compensation is made for any land that may be taken from the community.

Recommendations on the proposed development project

- ✓ The management should implement the project but must ensure all health and safety issues are addressed.
- ✓ The company should assist the surrounding stakeholders especially the health facilities when necessary.

12.1.5 Questionnaire Survey for Faith Based/Religious Institution

The following faith based institutions responded to the questionnaire.

- ✓ Vuma Gospel Centre
- ✓ Viungani P.E.F.A Church
- ✓ Mwakujuni Mosque –Masjid Safina
- ✓ Mkomani –Masjid Hudaa
- ✓ Mavueni/Gongoni Mosque -Masjid Alikhlasi
- ✓ Kibaoni/Takaungu –Masjid Jalal

Economic activities & livelihood of the area

- ✓ Wine tapping
- ✓ Livestock keeping
- ✓ Fishing
- ✓ Quarrying & stone harvesting
- ✓ Employment in both the public and private sector
- ✓ Crop production
- ✓ Commercial/Trading/businesses.
- ✓ Transport industry –bodaboda services

Issues & concerns regarding the proposed expansion project

- ✓ The project is likely to have detrimental impacts on the health of the people, animals, plants like coconuts & cashew nuts that are the people's lifeline and the general environment.
- ✓ Fraud and corruption should be curbed during employment of workers to the proposed project.
- ✓ The company should institute special programs to benefit the local during the lifespan of the project.
- ✓ There project developers should localize Takaungu area as the first beneficiaries of the proposed project.
- ✓ Cement production is prone to cause flue gases and dust which have detrimental impacts on the people's health.

Expected positive

- ✓ The proposed project is likely to increase the job opportunities in the area which will thus greatly reduce vices in the community.
- ✓ The people will be able to earn a livelihood especially the landlords to be and those coming to do business to meet increased population's needs.
- ✓ The proposed project will generally improve the infrastructures like hospitals & schools and the social amenities in the area.
- ✓ The raw materials will be sourced locally which will translate to low prices to end product hence making the construction industry an economical venture.
- ✓ The area and its neighbourhood will drastically develop.
- ✓ There is an anticipation of improved security around the areas of the proposed plants.

Expected negative impacts

- ✓ The people employee in the proposed project may have retrogressive characters that may be injurious to the social-economic set up of the local.
- ✓ The project may likely have detrimental impacts on the environment especially through air pollution and heating of coal will accelerate the global warming effects.
- ✓ The people's health will be affected by the flue gases and dust generated during the operation of the proposed project.
- ✓ Uncontrolled dust generation will affect crop production of the area hence livelihoods of the people will be affected.

Suggestions in regard to the proposed development

- ✓ The proposed project is good and should be implemented but the developer ought to install dust & flue gas arrestors in the cement production processes to eradicate/minimize their impacts on the health of the people, animal and plant life.
- ✓ The company should institute proper waste disposal mechanism during the project's life.
- ✓ The company should support the religious institutions with infrastructural services.
- ✓ The company should also aim to enhance the economic status of the area especially by giving the youth from the local community priority in terms of employment.

- ✓ The company should foster a good relationship between the management, workers and the local community.

Recommendations on the proposed development project

- ✓ The investor has to control the dust emission not to affect the health of the people, plants and crops.
- ✓ The local community should be given priority whenever opportunities arise during the life of the project.
- ✓ The wages and salaries should be reasonable and in line with the living standards of the period and not the ones that demean an individual/employee.
- ✓ The company management should ensure favourism and other malpractices like corruption and fraud while taking workers on board are not condoned.
- ✓ The company should assist the surrounding stakeholders by developing the infrastructures in the arealike road networks, health and educational facilities to help meet the people’s desired services reliably.
- ✓ There should be frequent consultations with stakeholders whenever new developments arise.
- ✓ The relevant agencies should ensure that enough security is provided as people from other areas are expected to flock the area while local youths should be absorbed in the company to avoid causing mayhem in the community.
- ✓ The company should extend its corporate social responsibilities to religious institutions within the areas around the project area.
- ✓ The project should be implemented as fast as possible and shouldn’t be a gimmick as we have seen other proposed projects but the first beneficiaries should be the local community and the people around Vipingo area.

12.1.6 Questionnaire Survey for Organized Group

The following groups responded to the questionnaire.

- ✓ Takaungu Beach Management Unit
- ✓ Timboni Youth
- ✓ Madeteni Youth

- ✓ Kadzinuni youth
- ✓ Uzinduzi Youth Bunge
- ✓ Vindakala Youth Bunge
- ✓ Mtamboni Youth Bunge
- ✓ MkwajuniTumaini Women Group
- ✓ KayandaTupendane Widows Women Group
- ✓ MaendeleoGiriama Dance
- ✓ KayandaMaendeleo Group
- ✓ KayandaNeema Women Group
- ✓ UpendoMkwajuni Women Group
- ✓ Takaungu Orphans &Venerable Women Group
- ✓ Afya Bora Takaungu Group

Economic activities & livelihood of the area

- ✓ Fishing
- ✓ Commercials/Trading/Business
- ✓ Farming
- ✓ Livestock keeping
- ✓ Tapping & selling of coconut wine
- ✓ Selling of firewood
- ✓ Charcoal burning & selling

Issues & concerns regarding the proposed expansion project

- ✓ The security of the area
- ✓ The likelihood of diseases occurrence when the project is implemented and other cement related impacts which will affect the human, animal and plant life.
- ✓ The agricultural production has gone down due to dust emanating from the cement factory processes and the expansion program means increased impact on the food production.
- ✓ Mistreatment of workers and looking down upon the local community.
- ✓ The proposed project should not be implemented because the company owners are not trustworthy for many people are suffering while the company is reaping handsomely.

- ✓ The company will take up our grazing and agricultural lands.
- ✓ The people will be rendered landless if the proposed project is implemented.
- ✓ The people's businesses may be interfered with.

Expected positive

- ✓ The company is bound to increase the production of cement to the owner while at the same time generating job opportunities for the people.
- ✓ The lifestyle of the people will be improved.
- ✓ The inhabitants will have a various means of earning a livelihood i.e. more businesses opportunities in the area.
- ✓ The proposed project is likely to scale down insecurity problem.
- ✓ There will be general development of the area.
- ✓ There is bound to be increased support for the needy in the society.
- ✓ The community around will be recognized as well as respected.
- ✓ The community around shall be given the first priority in every opportunity that arises.

Expected negative impacts

- ✓ The project is bound to impacts on the people's health like increased respiratory diseases.
- ✓ The plant and animal life shall be affected due dust and flue gases from the company processes.
- ✓ The project shall cause landlessness.
- ✓ The proposed project shall cause a deficit in food production.
- ✓ The community grazing land shall be taken away.

Suggestions in regard to the proposed development

- ✓ The company should be at the forefront of protecting the human and animal environment.
- ✓ The company should ensure that pollution and any form of leakages to environment are scaled down to habitable stateso no life is lost or damage to property occurs.
- ✓ The company should invest more in infrastructural and social facilities within the area like hospitals, schools and recreational centres.
- ✓ The food for hunger alleviation should be scaled up.

- ✓ The machine cut blocks by the company should also be sold to the local community at affordable prices for them to use in construction.
- ✓ Proper mechanisms should be instituted by the company to protect schools/learning institutions from the dust generated by the company trucks while plying on roads near of these facilities.
- ✓ The people, their culture and practices should be respected.
- ✓ The company should support the Youth and Women groups so that they may be economically independent which will also create respect and honour as well as trust in the company.
- ✓ The company should proceed with the proposed project but they should settle the landless individuals first.
- ✓ The company should reserve land for communal grazing.
- ✓ Roads/paths to the oceans should be set aside.
- ✓ The company should establish several health centres that are well equipped with facilities are medical practitioners to monitor the health of the people in and outside the company.
- ✓ There should be respect, good relationship and due care while implementing the proposed project between the company and the locals.
- ✓ The people who were coerced to selling their land against their wishes should be given the land back.

Recommendations on the proposed development project

- ✓ The expansion of the project should be undertaken for the benefit of the Kilifi County Government and its people but the life of the inhabitants should be protected.
- ✓ The proposed project implementers should be skilled and certified personnel.
- ✓ The project should not be implemented unless employment of natives is guaranteed and that a high percentage of the workforce should come from within the County and those to be employed be assured of human treatment by giving/providing them proper working tools/equipment e.g. protective clothing while other stakeholders are protected from the dust menace.
- ✓ The company should ensure that all its waste products are disposed in a clean and health manner so that no animal or human life is lost.

- ✓ The people living near the proposed project especially the youths should be given priority whenever an opportunity arises like employment or investment in a community project.
- ✓ The company should consider subsidizing cement for the locals given the raw materials and its investments are from the surrounding areas.
- ✓ Security should be prioritized on the list of its investment.
- ✓ The management should treat its workforce with dignity.
- ✓ The company should develop a program of addressing some challenges bedeviling the region like education and the escalating poverty levels in the community.
- ✓ Everyone should be employed so that there is no dependency in the community.
- ✓ Those to be employed in the company should be paid well and in accordance to the living standards of the time.
- ✓ There should be communication between the company and the locals whenever a problem arises within the company.
- ✓ We need development in our area hence the proposed project should be implemented.

12.1.7 Questionnaire Survey For Business/Commercial Group/Persons

The following business/commercial ventures responded to the questionnaire.

- ✓ Rea Vipingo Plantations Ltd
- ✓ Padbon Investments Co. Ltd
- ✓ Mama Njenga Farm (KomazaNdogo)
- ✓ MzeeJumaNyale (Nyale Shop & Investment)

Economic activities & livelihood of the area

- ✓ Cash crop farming –Growing and Processing of Sisal.
- ✓ Small scale farming
- ✓ Fishing
- ✓ Livestock keeping
- ✓ Poultry keeping
- ✓ Transport industry –Bodaboda service
- ✓ Employment in both public and private sectors
- ✓ Trade/commercial ventures

Issues & concerns regarding the proposed expansion project

- ✓ Management of dust from the factory is crucial to the environment and the residents in the neighbourhood.
- ✓ The company's lack of official residence with ablution blocks for their employees, seriously inconvenience our workers in the shower blocks/rooms.
- ✓ Proximity to the ocean is a threat to marine life.
- ✓ Vipingo area is turning into a residential area and the added volume of dust and its chemical reaction in a humid environment would not be environmental friendly to humans, crops and livestock.
- ✓ Dust/air pollution is a concern.

Expected positive

- ✓ The proposed project will provide employment to locals as well as to all Kenyans.
- ✓ The cement product will be locally sourced.
- ✓ It will foster development of the areas around the project whereby infrastructural and social amenities will be expanded greatly.
- ✓ There will be ready market for our products as the population will increase.
- ✓ The proposed project will lead to population increase of the area which is key to economic empowerment.

Expected negative impacts

- ✓ Excavation of the earth for the proposed will seriously deplete the top surface soil that is good for agriculture.
- ✓ Dust and Noise pollution are the most expected serious problems which will affect humans, animal and plant in the environment.
- ✓ The proposed project is bound to increase civil evil in the society with the influx of people in thirst of employment.
- ✓ The proposed project is bound to reduce land under agriculture which may lead to food deficiency in the region as well as nation.
- ✓ There is likelihood of accidents and injuries during construction and plant operations.
- ✓ Population increment may lead to overdependence on the few available resources.

- ✓ There will be poor health among the people if the environmental issues are not addressed to satisfaction.

Suggestions in regard to the proposed development

- ✓ They should conserve the environment by reclaiming the already excavated areas by planting trees.
- ✓ They should properly install dust arrestors to avoid polluting the environment with dust.
- ✓ The company should provide an official residence for their workers with well-equipped sanitary facilities to stop inconveniencing the neighbourhood residents.
- ✓ The proposed project should not be carried out at the proposed site but in an area far from residents.
- ✓ The proposed project is good and the owners should implement it.
- ✓ The proposed development is good for the area as it will facilitate development in the area besides improving the lifestyle of the people.

Recommendations on the proposed development project

- ✓ The proposed project is good and the owners should implement it as it's.
- ✓ The proposed project should be implemented but in an isolated location far from a residential area.
- ✓ Ensure the environment is kept clean and healthy for the people and other living and non-living things.
- ✓ The management should consider employing the local people to uplift their living standards.
- ✓ The company should address the dust problem especially when residential estates are being put up to avoid conflict.

12.1.8 Questionnaire Survey For Social Amenities

- ✓ Mazrui Social Hall -Takaungu
- ✓ Trevor Sisson Library –Kadzinuni

Economic activities & livelihood of the area

- ✓ General trading –kiosks, shops and open air markets.

- ✓ Transport sector –bodaboda (motorcycle riding) services.
- ✓ Quarrying and stone harvesting
- ✓ Fishing

Issues & concerns regarding the proposed expansion project

- ✓ Environmental degradation and destruction of the ecosystem of birds and butterflies will occur.
- ✓ There will be increased lawlessness/social vices.
- ✓ There will be increased pressure on the already insufficient social amenities.
- ✓ The project may cause landlessness in the community as some still feel the land shall be divided among them.
- ✓ The proposed project may lead to blockage or closure of access route to the beach/sea shore line.

Expected positive

- ✓ Employment opportunities
- ✓ The proposed project will widen the scope of earning a living.
- ✓ The proposed project will improve the living standards of the people.
- ✓ The project will spur infrastructural development of the area.
- ✓ The project will enhance the security system of the area.

Expected negative impacts

- ✓ The people's health will be affected i.e. lung and skin infections due to dust and flue gases.
- ✓ The residents may be blocked from accessing the shoreline as routes/roads/paths could be closed.
- ✓ The project will lead to emigration of birds, butterflies, small reptilians and mammals due to bush clearance and construction of the plant or as a result on the strain of the ecosystem.
- ✓ Dust generation will affect the flora of the area in terms of flowering hence plant and crop production will be greatly affected.
- ✓ The project will result into noise pollution.

- ✓ The proposed project will be a disaster if it won't benefit the people within the project catchment area.

Suggestions in regard to the proposed development

- ✓ The proposed project should be implemented with a focus of giving the natives the first priority in terms of employment for those who have right qualifications, establishing a bursary scheme to aid bright students/pupils and improving of the social amenities in the region.
- ✓ The project implementers should embark on developing the infrastructures in the area through corporate social responsibilities.
- ✓ The management should develop a reforestation program to accommodate the displaced/disturbed ecosystem for birds and small mammals/reptilians.

Recommendations on the proposed development project

- ✓ The management should have a mechanism of absorbing qualified natives in their workforce e.g. through the local leaders.
- ✓ The company should support established Environmental and other Organized Groups in their Campaigns and Awareness Acts through networking.
- ✓ The company should support the education, health and other establishments with infrastructures and necessary support to meet their needs reliably.
- ✓ The company should work hand in hand with the established institution in enhancing the lives of the people.
- ✓ The company and the relevant authorities should ensure security of the people is paramount on their list for the safe haven of the dwellers and a better Kenya.
- ✓ The company should strive to develop the area around through the proposed project.

12.1.8 Questionnaire Survey For Local Opinion Leaders

The following opinion leaders responded to the questionnaire.

- ✓ Moses M. Tsuma
- ✓ GonaBome
- ✓ Ambrose JohsonNyale
- ✓ MwanajumaAthuman

- ✓ GahahaMunga Chai
- ✓ Johnson Katana Chai (Tumbo)
- ✓ Alfred MsindahNgowa
- ✓ EliusMsukoNyambu
- ✓ Mary NyavulaKomoro
- ✓ Katana Fondo Dena
- ✓ KahindiCharo Katana
- ✓ TumuZiro
- ✓ UbaBangalaYongo
- ✓ Mwalimu Ali
- ✓ HarunNasoro

Economic activities & livelihood of the area

- ✓ Peasant farming e.g. maize, cowpeas and green grams.
- ✓ Small scale businesses
- ✓ Transport industry –Bodaboda service
- ✓ Tourism/Beach boys
- ✓ Employment in both the public and private sector.
- ✓ Fishing
- ✓ Selling of charcoal and firewood
- ✓ Building industry –local structures
- ✓ Local craft industry –use of makuti in the industry.

Issues & concerns regarding the proposed expansion project

- ✓ Dust and flue gases from the factory processes which may result in diseases in the environment.
- ✓ Displacement of people whose land may be used by the company rendering them squatters while at the same time losing their property that may be destroyed in the process without compensation.
- ✓ The land to be used for the proposed project might be agriculturally productive hence loosing a good junk of land to cement production at the expense of ailing the agricultural sector whose result is deficient food production for the people.

- ✓ Pollution of water wells hence making drinking water a more expensive or unhealthy for consumption.
- ✓ The proposed project has more demerits than the merits and going by the already established plant, some of our areas have not seen the benefit of the project being in the area.
- ✓ The working hours and payment for those to be engaged in the proposed work should be in line with the labour laws and wages/salaries in particular should be made against the current living standards.
- ✓ Mombasa cement lorries which ferry the limestone shale from Ngamani always dangerously overload and are driven recklessly: Expansion of the factory must ensure these comes to an end to stop exposing the humankind to a lot of hazards.
- ✓ The issue of poisoning hundreds of livestock for reasons which could have been tackled diplomatically through a simple dialogue with the area residents remains to be a big shame to Mombasa cement and the expansion should not be an addition to more poisoning.
- ✓ The company's contribution to some areas in the catchment area still remains a pipe dream for the community members have waited to see the fruits of the company's investment in the area to no avail.
- ✓ The roads and paths to the beach/ocean may be closed.

Expected positive

- ✓ The proposed project is good for it will foster development in the area.
- ✓ The project will also create employment opportunities for our children.
- ✓ The cement factory products will be easily accessed and at a reduced cost for they will be locally sourced.
- ✓ Social amenities and infrastructures like road, schools and hospitals shall be developed.
- ✓ The proposed project will spur many business opportunities for the people with the region.
- ✓ The project will reduce idleness in the community as people will have work to engage in.

Expected negative impacts

- ✓ The proposed project will cause dust and noise pollution that will affect learning in the nearby schools.
- ✓ The air pollution will cause disease in the environment like TB and lung cancer.
- ✓ Water pollution will make water which is a precious commodity a more expensive need while soil pollution will have impacts on agricultural production.
- ✓ Cement dust will be hazardous to crops, animal and the community around.
- ✓ The proposed project will lead to limited grazing fields for the community's livestock.
- ✓ The project will emit more carbon (flue gases) in the environment leading to air pollution
- ✓ The proposed project will reduced the land under vegetation cover and thus loss of biodiversity.

Suggestions in regard to the proposed development

- ✓ The company should involve experts who are apt on the likely impacts the company may have on the people, property and the environment.
- ✓ The company should enhance donations and sponsorship in the community to improve the infrastructures and social amenities besides giving grants and soft loans to community members for empowerment purposes.
- ✓ The proposed project should be implemented but 'the back to community returns'should be impartially distributed in the whole catchment region of the company.
- ✓ The company should put the local community in perspective in the arising employment opportunities.
- ✓ The management should provide good and efficient working tools/equipment especially the personal proactive equipment for the workers use.
- ✓ The project implementers should involve the local community in every step they take in the implementation of this proposed project and also respect their input.
- ✓ The company should in the long run build a full primary and Secondary school and name it after Mombasa Cement for the community to enjoy the pride of having a factory in the area.
- ✓ The management of the proposed project should know the community supports the proposed idea and working together/in partnership shall make the project a success.

- ✓ The project implementers should build very many health facilities in the area to address the health and environmental problems.

Recommendations on the proposed development project

- ✓ The proprietor should only construct only one plant and not the proposed two plants.
- ✓ The project should be implemented but environmental issues should be critically looked into for the sake and health of the residents i.e. the company should put mechanisms in place to protect and conserve the environment from pollutants.
- ✓ The proposed project should not proceed/ be put on hold for us as a community or as residents have not seen the fruits of it for the company have not even responded on the need of helping our children with bursaries to join institutions of higher learning.
- ✓ The project implementers should involve professionals who have the skill and knowledge in setting up the proposed plants.
- ✓ The project implementers should ensure that locals are given the first opportunity in all the sectors created to coordinate and implement this project.
- ✓ The stakeholders including the chiefs and the local leaders should be respected and recognized as part of the initiators of the proposed project.
- ✓ The management of the proposed project should involve all the local leaders including the ‘Wazee wa NyumbaKumi’ when it is recruiting the staff/labourers to the proposed project.
- ✓ The management should ensure that the remuneration of workers dignifies the workers input.
- ✓ The management must ensure community contribution is applied effectively and conveniently.
- ✓ The management has to ensure it involves the community and stakeholders in matters concerning the community public interests and also every step the company is undertaking.
- ✓ The company/management should hold yearly meetings with the local community to brief them on the challenges and advancements made in relation to the prosperity of the company.

12.2 Public Baraza

Public consultation through public meetings involved carrying out three public meetings within the neighbourhood of the proposed project site. Prior to conducting the public meetings notices to the general public were prepared and posted in strategic locations inviting and informing the public concerning the proposed barazas, the venue, date and time of each baraza.

12.2.1 First public Baraza

The first stakeholder consultative meeting (baraza) was held at the chief's office grounds – Takaungu Location, Kilifi County on 26thnovember 2015. Appendix 14 are detailed minutes of the proceedings of the first baraza.

The following were the main views, issues and concerns that emanated from this meeting:

- The proposed project should only be undertaken if it has fulfilled all the required legal legislations and the demands of the community.
- The company has not lived to its promises it set and agreed with the community before starting any of their operations in the community while some undertakings by the company like the feeding program seem to be a ploy to silence the critics while continuing to suppress the community.
- The proposed project is going to create a lot job opportunities.
- Employment of the youths/absorbing of more youths in the proposed project by the company will greatly reduce insecurity issues/petty crimes and also improve on the relationship between the company and community.
- All current environmental concerns by the stakeholders should be addressed before the company embarks on this expansion project mission.
- The company should employ proper technologies in all its process especially in curbing dust which is the biggest nuisance in cement production.
- All public access roads within the company's catchment area should be maintained by the company.
- The company should also consider creating good/well maintained access roads within their land premise that will enable the fishmongers, beach users and the community members to access the ocean.

- The company which has been operating in the area carries out corporate social responsibilities.
- The corporate social responsibility undertaken by the company is sometimes done behind the knowledge of elected/appointed leaders and or key stakeholders of the company's catchment area.
- The community should consider rejecting the whole idea of the proposed expansion project by considering between health and wealth.
- The proposed expansion project is going to have adverse effects on livelihoods of the community especially on artisanal stone miners and on agricultural produce.
- The workers welfare is not put in much consideration by the company e.g. poor remuneration, long working hours and harassment from seniour management which must be addressed before considering this expansion.
- The land acquisition and price tag is so questionable of which some community members feel that they were cheated out of the deal.
- The company is urged to do better in terms of employment opportunities and if the operations are not geared towards benefitting the community, then their isn't need for the expansion.

Proposals/suggestions to address the above issues/concerns

- All the operations of the company should be limited to legal frame work while issues emanating from the operations should be dealt using the right channels.
- The company and community should ensure that frosty relationship is dealt with and a friendly environment should be cultivated for the benefit of all.
- The company should employ mechanisms that will minimize the negative impacts from the proposed expansion.
- The company should be above board when handling its workers besides ensuring that they are remunerated well to cater for their needs.
- The company and management should involve all and sundry in planning and executing its corporate social responsibility.
- The local community members should be given priority especially the youths in terms of employment and other opportunities that may arise from the proposed project.

- The company should complete all projects it has initiated in the community as well inaugurating more development conscious projects for the community.
- The community members made several requests that company should accomplish as they go about on their proposed project as outlined in the ‘baraza’ minutes of the stakeholder consultative forum.
- Involve the Public Health Officers in the whole program to address the health concerns.
- Workers/Employees from the company being harassed or treated unfairly should follow set up norms in finding a lasting solution or seek reprieve from the relevant authorities if they feel they have not been properly listened to as non is above the law.

Other recommendations

- There is need to have a joint socio-economic development committee between the company and all other key stakeholders to deliberate on matters affecting both the company and the community as well as for environmental sanity.
- Good relationship between the company and the community is paramount for symbiotic benefits of both parties.
- The community should have a mind shift from be complainants as victims by embracing a positive mindset on socio-economic investments in the region.
- The community members should organize themselves in groups to bolster their bargaining power in matters related to socio-economic and human development besides dealing with company.
- The community members should embrace education while parents should instill good morals in their children if they want to remain relevant in the current competitive society.

Plate 8: proceedings during the first public baraza

12.2.2 Second baraza

The second stakeholder consultative meeting (baraza) was held at the Takaungu Senior Assistant Chief's Office Grounds –Takaungu Location, Kilifi County on 28thNovember, 2015. Appendix 15 is the detailed minutes of the proceedings of the first baraza. The following were the main views, issues and concerns that emanated from this meeting:

- The proposed expansion project is a good idea if only all the negative impacts associated with it are addressed fully because if left undeterred, all persons irrespective of creed and social standings will suffer along with their property.
- The proposed expansion may have adverse health impacts on the community.
- The project in question has already caused a serious change in the landscape of the area and with the proposed expansion will only accelerate it.
- Fugitive dust is the main concern of the proposed project.
- Dust emission from trucks from trucks ferrying quarried material is a great concern to the neighbouring villages and schools.
- The acquisition of the land that hosts the proposed project site was not done fairly for its price tag per acreage was much below the expectation in comparison with various projects being undertaken across the country which is the first failure of the company.
- The fencing of the land that hosts the project site has blocked some community members who did not sell their land from accessing their homes besides blocking accesses to the beach/ocean which calls the company to reconsider this act.

- The proposed project should go through all the required legislations/channels before any operations are undertaken while views and concerns of all stakeholders should be taken on board.
- The proposed project and other company activities should mutually benefit both the company and the community.
- Sound relationship between the people and the company is vital if the community intends to benefit from it.
- The company has been carrying out its mandate in terms of corporate social responsibility which can be cited across the project catchment area.
- The efforts by the company in terms of corporate social responsibility are acknowledged but the company needs to liaise with the local leaders of the area while carrying out this noble course.
- Some areas in the project site complained to be sidelined by the company's management when they are carrying out their corporate social responsibilities.
- The workers should be provided with humane working conditions like construction of shades for those working in open fields to protect them from extreme weather conditions and reasonable remuneration in this high living standard times.
- The company's operations have led to increased security in the area as idle youths and individuals have been absorbed in working system and the proposed expansion will lead to a serene environment free from crimes.
- The company which is already carrying out its activities in the area cannot be carrying out its full operations without the knowledge of the government (having followed the required legislations) and the blessings of the local leaders which is a call on all the people to stop the hue and cry, and see how practical they can benefit from the proposed project.
- The company has encroached on BMU's and or riparian areas.
- The proposed project should only be implemented after a socio-economic, archeological and ecological survey has been established and that the proposed project has superior returns to other alternative establishments.

Proposals/suggestions to address the above issues/concerns

- The company should be on the forefront of protecting and taking good care of the environment that it operates from for nature is a friend if you are friendly but it is the greatest enemy when you go on the mission to destroy it for it will destroy you.
- The company should ensure the right to a clean and healthy environment, and the right to have a protected environment for the benefit of the present and future generations as anchored in the constitution is assured in all its operations.
- The company should work hand in hand with the community in protecting the environment as it is everyone's mandate to do so.
- The company should develop a workable afforestation and re-afforestation plan that can be implemented between them and the neighbouring communities.
- The management should use the latest technology in all its processes to curb any emanating dust.
- The company should raise higher their chimneys.
- The community should form a committee and seek an independent opinion on the proposed project which will be free to challenge the outcome of the whole Environmental Impact process if they are not contented with it.
- The company should provide proper personal protective equipment to its workforce and enforce on their effective use besides providing them with two packets of milk to lessen the impacts of fugitive dust.
- The company should consider tarmacking roads used by the quarry trucks and other roads in the area to curb the fugitive dust.
- The company should unblock all access roads to people's homes and to the beaches/marine areas.
- The people's health should be given paramount priority in the whole lifespan of the project.
- The project proponent should consider putting up an ultra-modern health facility with medical practitioners that will look the health of both the staff of the company and of the community members who may be affected by the operations of the proposed project.
- The implementation of the project should go hand in hand with the creation of employment opportunities for the community members, education of their children and improving the living standards of the people.

Plate 9: Procedings during the second baraza

12.2.3 Third Baraza

The third stakeholder consultative meeting (baraza) held at the Kadzinuni Primary School grounds Takaungu Location, Kilifi County on 30th nov, 2015. Appendix 16 is detailed minutes of the proceedings of the first baraza. The following were the main views, issues and concerns that emanated from this meeting:

- The proposed project will create employment opportunities for the people from the community as well as across the country and the national borders.
- The proposed project will increase the negative impacts as already witnessed in Takaungu areas like dust emission that has led to reduced crop production.
- The project is bound to increase noise pollution, dust emission and accidents on the road and at the company during operations.
- The proposed project will lead to influx of people in Takaungu areas hence exerting pressure on the social amenities.
- The flue gases from the company may have an effect on the community and its surrounding in the long run and therefore the lead project experts must advise the proponent on the appropriate measures to undertake.
- The proposed project should be handled in an appropriate manner not to cause pollution on the water mass.
- The Mombasa Cement Ltd has blocked the accesses to grazing and fishing grounds for the community.
- All riparian areas should be protected and the cement activities should not interfere with people accessing the beaches (e.g. BMU sites for fishermen).

- The proposed project is a good idea within the area but the proponent must first harken to our demands as a community.
- The company has given the youth from the area a raw deal in terms of employment and in educational sponsorship programs.
- The community members and most of the leaders lack the requisite environmental knowledge that the experts may be seeking before the final submission of the report as information flow is really wanting on the ground.
- Civic education for the community members is necessary for them to know the pros and cons of the expansion program and it can be done through print of pamphlets or written materials that will help the members make an informed decision.
- The proposed expansion project should be handled with utmost sanity so that effects witnessed from similar projects and others elsewhere should not befall the area.
- The company is currently using poor mining/quarrying practices which have to come to an end like abandoning quarries after mining without rehabilitating them which pose a risk in the community.
- The company carries out corporate social responsibility as mandated and the community members could attest to it though it still feels that more should be done by the company across the catchment area without favoring a particular area over the other besides involving all the key stakeholders from the region.
- A socio-economic survey should be conducted around the community to establish the benefits of the proposed expansion project economically versus the harm it may cause to the socio-economics of the community.
- The relevant authorities should also carry out an archeological study to establish all the shrines and historical sites that Takaungu is known for and if they are protected for or not.
- The land compensation value by Mombasa Cement Ltd was too low of which the company should think of starting sustainable livelihood projects within the community.

Proposals/suggestions to address the above issues/concerns

- The management should employ efficient and effective technology that will be able to curb the dust and noise emitted by the company’s operations.

- Drivers should be inducted to uphold the road safety rules and regulations while other efforts should be put in place to minimize or eliminate road accidents.
- The company should unblock all access roads to the community grazing grounds and riparian sites like the beach areas for fishermen.
- The BMU sites and all riparian lands must be protected from the company's activities.
- The company should develop an afforestation and re-afforestation plan that will include the community members on how to rehabilitate their quarries and the region they source their raw materials from.
- The company should work with like-minded persons/organizations and relevant authorities to set up facilities that absorb the pressure of the influx of the people in the area like building and equipping of an ultra-modern Health facility with trained medical personnel.
- The company should give first priority to members of the community with relevant knowledge and skills before outsourcing from other regions or places.
- The proponent and management should be advised by the team of experts to use the most appropriate technologies that will ensure that flue gases are controlled and no adverse impacts should befall the community in the long run.
- The company should use proper and safe mode of quarrying/mining practices that will not pose as a risk to the community members as well rehabilitating all their abandoned quarries.
- The law enforcers and other key stakeholders should ensure that the company complies with the requisite legislations and recommended forms of operation throughout the project lifespan.
- A research study should be carried out to be establishing the correlation between the low crop production and eye problems in the Takaungu areas in relation to the dust generated by the company.
- The community leaders together with relevant aligned agencies should organize and carry out civic education advantages and disadvantages of this expansion program on the community members before a final decision is made after including their informed decision.

- The company should develop a program that will impart knowledge and skill to the local community members especially the youths through apprenticeship at the company or sponsoring the bright and or the needy students/pupils that can be absorbed in the management later on completion of studies to improve the education level in the area besides bringing an end to ridicules that members of the community can be employed for lack of education.
- The company shouldcontinue carrying out its corporate social responsibility mandate across the project catchment area and the entire key stakeholder should be involved in planning and executing the earmarked projects.
- Relevant authorities and interested parties should contact the various surveys demanded by the community before an informed decision is made on the proposed project.

Other recommendations

- The company should work closely with 'WazeewaNyumbaKumi' on issues of the community as they are the ones who are aware of issues on the ground.
- The company should help the community in establishing sustainable projects in the community given that massive lands formerly used by the community for their livelihood is in the hands of the company and earmarked for use in the proposed project.
- A committee comprising all key stakeholders should be formed to liaise with the company on behalf of the community.
- Leaders with selfish interests should set it aside and welcome development programs that will enhance the livelihoods of the community members.
- The community members should organize themselves in groups and or work as a united group through an established committee to augment their bargaining power with the Mombasa Cement Company or any other interested development partner who wishes to invest in the region.
- The Mnarani Member of the County Assembly together with the area Sub-Chief (Mkomani/Mkwajuni Sub-Location) to liaise with the Rea VipingoSisal Management to have one road developed for public use.

13. ENVIRONMENT MANAGEMENT AND MONITORING PLAN

Implementation of the proposed expansion of the Mombasa Cement factory will require careful and sound environmental planning to ensure that potential negative impacts are appropriately mitigated to ensure environmental conservation and sustainable development. To achieve this; MCL must develop binding policies that will guide the operation of the proposed expansion

To achieve this MCL will develop policies that will guide the implementation of the proposed expansion. The policies once developed will be vital in the following ways among others:

- ✓ The policies will enable management to develop and maintain sound relations with all stakeholders.
- ✓ The policies will enable management put in place measures and structures that will care for the safety, health and welfare of all workers and the neighbouring community to the project site.
- ✓ The policies will provide a framework for management to plan for, and put in place, monitoring programmes that will ensure conservation and protection of the environment.
- ✓ The policies will provide a framework for management to assume its corporate responsibility for its activities with regard to conservation of the environment as well as for the well-being of the local community.

This environmental management and monitoring plan consist of the following:-

a) Company management policies
b) Potential positive impacts as a result of project implementation.
c) Potential negative environmental impacts as a result of project implementation
d) Proposed mitigation measures of potential negative impacts
e) Action plans
f) Environmental monitoring
g) Conceptual decommissioning plan

13.1 Management policies

MCL will need to develop and document policies that will guide construction and operation of the proposed additional two new cement factories in addition to the existing cement factory. The policies once developed will be vital in the following ways among others:

- ✓ The policies will enable management to develop and maintain sound relations with workers and the neighbouring community;
- ✓ The policies will enable management put in place measures and structures that will care for the safety, health and welfare of all workers and the neighbouring community;
- ✓ The policies will provide a framework for management to plan for, and put in place, monitoring programmes that will ensure conservation and protection of the environment, appropriate minimization of gaseous emissions, minimization of dust, solid waste management and disposal , appropriate liquid waste management and disposal; and
- ✓ The policies will provide a framework for management to assumes its corporate social responsibility for its activities with regard to conservation of the environment as well as for the well-being of the local community.

MCL therefore should develop and document the following policies:-

a) Environmental Management Policy
b) Occupational Health and Safety Policy
c) Local Community Policy
d) Employment Policy

13.1.1 Environmental Management Policy

The environmental policy to be developed should be one that enables MCL to carry out company activities with the highest regard to the natural environment and sustainable utilisation of environmental resources therein. The policy should therefore cover the following, among other issues:-

- ✓ All legal requirements that will need to be complied during operation of the clinker production plant and associated quarries;
- ✓ Measures to be put in place to ensure continuous environmental improvement and performance through monitoring of clinker production activities;

- ✓ Ways to ensure that utilisation of natural resources is optimal with measures in place to ensure resource availability for future generation;
- ✓ Awareness creation to the surrounding community regarding sustainable utilisation of natural resources, protection of sensitive ecosystems and bio-diversity maintenance for communal livelihood; and
- ✓ Balancing between natural resource use, environmental conservation and economic development.

13.1.2 Occupational Health and Safety Policy

The Occupational Health and Safety Policy to be developed should enable MCL put in place appropriate measures that will ensure that the health, safety and welfare of all employees is cared for; together with the health requirements of the local community The policy should highlight the following, among others:-

- ✓ Quarry safety
- ✓ Clinker and cement production safety
- ✓ Safety measures for other machines and equipment
- ✓ Appropriate safety and rescue equipment to be availed in all work places
- ✓ Emergency procedures and actions
- ✓ Risk minimisation of accidental damage to employees, community and environment
- ✓ Machine maintenance and machine operator proficiency
- ✓ Training in safety.

13.1.3 Local Community Policy

MCL Vipingo to develop a Local Community Policy that ensures that the company develops and maintains sound relations with her employees and the local community on mutual respect and active partnership. The policy should highlight on ways MCL should:-

- ✓ Work with the local community and Government Departments and Agencies to achieve sustainable community development;
- ✓ Promote public awareness in regard to monitoring of developments at Vipingo; potential environmental consequences to the area and the role of the local community;
- ✓ Propose ways of enhancing information flow from management to the community and employees, and vice visa;

- ✓ Community capacity building; and
- ✓ Active engagement of the local community in the project.

13.1.4 Employment Policy

The Employment Policy to be developed by MCL should take into consideration the varying employment needs of the community. The policy should endeavour to protect the local community from unfair competition when it comes to recruitment of workers to work in the cement plant and associated quarries. The policy should cover the following, among other issues:-

- ✓ Local community considerations in employment;
- ✓ Training needs for employees;
- ✓ Employment of people with specialised skills;
- ✓ Casual Workers;
- ✓ Compensation, allowances and benefits; and
- ✓ Terms of payment and scales.

13.2 Potential positive impacts

13.2.1 Introduction

According to the Economic Survey of the Kenya Bureau of statistics of 2014, cement production registered an accelerated growth of 7.8 per cent in 2013 compared to a growth of 4.8 per cent in 2012. This translated into 5,059.1 thousand tonnes in 2013. Cement consumption and stocks also increased from 3,991.2 thousand tonnes in 2012 to 4,266.5 thousand tonnes in 2013 as a result of increased construction activities. For a second consecutive year, imports of cement declined to stand at 34.4 thousand tonnes in 2013. Total exports of cement to Uganda and Tanzania, which had decreased in 2012, reversed to record 594.0 thousand tonnes in 2013. Table 20 summarizes this information.

Table 25: Cement Production and Utilization, 2009-2013

'000 Tonnes

YEAR	PRODUCTION	IMPORTS	CONSUMPTION	EXPORT TO

			AND STOCKS	Uganda and Tanzania	All other counties
2009	3,320.3	35.2	2,671.3	608.2	76.0
2010	3,709.8	27.1	3,085.2	548.3	103.4
2011	4,478.4	53.0	3,870.9	583.1	125.3
2012	4,693.7	35.3	3,991.2	561.7	176.7
2013	5,059.1	34.4	4,266.5	594.0	233.9

Source: Economic Survey of the Kenya Bureau of statistics of 2014

Implementation of the proposed expansion of the Mombasa Cement factory at Vipingo may results in positive impacts. Potential positive impacts likely to result from the proposed expansion may include:-

- ✓ Increased exploitation of minerals used in cement production
- ✓ Increase in cement production in Kenya
- ✓ Reduction in cement imports
- ✓ Increase in Cement exports
- ✓ Employment opportunities
- ✓ Support of local businesses
- ✓ Increased revenue to government

13.2.2 Increased exploitation of common minerals used in cement production

The proposed expansion of Mombasa Cement factory at Vipingo will likely result in increased mining and exploitation of common minerals used in cement production. Such common minerals include coral limestone which is the bulk raw material used in cement production. Other minerals whose exploitation is likely to increase as a result of the expansion may include shale, bauxite and iron ore.

13.2.3 Increase in cement production in Kenya

The proposed expansion of Mombasa Cement factory at Vipingo seeks to triple the current production of clinker and cement. This if achieved will effectively contribute to significant increase in cement production in Kenya.

13.2.4 Reduction in cement imports

The proposed expansion of Mombasa Cement Vipingo Factory will mean there will be more cement in Kenya than before. This will mean previous cement deficit will be farther narrowed. There will thus be less need for cement importation. Reduced cement importation will translate to reduced spending of foreign currencies; this will mean there will be more foreign currency reserves due to reduced cement importation.

13.2.5 Increase in Cement exports

The proposed expansion of Mombasa Cement Vipingo factory will result in production of more cement and clinker. This will mean that there will be more cement and clinker available for export than was previously. Increased export of cement and clinker will translate to increased foreign exchange earnings for the county.

13.2.6 Employment opportunities

The proposed expansion of Mombasa Cement factory will provide opportunities for employment for more people to work in the expanded factory. It is envisaged that the workforce may triple to cater for the expansion needs.

13.2.7 Support of local businesses

Services of local businesses such as transporters will be required to cater for the expanded factory. This will contribute to growth and development of such businesses. Other businesses may start or be farther developed to cater for the needs of the expanded factory such businesses likely to grow my include housing to cater for the increased workforce, hospitals, schools, shops among others.

13.2.8 Increased revenue to government

The proposed expansion of Mombasa Cement Vipingo factory will translate to increased tonnage of cement and clinker that will be produced. Tis will translate to increased tonnage of sells of clinker and cement translating to increased profits to the company. Increased profits will translate to increased taxes hence increased revenue to government. The expansion will translate to increased use of raw materials this will result to increased cess to the Kilifi County Government among other taxes.

13.3 Potential Negative Impacts

13.3.1 Impact identification

The International Finance Corporation Performance Standard 1 paragraph 7 emphasizes on the process of identifying environmental risks and impacts. The type, scale and location of the project guided the scope of the impact identification. The direct and indirect project-related impacts on biodiversity and ecosystem services and residual impacts were considered during the assessment of impacts in accordance to the IFC Performance Standard 6 paragraph 6. Project components potentially have impact on environment by altering terrestrial coastal habitats. After conducting field observation, impact assessment was confined within the scope of study on fauna in the terrestrial areas.

An ecological Risk Assessment Matrix developed by Kurrent Technologies Ltd 2012 was used to assess impacts of the project on biodiversity. The **extent** of impact can be limited to the project site and to specific activity at particular period, or affect areas beyond the project site. **Duration** in which the impact takes place is also considered in the evaluation of the impact. The period can be specific to the period of certain activities or could be related to the occupancy period of the project development. Thus, in terms of duration an impact can be viewed as a short, medium, long term impact or permanent. Impact can affect biodiversity partially or completely. For instance only small part of habitat, ecological processes or small population of species can be destroyed by the impact. Thus, **magnitude** of an impact was evaluated as proportion of the environmental entity affected. The probability of the impact to happen was derived from the frequency of the activity and frequency of impacts. The four characteristics described above were used to synthesise significance of the impact. See below the scale of risk assessment matrix (figure 10).

Figure 13: an ecological Risk Assessment Matrix

EXTENT

Localized (At localized scale and a few hectares in extent)	1
Study area (The proposed site and its immediate environs)	2

MAGNITUDE

Small and will have no effect on the environment	0
Minor and will not result in an impact on the processes	2

Regional (District and provincial level)	3
National (Country)	4
International (Beyond Kenya)	5

Low and will cause a slight impact on the processes	4
Moderate and will result in process continuing but in a modified way	6
High (processes are altered to the extent that they temporarily cease)	8
Very high and results in complete destruction of patterns and permanent cessation of the processes	10

DURATION

Very short (0 – 1 Years)	1
Short (1 – 5 Years)	2
Medium term (5 – 15 years)	3
Long term (>15 years)	4
Permanent	5

PROBABILITY

Highly improbable (<20% chance of occurring)	1
Improbable (20 – 40% chance of occurring)	2
Probable (40% - 70% chance of occurring)	3
Highly probable (>70% - 90% chance of occurring)	4
Definite (>90% chance of occurring)	5

Figure 14: Method used to determine the environmental risk: Risk = (Extent + Duration + Magnitude) x Probability

		CONSEQUENCE (Extent+Duration+Magnitude)																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PROBABILITY	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
	5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

Low	<30	Where this impact would not have a direct influence on the decision to develop in the area
Medium	30-60	Where the impact could influence the decision to develop in the area unless it is effectively mitigated
High	>60	Where the impact must have an influence on the decision process to develop in the area

Figure 15: Confidence of assessment table

The degree of confidence in predictions based on available information, Kurrent Technologies Ltd. judgment and/or specialist knowledge	Low
	Medium
	High

Potential negative impacts that may result from the implementation of the proposed expansion of the Mombasa Cement Limited Vipingo factory may include: -

- ✓ Increased gaseous emissions
- ✓ Increased dust emissions
- ✓ Increased noise disturbance
- ✓ Occupational injuries and or accidents
- ✓ Waste (liquid and solid) related pollution
- ✓ Negative impacts on local fauna
- ✓ Negative impacts on local flora
- ✓ Negative impacts on avifauna

13.3.2 Gaseous Emissions

13.3.2.1 Background

There are three main sources of gaseous emissions from a cement production system namely raw materials, the fuel, and the process itself. A brief elaboration of each source as follows.

13.3.2.2 Raw Materials

The predominant constituent of the cement raw material mix is calcium carbonate, the calcareous component is limestone. Since the raw mix constitutes over 75% calcium carbonate the degree of purity of the calcareous component determines the amount that is contained in the raw material mix. About 48% of the weight of the calcium carbonate is carbon and oxygen, the calcareous component of the raw material mix is a significant source of CO_2 emissions through calcination (decarbonization). Coral limestone the source of calcium carbonate to be used in clinker manufacture originated in an ocean, chlorine is present as a trace element, and this chlorine is available in the flue gas stream for the generation of hydrogen chloride. Limestone also contain sulfur in the form of sulfates, sulfides (metallic and organic), and, rarely, elemental sulfur. Sulfates pass through the kiln system without transformation into SO_2, but sulfides and elemental sulfur can result in the generation of SO_2 through the oxidation of sulfur in kiln systems. If localized reducing conditions exist in the pyroprocessing system, sulfates can be converted to SO_2. Limestone also can contain petroleum and/or kerogens that can be partially volatilized or pyrolyzed at temperatures present at the feed end of the pyroprocesses to result in organic emissions. These organic constituents or their nonvolatile residues can result in CO emissions when burned in an oxygen-deficient section of the pyroprocessing system. The non-calcareous component of the raw mix includes shale which is natural in origin, these materials can contain sulfates, sulfides (metallic and organic), and elemental sulfur that have the potential to generate SO_2.

13.3.2.3 Fuel

Coal will be the main fuel used in clinker burning at Mombasa Cement factory, the coal is prepared for combustion in direct-fired coal mill system. The combustion of this carbonaceous fuel results in the formation of CO_2 and the potential formation of CO if oxygen deficiency and/or poor mixing of fuel and air exist at the combustion site. In addition, localized combustion conditions affecting combustion reactions may result in the formation of other organic products of incomplete combustion. The sulfur contained in coal is in the form of sulfates, sulfides (metallic and organic), and elemental sulfur. The sulfides and elemental sulfur are oxidized readily to SO_2 during combustion of the coal. Coal also contains nitrogenous compounds that are oxidized to NOX, i.e., fuel NOX, or converted to small quantities of free NH3 during combustion.

13.3.2.4 Process

The formation of gaseous pollutants primarily occurs in the horizontal rotary kiln and raw mill as the consequence of oxidation or other processes at a relatively high temperature. Process gas is vented through three points i.e., the discharge of the rotary kiln or /raw mill, the alkali bypass, and the coal mill, these points are equipped with a particulate matter control device (PMCD). Mombasa Cement proposes to use the precalciner kiln system in this process, there will be a special vessel called a calciner located between the rotary kiln and the preheater tower into which fuel is introduced. It is in this vessel that the bulk of the calcinations of the calcareous component of the raw mix take place. The calcination reaction requires the most thermal energy of any reaction in the cement-making process. Typically, hot tertiary air is taken from the clinker cooler or kiln firing hood and ducted outside the kiln to the precalciner vessel for combustion support. This precalciner configuration of a cement pyroprocessing system is the most fuel efficient and stable the system provides the highest clinker production rate with the shortest rotary kiln and the smallest “footprint” on the ground. Gases produced from the clinker production process include carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and ammonia.

Carbon dioxide

Carbon dioxide results from the combustion of coal fuel and the calcination of the limestone component of the raw material mix, an essentially unavoidable and fixed consequence of clinker manufacture. Of the total amount of CO_2 emitted from a cement kiln, about half of the CO_2 originates from the raw material while the other half originates from the combustion process.

Carbon monoxide

CO is a product of incomplete combustion of carbonaceous fuel resulting from insufficient oxygen at the combustion site, insufficient mixing of oxygen and fuel at the combustion site, and/or rapid cooling of the combustion products to below the ignition temperature of CO prior to its complete oxidation. CO can be formed unintentionally at any of the combustion sites in the pyroprocessing system. The emission of CO usually represents partially burned and underutilized fuel. However, as a result of using oxygen-deficient combustion in the riser duct or calciner as a NOX control strategy, CO sometimes is generated in the pyroprocess and may appear in the flue gas discharge if it is not somehow oxidized following its formation.

Nitrogen oxides

There are four mechanisms of NOX formation in cement kilns of which thermal and fuel NOX formation is the most important. Thermal NOX results from the oxidation of molecular nitrogen in air at high temperature. This phenomenon occurs in and around the flame in the burning zone of a cement kiln at a temperature greater than 1200ºC. Fuel NOX results from the oxidation of nitrogen in the fuel at any combustion temperature found in the cement process. Because of the lower combustion temperature in the calciner and some sites of supplemental fuel combustion, the formation of fuel NOX often exceeds that of thermal NOX at these locations.

Sulfur dioxide

Sulfur dioxide results from the oxidation of sulfide or elemental sulfur contained in the fuel during combustion. In addition, sulfide or elemental sulfur contained in raw materials may be “roasted” or oxidized to SO_2 in areas of the pyroprocessing system where sufficient oxygen is present and the material temperature is in the range of 300-600°C. In addition, sulfates in the raw mix can be converted to SO_2 through localized reducing conditions in the kiln system.

Ammonia

Trace quantities of NH3 in the exhaust gas from the rotary kiln gas result from the pyrolysis of nitrogenous compounds in coal and raw materials. In addition, atmospheric reactions occur just outside of the stack between NH3 and the oxides of sulfur or HCl that produce ammonium sulfate, ammonium bisulfate, or ammonium chloride as very fine particulate matter (PM).

13.3.3 Dust emissions

13.3.3.1 Background

Dust can be defined as an aerosol and disperse system that consists of small solid particles suspended in a gaseous medium. Separate particles and particle aggregates—from ultra-microscopic particles to those visible with the naked eye—have various shapes and compositions. In most cases, dust is formed as a result of the dispersion of solid bodies. It consists of particles that range in size from 10^{-7} to 10^{-4} m and that carry an electrical charge or are electrically neutral. Dust concentration, or dust content, is expressed by the number of particles or their total weight per unit volume of gas (air). Dust is unstable; its particles adhere during Brownian motion or during sedimentation. Dust from cement or more appropriately cement particulate matter, at a cement plant is typically caused by physical attrition, combustion particle burnout, or nucleation. Physical attrition occurs as particles abrade against each other. Particles generated by physical attrition range from less than 10 micrometers in size to more than 1,000 micrometers. Combustion particle burnout refers to the residues remaining from the pyroprocess. These particles are typically in the 1 to 100 micrometer range. Nucleation particles are generated when materials that are in a vapor form condense. These particles are truly very small, usually between 0.1 and 1.0 micrometers.

13.3.3.2 Potential sources of dust

Likely sources of dust from the proposed expansion of the cement plant could include the following;-

- ✓ Crushing of limestone at the limestone crusher
- ✓ Pre-blending of crushed limestone
- ✓ Handling and mixing of additives (shale, bauxite and iron ore)
- ✓ Blending of raw mill
- ✓ Grinding of coal in the coal mill
- ✓ Moving of raw mill along production line
- ✓ Handling of generated clinker.
- ✓ Cement grinding and packaging.

13.3.3 3 General health effects of cement dust

Health effects of cement dust may include occupational lung disease, skin irritation, conjunctivitis, stomach ache, headache, fatigue and carcinoma of lung, stomach and colon. A brief explain on these health effects is as follows.

- ✓ The aerodynamic diameter of cement particles range from 0.05 to 5.0 micrometer in diameter. These particles are respirable in size hence Portland cement is important as a potential cause of occupational lung disease.
- ✓ This particle size distribution would make the tracheobronchial respiratory zone, the primary target of cement deposition.
- ✓ The main route of entry of cement dust particles in the body is the respiratory tract and / or the gastrointestinal tract by inhalation or swallowing respectively.
- ✓ Both routes, especially the respiratory tract are exposed to numerous potentially harmful substances in the cement mill environment. The physical properties that are of importance include particle size and density, shape and penetrability, surface area, electrostatic charge, and hygroscopicity. Among the more important chemical properties influencing the respiratory tract's response is the acidity or alkalinity of the inhaled agent. The deposition of inhaled material is primarily dependent on particle size and is best described in forms of an aerodynamic diameter. All particles with an aerodynamic diameter in excess of 10mm are deposited on the mucous membrane in the nose and pharynx and particles between 3 and 10mm in diameter can be deposited throughout the tracheobronchial tree. Particles between 0.1 and 3mm in diameter are mostly deposited within the alveoli and particles smaller then 0.1mm remain in the air stream and are exhaled. The pathogenesis is most probably due to its irritating, sensitizing and pneumoconiotic properties.
- ✓ High concentration and / or prolonged inhalation of cement dust in cement industry workers can provoke clinical symptoms and inflammatory response that may result in functional and structural abnormalities.
- ✓ Clinical features of cement mill workers exposed to cement dust in cement mill could include chronic cough and phlegm production, impairment of lung function, chest tightness, obstructive and restrictive lung disease, skin irritation, conjunctivitis, stomach ache, headache, fatigue and carcinoma of lung, stomach and colon.

13.3.3.4 Potential negative impacts of cement dust

Potential negative impacts of exposure to cement dust would include

- ✓ Lung infection resulting from inhaling of cement dust
- ✓ Skin irritation
- ✓ Itching of the skin
- ✓ Irritation of the eyes
- ✓ Chronic cough
- ✓ Reduced visibility
- ✓ Choking of plants

13.3.4 Increased Noise disturbance

13.3.4.1 Introduction

Noise can be defined as any undesirable sound that is intrinsically objectionable or that may cause adverse effects on human health or the environment {EMC (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009}. Noise can be either intermitted or intrusive. Intermitted noise is noise whose level suddenly drops to several times the level of background noise, on the other hand; intrusive noise is external or noise from another part of the building which penetrates the structural defences of a room or building. Noise can also be defined unwanted or undesirable sound derived from sources such as industrial set up and operations, road traffic or construction works that interferes with normal activities such as conversation, sleep or recreation.

13.3.4.2 Noise generation/sources

Industrial machinery and processes are composed of various noise sources such as rotors, stators, gears, fans, vibrating panels, turbulent fluid flow, impact processes, electrical machines, and internal combustion engines among others. The basic mechanism of noise generation can be due to mechanical noise, fluid noise and/or electromagnetic noise. Sound fields in the workplace are usually complex, due to the participation of many sources which may include propagation through air (air-borne noise), propagation through solids (structure-borne noise), diffraction at the machinery boundaries, reflection from the floor, wall, ceiling and machinery surface, absorption on the surfaces among others. The mechanisms of noise generation depend on the particularly noisy operations and equipment including crushing, riveting, blasting (quarries and mines), shake-out (foundries), punch presses, drop forges, drilling, lathes, pneumatic equipment, tumbling barrels, plasma jets, cutting torches, sandblasting, electric furnaces, boiler making, machine tools for forming, dividing and metal cutting, such as punching, pressing and shearing, lathes, milling machines and grinders, pumps and compressors, drive units, hand-guided machines, self-propelled working machines, in-plant conveying systems and transport vehicles.

13.3.4.3 Health Effects of noise

Noise health effects are the health consequences of elevated sound levels. Elevated workplace or other noise can cause the following health effects, hearing impairment, hypertension, ischemic heart disease, annoyance, bowel movements and sleep disturbance. Noise exposure has also been known to induce tinnitus, hypertension, vasoconstriction and other cardiovascular impacts. Elevated noise levels can create stress, increase workplace accident rates, and stimulate aggression.

13.3.4.4 Potential negative impacts of noise

- ✓ Continuous exposure of workers at the work place to high noise levels for a long time may result in noise induced hearing loss.
- ✓ Extremely laud noise at the work place can result in immediate lasting damage to the worker’s hearing mechanism.
- ✓ Exposure of workers to laud noise will result in reduction of productivity and efficiency of the workers at the work place, this will ultimately translate to overall reduction of productivity in the workplace and hence reduced output.
- ✓ Exposure of a worker to laud noise can upset the sense of balance and cause blood vessels to constrict, this will result in a rise in blood pressure hence reduction in the volume of blood flow.
- ✓ High noise levels at the work place can result in fatigue, headache, nervousness, irritability and high pretension; this will increase the likelihood of accidents at the workplace.
- ✓ Exposure of a worker to high noise levels will result in stressing the worker and thus result in reduced concentration.

13.3.5 Occupational injuries and or accidents

The most significant occupational health and safety impacts occurring during the construction and operational phase of cement manufacturing plant include, dust, heat, noise and vibrations, physical hazards, radiation, chemical hazards and other industrial hygiene issues .

13.3.5.1 Dust

Exposure to fine particulates is associated with work in most of the dust-generating stages of cement manufacturing, but most notably from raw material handling, and clinker / cement grinding. Exposure to active (crystalline) silica dust (SiO_2), when present in the raw materials, is a relevant potential hazard in the cement manufacturing.

13.3.5.2 Heat

The principal exposures to heat in cement manufacturing occur during operation and maintenance of kilns or other hot equipment, and through exothermic reactions.

13.3.5.3 Noise and Vibrations

Exhaust fans and grinding mills are the main sources of noise and vibrations in cement manufacturing plants.

13.3.5.4 Physical hazards

Injuries during cement manufacturing operations are typically related to slips, trips, and falls; contact with falling / moving objects; and lifting / over-exertion. Other injuries may occur due to contact with, or capture in, moving machinery (e.g. dump trucks, front loaders, forklifts). Activities related to maintenance of equipment, including crushers, mills, mill separators, fans, coolers, and belt conveyors, represent a significant source of exposure to physical hazards.

13.3.5.5 Radiation

An X-ray station is sometimes used to continuously monitor the, raw material mix on the belt conveyor feeding the raw mill. Operators of this equipment should be protected through the implementation of ionizing radiation protection measures.

13.3.5.6 Chemical Hazards and other Industrial Hygiene Issues

Chromium may contribute to allergic contact dermatitis among workers handling cement. Prevention and control of this potential hazard includes a reduction in the proportion of soluble chromium in cement mixes and the use of proper personal protective equipment (PPE) to prevent dermal contact.

13.3.6 Waste related pollution

13.3.6.1 Solid waste

Sources of solid waste in cement manufacturing can be of three categories namely process waste, domestic waste and office waste. Process waste includes clinker and cement production waste, mainly composed of spoil rocks, which are removed from the raw materials during the raw meal preparation. Another potential waste stream involves the kiln dust removed from the bypass flow and the stack, if it is not recycled in the process. Limited waste is generated from plant maintenance (e.g. used oil and scrap metal). Other waste materials may include alkali or chloride / fluoride containing dust buildup from the kiln. Domestic waste include waste from canteen and other eating places within the plant and waste from dwelling houses of staff such waste include food left offers, wastepaper. Office waste includes wastepaper, electronic waste and sweepings.

13.3.6.1.1 Potential negative impacts of solid waste

- Air pollution especially from kiln dust
- Skin irritation when in contact
- Water pollution
- Production loss
- Irritation of eyes
- Chocking of plants
- Odor from decomposing food leftovers from the canteen
- Blockage of drainage system by scrap and other non-decomposing solid wastes.
- Some electronic office waste such as used toner cartridges and absolute office electronic equipment contain hazardous substances.

13.3.6.2 Liquid waste

Liquid waste generated from cement manufacturing process includes industrial process wastewater, sanitary wastewater, storm water and waste oil. Wastewater is generated mainly from utility operations for cooling purposes in different phases of the process (e.g. bearings, kiln rings). Wastewater is also generated from sanitary facilities from the plant, from cleaning of floors and other surfaces and from tools and equipment cleaning such as motor vehicles. Process wastewater with high pH and suspended solids may be generated in some operations. Techniques for treating industrial process wastewater in this sector include flow and load equalization with pH adjustment; sedimentation for suspended solids reduction using settling basins or clarifiers; multimedia filtration for reduction in non settleable suspended solids. Waste oil is generated from servicing of machines and equipment. Handling of the waste oil includes water separation for reuse, selling to recyclers and burning in incinerators.

13.3.6.2.1 Potential negative impacts of wastewater generation

- ✓ Water shortage due to high use.
- ✓ Water contamination due to high dissolved solids and other contaminants
- ✓ Contamination of ground water if untreated contaminated wastewater is discharged into the environment
- ✓ Odor from untreated contaminated wastewater
- ✓ Degradation of the quality of water of the receiving water body if contaminated wastewater is discharged into aquatic environment prior to treatment.
- ✓ Contamination of soils if contaminated wastewater is discharged into the ground prior to treatment

13.3.7 Negative impacts on local flora

Implementation of the proposed expansion of MCL Vipingo will have a direct negative impact on local vegetation. This is because the vegetation on site will have to be cleared to pave way for the construction of clinker and cement plant, other associated components and opening up more areas for quarrying to obtain raw material. The result impact of vegetation clearance will include the following:

- ✓ Diminishing of local carbon sink resulting in reduced area capacity of carbon sequestration.
- ✓ Overall reduction of flora in the area and overall loss and/or reduction of ecological and economic services derived from the lost vegetation.

- ✓ Reduction in local greenery.

An analysis of the potential negative impacts likely on local flora using ecological Risk Assessment Matrix developed by Kurrent Technologies Ltd 2012 is as follows.

Table 26: Analysis of unmitigated impacts on local flora

Unmitigated impacts on local flora	
Extent of impact	2
Magnitude of impact	8
Duration of impact	4
Probability of impact	5
Risk = (Extent + Duration + Magnitude) x Probability	70
Confidence of Assessment	High (70)

13.3.8 Negative impacts on local fauna

13.3.8.1 Mammals and herpetofauna

Based on the knowledge on hazards, ecological hazards in terrestrial ecosystem can be coined to be any biological, chemical, mechanical, environmental or physical agent that is likely to cause harm to other organisms and damage to habitats and ecological processes in the environment in the absence of their control. Potential risks that would likely occur when project is implemented. These include:

- Movement of animals (mammals and herpetofauna)
- Foraging areas for insect pollinators
- Ecological life cycles of butterflies

Ecological risk/impact assessment focused on the sensitive issues within the project footprint. The total area of the project footprint and the potential new project area. Fauna diversity and population in the area is low. Clinker and cement plant construction and acquisition of more raw materials through quarrying would potentially affect movements of these animals across the landscape. Due to low population of this group in the area, chances of interference would also be low.

Table 27: Impact analysis on terrestrial fauna during construction phase

Unmitigated impacts on movement of fauna during Construction Phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	2
Probability of impact	3
Risk = (Extent + Duration + Magnitude) x Probability	-24 (Low)
Confidence of Assessment	
Recommendation	Rehabilitation of sites to be affected to ensure it attains current status

Table 28: Impact analysis on terrestrial fauna during operational phase

Unmitigated impacts on movement of fauna during Operation Phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	2
Probability of impact	2
Risk = (Extent + Duration + Magnitude) x Probability	-16 (Low)
Confidence of Assessment	
Recommendation	Rehabilitation of sites to be affected to ensure it attains current status

13.3.8.2 Butterflies

The project area is distributed within the dry areas that affect the presence of vegetation and ultimately the distribution of butterflies. The life stage of butterflies that normally provide survive during the dry season is pupa. The pupa is normally attached to the dry stalks plants until the next wet season when there are leafy plants. During wet season, they turn into larval stage and then to adults. This area potentially provides “breeding sites” for the butterflies. Clearance of vegetation would be reducing the size of the area for breeding.

Table 29: Impact analysis on butterflies *during* construction phase

Unmitigated impacts on the ecological life cycles of butterflies during Construction Phase	
Extent of impact	2
Magnitude of impact	6
Duration of impact	2
Probability of impact	3
Risk = (Extent + Duration + Magnitude) x Probability	-30 (Medium)
Confidence of Assessment	
Recommendation	Propose mitigation measure
Comments/mitigation • Patches of shrubs and herbs should be reserved throughout the year in order to support the life cycles of butterfly species. • Establishment of conservation offsets to provide similar service to the pollinators.	
Mitigated impacts on the ecological life cycles of butterflies during Construction Phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	2
Probability of impact	2
Risk = (Extent + Duration + Magnitude) x Probability	-16 (Low)
Confidence of Assessment	
Recommendation	Maintain mitigation measure

Table 30: Impact analysis on butterflies *during* operational phase

Unmitigated impacts on the ecological life cycles of butterflies during Operation Phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	2

Probability of impact	2
Risk = (Extent + Duration + Magnitude) x Probability	-16 (Low)
Confidence of Assessment	
Recommendation	Maintain current status
Comments/mitigation Maintain current status	

13.3.8.3 Reduction of foraging areas for insect pollinators

Clearance of vegetation for construction of clinker and cement plant and quarrying for more raw materials has the potential to reducing the area of foraging for the insect pollinators such as the butterflies and bees. Insect pollinators rely on the vegetation for food nectars and fruit juice. Development activities normally take up more areas from the natural habitats that serve these taxa on various ecological services including foraging. When these areas are continuously reduced, the insect pollinators are left with small areas hence their population is affected with the little resource. However, most of the insect pollinator has the tendency of local movements for foraging and breeding. This ecological behaviour provides them with the capacity for resilience.

Table 31: Impact analysis on foliage areas for insect pollinators during construction phase

Unmitigated impacts on the foraging areas for insect pollinators during Construction Phase	
Extent of impact	2
Magnitude of impact	6
Duration of impact	2
Probability of impact	3
Risk = (Extent + Duration + Magnitude) x Probability	-30 (Medium)
Confidence of Assessment	
Recommendation	Propose mitigation measure
Comments/mitigation • Patches of shrubs and herbs should be reserved throughout the year in order to support the life cycles of butterfly species. • Establishment of conservation offsets to provide similar service to the pollinators.	

Mitigated impacts on the foraging areas for insect pollinators during Construction Phase	
Extent of impact	2
Magnitude of impact	2
Duration of impact	2
Probability of impact	2
Risk = (Extent + Duration + Magnitude) x Probability	-12 (Low)
Confidence of Assessment	
Recommendation	Maintain mitigation measures

Table 32: Impact analysis on foliage areas for insect pollinators during operational phase

Unmitigated impacts on the foraging areas for insect pollinators during Operation Phase	
Extent of impact	2
Magnitude of impact	4
Duration of impact	2
Probability of impact	2
Risk = (Extent + Duration + Magnitude) x Probability	-16 (Low)
Confidence of Assessment	
Recommendation	Maintain current status
Comments/mitigation Maintain mitigation measures	

13.3.8 Negative impacts on avifauna

The implementation of the proposed project will lead to negative impacts to avifauna in the area. The project has the potential to affect the avifauna of the project area from the associated activities. This is mainly through ecological disturbance leading to displacement or exclusion of birds. For some of the species, there will be complete annihilation of their habitats. This is because the project activities are likely to cause site-specific negative impacts on the biophysical environment of the project area which will affect avifauna in various ways including increased pressure and/or loss of habitat and essential resources for food and nesting for birds.

The following are the potential impacts on avifauna at the proposed site

- The impacts of direct habitat loss due to annihilation of the species habitats.
- The impacts of habitat modification due to changes in land management.
- The impacts of indirect habitat loss due to the displacement of birds as a result of construction, and maintenance activities,

As a wintering/feeding ground for some of the migrants, it is also possible that the species will have to find alternative sites. The effects of the proposed project on birds are highly variable and will depend on a wide range of factors including:

- Specification of the development – how expanse and level of the transformation,
- Topography of the surrounding land,
- Habitats affected
- Number and species of birds present.
- Land uses within the surrounding matrix and availability of alternative sites for these species

13.3.8.1 Loss of avifauna habitats

Potential negative impacts on avifauna population were quantitatively assessed against the set criteria. Activities associated with the project during construction will involve; movement of machinery vegetation clearance, excavation, levelling and compaction, and actual construction works of project components. Bird habitats are expected to be affected through various processes and activities including:-

- Construction activities will result in destruction of bird habitats at the construction sites.
- Equipment activity at the proposed project site may result in trampling on habitats of ground dwelling birds, including bird nests.
- Project implementation may result in bird habitat fragmentation making the habitat less attractive to bird.
- Disturbance of birds may occur during all phases of the project as a result of increased on-site human activities during site preparation, and plant operation activities.

An analysis of the potential negative impacts likely to result from avifauna habitat loss using ecological Risk Assessment Matrix is as follows.

Table 33: Impact analysis for avifauna habitat loss

Unmitigated impacts on Avifauna habitat loss	
Extent of impact	2
Magnitude of impact	6
Duration of impact	5
Probability of impact	5
Risk = (Extent + Duration + Magnitude) x Probability	65
Confidence of Assessment	High (65)

13.3.8.2 Habitat Modification from associated project activities

Implementation of the proposed project may result in modification of habitats for avifauna at the proposed project site and its environs. Vegetation clearance to pave way for project implementation will destroy bird feeding grounds, bird nesting ground and complete interfere with the daily routine of the birds. The results of habitat modification to local avifauna will include;

- ✓ Disruption on breeding patterns which will results on diminished bird population.
- ✓ Migration and relocation of the affected bird species from the area which will affect the local food chain.
- ✓ Loss of ecological services associated with birds such as pollination.
- ✓ Destruction of migration route for migrant bird species.
- ✓ Destruction of foraging grounds of local resident species.

An analysis of the potential negative impacts likely to result from avifauna habitat modification using ecological Risk Assessment Matrix is as follows.

Table 34: Analysis of unmitigated impacts on avifauna habitat modification

Unmitigated impacts on Avifauna habitat modification	
Extent of impact	5
Magnitude of impact	6
Duration of impact	5
Probability of impact	5
Risk = (Extent + Duration + Magnitude) x Probability	80
Confidence of Assessment	High (80)

13.4 Proposed Mitigation Measures

13.4.1 Proposed mitigation measures of gaseous emissions

13.4.1.1 Mitigation of Sulfur Dioxide Emissions

Emission of sulfur dioxide from clinker production process can be mitigated by using the following technologies; inherent scrubbing, oxygen control (increase), fuel substitution (lower total sulfur), raw material substitution (lower sulfide sulfur), raw material alkali/sulfur balance, in-line raw mill, peheater upper stage hydrated lime injection, calcined feed recirculation, cement kiln dust internal scrubber, preheater upper stage trona injection and calcium-based internal scrubber. A brief explanation of each of the technology is as follows.

Inherent scrubbing

Inherent scrubbing is a combination of design characteristics of the cement pyroprocessing system which aid in removing some SO_2 from the flue gas stream. These include oxidizing atmospheres, long residence times, appropriate process temperature windows, intimate mixing of gases and reactive solids, and the ability to remove from the process an intermediate material, i.e., cement kiln dust (CKD), that contains absorbed sulfur.

Oxygen control (increase)

Control of SO2 originating in fuel can be improved by an increase in oxygen (excess air) in the rotary kiln. Oxygen increase will result in oxidizing of sulfur to a solid sulfate that is retained in the clinker or expelled from the system.

Fuel substitution (lower total sulfur)

In precalciner kiln systems, the emission of SO_2 that originates in the fuel is often nil because of the inherent ability of the calciner and an alkalibypass equipped kiln to absorb and/or remove sulfur. In the other systems and under certain process conditions, e.g., a deficiency of alkali metals, sulfur in the fuel can result in emissions of SO_2. It is intuitive that a reduction in the sulfur content of a solid fuel or the change to a sulfur free fuel, e.g., natural gas, has the potential to reduce SO_2 emissions.

Raw material substitution (lower sulfide sulfur)

Replacement of a raw material that contains sulfide sulfur with one of lower sulfide sulfur concentration reduces the potential for generation of SO_2 in the upper stages of the preheater tower. Sulfide sulfur in cement raw materials is most often in the form of iron pyrite but other sulfide compounds, including those of organic origin, may contribute to the potential for SO_2 generation. Selective purchasing, selective quarrying or judicious blending of available raw materials is used to accomplish the replacement.

Raw material alkali/sulfur balance

Raw material alkali/sulfur balance involves stoichiometrically balancing of the sulfur in the kiln system with the alkali metals, sodium and potassium. Under oxidizing conditions in the kiln, the sulfur preferentially forms alkali sulfates. If there is a deficiency in alkali metals, SO_2 can pass through the system even though there is an apparent abundance of calcium oxide with which the SO_2 could react and be retained in the clinker. Balancing the input of alkali metals to the input of sulfur can reduce SO_2 emissions.

In-line raw mill

The presence of finely divided calcium carbonate in the high-moisture atmosphere of an in-line raw mill, and the intimate contact of the solids and flue gas result in SO_2 scrubbing environment. A reduction in the concentration of SO2 in the flue gas is significant during mill operation.

Pre-heater upper stage hydrated lime injection

To serve as an SO_2 absorbing reagent, powdered hydrated lime (calcium hydroxide) can be introduced into an appropriate location in the upper stages of the preheater tower that is an integral component of both preheater or precalciner kiln systems. The hydrated lime and SO_2 can react directly or, more likely, the hydrate is converted to calcium oxide to form an effective scrubbing reagent at the location in the process where sulfide sulfur is being converted to SO_2.

Calcined feed recirculation

Calcined feed recirculation is a technology whereby a small quantity of partially calcined kiln feed, e.g., 5%, is removed from the calciner vessel of a precalciner kiln system and pneumatically conveyed to an appropriate point in the upper stages of the preheater tower. The calcium oxide in the calcined feed is an effective scrubbing reagent at the location in the process where sulfide sulfur is being converted to SO_2.

Cement kiln dust internal scrubber

Cement kiln dust internal scrubber is a technology in which dry, lime-rich CKD from the alkali bypass Particulate Matter Collection Device (PMCD) on a precalciner kiln system is re-circulated to the conditioning tower ahead of the bypass PMCD in the gas flow path. In the presence of the water in the conditioning tower that is used for temperature moderation, this calcium oxide becomes an effective SO_2 scrubbing reagent.

Preheater upper stage trona injection

A variant of the hydrated lime injection technology is the use of powdered trona, a naturally occurring crystalline form of sodium carbonate/sodium bicarbonate, as the absorbing reagent in a preheater tower. At temperatures found in the preheater tower, the sodium salt decomposes to sodium oxide with which the SO_2 can react and form a relatively stable solid.

Calcium-based internal scrubber

The conditioning tower used for flue gas temperature control at the discharge of the preheater tower of a preheater or precalciner kiln system initially can be installed as or subsequently retrofitted to become an internal dry scrubber using slurry of calcium hydroxide as the scrubbing reagent.

13.4.1.2 Mitigation of Nitrogen Oxides Emission

Emission of Nitrogen Oxides from clinker production process can be mitigated by using the following technologies; oxygen control (decrease), indirect firing, low-NOX burner, mid-kiln firing, process improvements, process control improvements, low-NOX calciner, staged combustion, semi-direct firing, mixing air fan and cement kiln dust insufflation. A brief explanation of each of the technology is as follows.

Oxygen control (decrease).

For control of NOX originating at the high temperature combustion site in a rotary kiln, a decrease in oxygen (excess air) in the burning zone tends to minimize the generation of thermal and fuel NOX. Both of these mechanisms of NOX formation are oxygen dependent. The reduction in excess air reduces the strength of the oxidizing conditions in the rotary kiln and usually causes an increase in SO_2 generated from the fuel used in the main flame.

Indirect firing

In the indirect-fired system, the powdered coal is separated from the drying and transport air by cyclones and/or fabric filters, and is stored in a bin or silo prior to being metered and pneumatically transported by ambient air to the combustion site. In an indirect-fired system, the primary air can be reduced to about 10-15% of the total combustion air. Since the generation of both thermal and fuel NOX is oxygen dependent, the reduction in available oxygen in the flame envelope in an indirect-fired coal system results in a reduction in NOX generation. Indirect coal firing systems generally result in improved thermal efficiency for the kiln system and a reduction in CO_2 emissions.

Low-NOX burner

Adjustable burners with proprietary designs reduce NOX generation through the mixing scheme for fuel and primary air by reducing flame temperature, altering turbulence in the flame, and establishing oxygen-deficient recirculation zones in the flame.

Mid-kiln firing

Mid-kiln firing primarily provides for staged combustion once per revolution of the kiln, a single charge of fuel is introduced into the calcining zone through the kiln shell using a gated feed device. As the carbonaceous fuel charge burns in the low oxygen environment of the calcining zone, free radicals are generated that in turn chemically reduce the NOX that was generated in the burning zone to molecular nitrogen.

Process improvements

Improvement in an existing kiln system that improves the thermal efficiency of the process will be accompanied by a reduction in long-term NOX emissions per ton of clinker this is primarily because of the reduced consumption of fuel per unit of production.

Process control improvements

Process control improvements are characterized by the installation of new or better instrumentation and/or process control systems. In older kiln systems, the improvement might mean replacing an analog process control system with a digital computer. In newer kiln systems with an adequate digital computer, the use of one of the expert or fuzzy logic control systems and the necessary process instrumentation could represent a significant process control improvement. In essence, the expert systems are satellite computers that guide the process computer in controlling the kiln system. They are able to detect subtle changes in the process and to take corrective action more rapidly than the central control room operator. The common purposes of most process control improvements on kiln systems are to improve thermal efficiency and the clinker production rate. However, if a process control improvement project simply results in a more stable pyroprocessing system, lower NOX emissions over the short term, the long term, and per ton of clinker will result.

Low-NOX calciner

Cement pyroprocessing systems offer proprietary calciner designs that carefully control the mixing sequence of fuel, air, and raw materials in the calciner vessel. The common feature of all these systems is an oxygen-deficient initial combustion zone in which free radicals are generated that subsequently react with NOX to form molecular nitrogen and other reaction products.

Staged combustion

Staged combustion (sometimes called secondary firing) involves developing a reducing zone in the flue gas flow path after the burning zone in which free radicals produced during staged combustion of hydrocarbon fuels react with NOX from the burning zone to form molecular nitrogen and other reaction products. The most prevalent location for staged combustion is in the riser duct between the discharge of the rotary kiln and the calciner vessel.

Semi-direct firing

Semi-direct firing systems for solid fossil fuels have the benefit of potentially reducing NOX generation through a reduction in primary air for the main kiln burner while avoiding the source of particulate matter emissions from the coal mill particulate matter combustion device found in an indirect-fired system. When compared to a direct-fired system, the reductions in NOX generation attributed to a semi-direct system can be as great as those that would be experienced with an indirect-fired system. Semi-direct firing systems mechanically separate the powdered coal in the coal mill exhaust from the coal drying and transport air to provide for better combustion control through independent metering of the coal being fed to the kiln and to sometimes reduce the quantity of primary air used in the main burner pipe.

Mixing air fan

Mixing air fan involves operating the flame at the discharge end of a rotary kiln with reduced oxygen at the combustion site, the generation rate of thermal and fuel NOX becomes less than if a large excess of oxygen were present. In addition, free radicals are formed in the flame that could react with NOX to form molecular nitrogen in the appropriate temperature window located downstream of the burning zone in the flue gas flow path.

Cement kiln dust insufflation

Cement kiln insufflations involves recycling usable Cement Kiln Dust (CKD) to the pyroprocess, CKD sometimes is injected or insufflated into the burning zone in or near the main flame. The presence of these cold solids within or in close proximity to the flame has the effect of cooling the flame and/or the burning zone thereby reducing the formation of thermal NOX.

13.4.1.3 Proposed mitigation of Carbon Monoxide Emission

Emission of carbon monoxide from clinker production process may be mitigated using the following technologies; good combustion practice, excess air (increase), raw material substitution, pyroprocessing system design and mixing air fan. A brief explanation of each this technology is as follows.

Good combustion practice

The most prevalent technology used for control of CO generation in cement kiln systems is good combustion practice. At each combustion site, adequate time, temperature, and turbulence are provided to make certain that the carbon component of the fuel is fully oxidized to CO_2. Good combustion practice contributes to maximum thermal efficiency, reduced operating cost, and the minimization of the emissions of NOX, CO_2, SO_2, and organic PICs.

Excess air (increase)

To provide for maximum thermal efficiency, the volumetric concentration of oxygen in the flue gas at the feed end of a rotary kiln and/or the exit of the preheater tower normally are held as close as possible to 1%. Because of site-specific conditions, this oxygen concentration may be insufficient to allow for complete combustion, and CO may be generated at the combustion site. A slight increase in the amount of air passing through the kiln system is often sufficient to reduce the excess CO emissions.

Raw material substitution

Some cement raw materials contain carbonaceous components that are only partially oxidized to CO in the low-temperature regions of the pyroprocess. These situations also may present excessive emissions of organic pollutants. Depending on local availability and costs, replacement of the offending raw material by selective purchasing, selective quarrying or judicious blending may be an effective technology to reduce emissions of CO and/or organic material.

Pyroprocessing system design

Emission of CO from unburned fuel represents an economic loss, to avoid this; the design of the clinker production plant should ensure complete combustion of fuels. In those situations where CO generation occurs simultaneously with the deliberate generation of free radicals used as reducing agents to minimize NOX emissions, the process normally is designed to oxidize residual CO to CO_2 once the NOX reduction has been accomplished.

Mixing air fan

Mixing air fun technology involves introducing high-pressure air in the range of a 2-10% replacement of the primary combustion air which is injected through the shell of the rotary kiln into the calcining zone to provide additional oxygen to the post-combustion flue gas to meet stoichiometric requirements and the kinetic energy necessary for the adequate mixing of flue gas within the kiln. To reduce CO emissions, this technology has an effective synergy with mid-kiln firing of solid fuel.

13.4.1.4 Mitigation measures of Carbon Dioxide Emission

Emission of carbon dioxide from clinker production process can be controlled using the following technologies; improved thermal efficiency, clinker substitution, improved electrical efficiency, raw material substitution and mineralizers. A brief explanation of each of the technology is as follows.

Improved thermal efficiency

The reduction in the amount of carbonaceous fuel burned in a cement kiln system through improved thermal efficiency has a direct relationship to the reduction in emissions of CO_2. Improvements in thermal efficiency are accomplished primarily through process and process control improvements. Maintenance of components of a kiln system that affect thermal efficiency, e.g., chains and seals, contribute to the maximization of the thermal efficiency of a given kiln system. Complete replacement of a kiln system with a more thermally efficient kiln system achieves a measurable reduction in CO_2 emissions per ton of clinker.

Clinker substitution

The substitution (blending) of other cementitious materials for clinker in the cement matrix reduces the amount of CO_2 generated per ton of cement produced and/or used. The blending can occur at the cement plant through intergrinding of the cementitious materials in the finish mill or at the location of the end user, e.g., a ready mixed concrete producer.

Improved electrical efficiency

A reduction in the amount of electricity used to produce a ton of cement indirectly results in lower emissions of CO_2 from fossil fuel fired power plants. Many of the pollution abatement technologies decrease the electrical efficiency of a cement plant, e.g., larger fans using more electrical power are required to overcome pressure drop across equipment or to move a larger volume of flue gas.

Raw material substitution

Raw material substitution can be marginally effective in reducing CO2 emissions from cement pyroprocesses. Through control of the chemistry of the raw material mix, the clinkering temperature can be lowered slightly thereby requiring marginally less carbonaceous fuel to complete the desired reactions. A change in raw materials is often necessary to significantly alter the raw mix chemistry.

Mineralizers

When added to the raw material mix, certain chemicals, e.g., calcium fluoride, are known to reduce significantly the clinkering temperature and the carbonaceous fuel required to sustain the pyroprocess.

13.4.1.4 Mitigation of Ammonia Emission

Emission of ammonia from clinker production process can be mitigated through raw material substitution and tailpipe scrubber technologies; A brief explanation of each of the technology is as follows.

Raw material substitution

The involvement of NH_3 in the formation of detached plumes and as a precursor to haze formation can be a concern. If a component of the raw material mix contains nitrogenous components that are converted to or liberated as NH_3 in the pyroprocess, the raw material could be replaced if a suitable, economically-viable substitute is locally available through selective purchasing, selective quarrying or judicious blending.

Tailpipe wet scrubber

NH_3 is highly soluble in water so a water spray tower should suffice to scrub NH_3 from the flue gas. The spray tower also would remove some soluble SO_2 and residual organic compounds from the flue gas.

13.4.2 Proposed mitigation measure of exposure to cement dust

Dust removal

Exposure to cement dust can be mitigated by removing the cement dust being generated. Three dust removal technologies to remove dust from the clinker production line namely water sprinkling, bag filters and electrostatic precipitators can be employed to remove the generated dust. Water sprinkling to remove dust can be done in three areas of the limestone crusher section namely at the limestone hopper, dump hopper and belt conveyor system. The bag filter technology can be used in the plant to suck out dust generated. The system can be used in the following sections limestone crusher, limestone pre-blending stockpile, additive storages, raw material hoppers, raw mill building, blending silo, pre-heater tower, coal mill, clinker storage and dispatch station, cement mill and cement packaging and dispatch. Electrostatic precipitator technology can employed at the clinker crusher section.

Dust removal by use of bag filter technology

High efficiency fabric filters are used for controlling dust emissions from cement production material handling and product bagging systems. The bag filters system range in number depending on the size and production capacity of the cement plant. Separate fabric filter control systems ranging in size from 30 actual cubic meters per minute capacity to more than 100,000 actual cubic meters per minute capacity. Fabric filter operation can be described in three sequential steps:

- ✓ Filtration of particles from the gas stream
- ✓ Gravity settling of the dust cake
- ✓ Removal from the hopper

Each of these steps must be performed properly to ensure high efficiency particulate collection. In fabric filter systems, particles are removed by 1) inertial impaction, 2) Brownian displacement, 3) electrostatic attraction, and 4) sieving. All four of these mechanisms are active in essentially all fabric filters simultaneously; however, the relative importance of each mechanism differs among fabric filter systems due primarily to the characteristics of the filtration media, the particulate matter size distribution, and the chemical composition of the particulate matter. The ability of fabric filters systems to remove particles over the entire size range of industrial concern of 0.1 to 100 micrometers is achieved due to the complementary characteristics of these removal mechanisms. Inertial impaction is highly efficient for large particles and Brownian displacement is efficient for small particles. Electrostatic attraction and sieving can be effective over the entire particle size range.

Proper design, operation, and maintenance are needed to achieve high removal efficiency.

- ✓ One of the main design requirements is to provide sufficient filter media in the fabric filter system. The quantity of filtration media is expressed in terms of the air-to-cloth ratio (gross) defined below: A/C=Gas flow rate, m^3/min (actual)/Total filtration media area, m^2n As the air-to-cloth ratio increases, the localized gas velocities through the dust cake and fabric increase. At high air-to-cloth values, some small particles can gradually migrate through the dust layer and fabric. This is possible because dust particles within the cake are retained relatively weakly. After passing through the dust cake and fabric, these particles are re-entrained in the clean gas stream leaving the bag. To minimize emission problems related to excessively high air-to-cloth ratios, the design levels are limited. As an example, typical air-to-cloth ratios for plenum pulse fabric filters usually range from 0.6 to 2.4 (m^3/min per m^2).

- ✓ A second important design requirement is to provide sufficient filtration media cleaning capability. Routine cleaning of the filtration media is needed to ensure that a portion of the dust is removed from the filtration media surfaces to prevent excessively high gas flow resistance. In most types of fabric filters, agglomerated clumps or flakes of particulate matter are removed from the filter media surface. By allowing the material to agglomerate on the particle surface, the gravity settling of material from the vertical filter media to the hoppers below is facilitated. As indicated earlier, gravity settling of the collected material is an essential second step in the filtration process. Optimal cleaning of fabric filters also requires cleaning on the frequency and intensity most appropriate for the specific characteristics of the dust cake. Plant personnel operating and maintaining the fabric filters have an important role in ensuring proper cleaning. Bags that are allowed to collect dust have critical impacts on the entire system. Fugitive emissions increase, pressure drop across the bag house increases due to higher system resistance, the flow rate along with the fan current decreases for the same reason, the fan static pressure increases, and the hood static pressure decreases along with the decrease in flow rate.
- ✓ The third general design area of importance in all fabric filtration systems is the solids collection and handling systems. Cement plant sources generate relatively large quantities of material that must be collected and transported. Continuous removal of the solids from the fabric filter system is needed to ensure proper operation.

Cement dust management

Keeping in view the hazards of cement dust it is advisable therefore, the cement industry management, their workers and health officials should work together to adopt technical preventive measures, such as well-ventilated work areas and workers should wear appropriate personal protective equipment. It is also suggested that cement mill workers must undergo pre-employment and periodic medical surveillance tests. These measures would help to identify susceptible workers in due time and improve the technical preventive measures that will decrease the risk of occupational hazards in the cement industrial workers.

Potential negatively impacts likely to a result from exposure to cement dust can be mitigated in the following ways among others:-

- Proper maintenance of the de-dusting systems i.e. water sprinkling, bag filters and electrostatic precipitators to ensure efficiency in dust collection.
- Workers to undergo pre-employment and periodic medical surveillance tests by a designated medical practitioner.
- Workers working in dusty area should wear appropriate Personal Protective Equipment all the time.
- Management to ensure strict enforcement on the use of personal protective equipment by all workers.
- Management to ensure that the workplace is always well ventilated.
- Workers to be trained on the importance of making proper use of personal protective equipment provided.

13.4.3 Proposed mitigation measures of increased noise

Management of noise effects

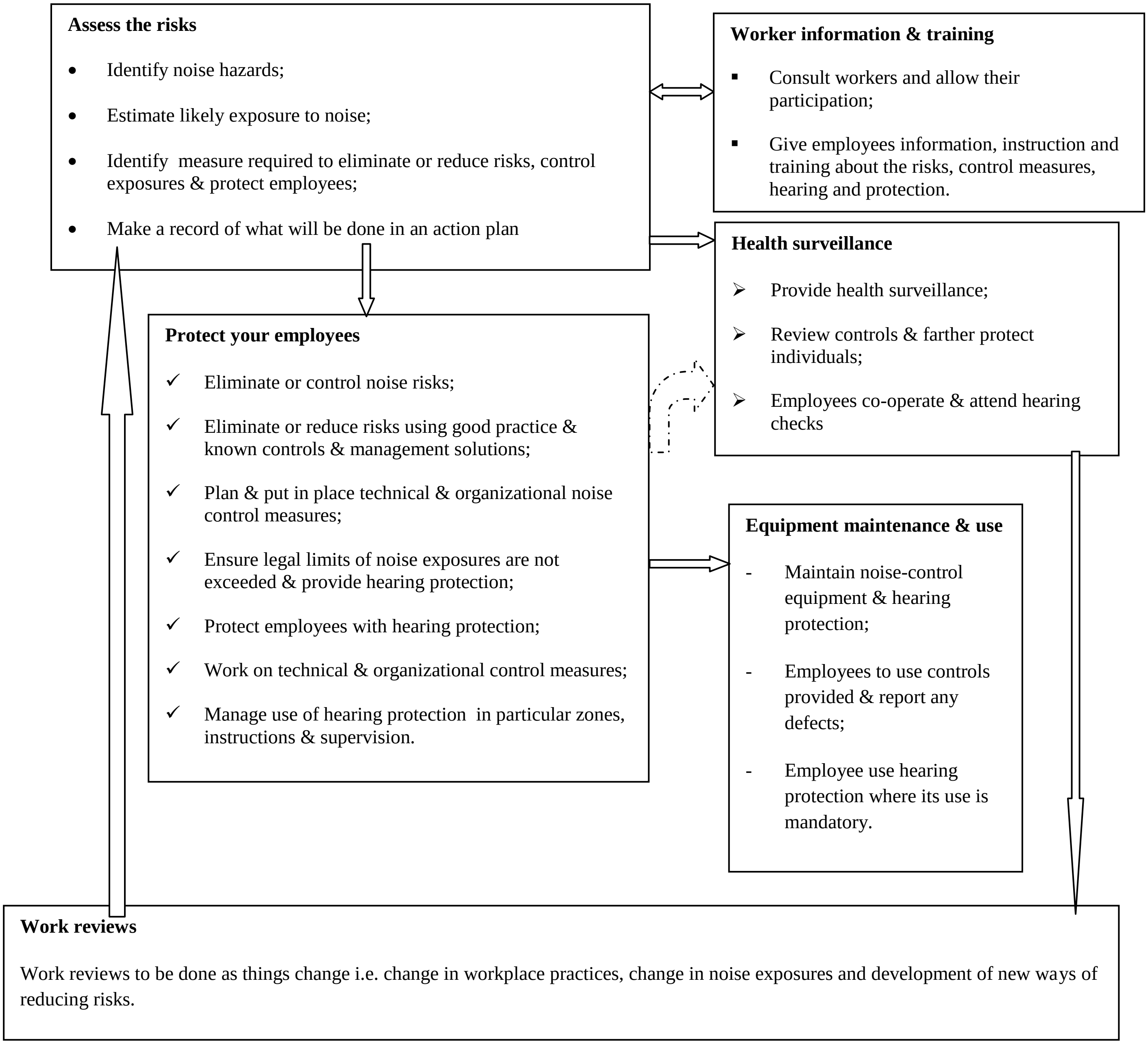
Management of the noise risks can be done in six steps namely:-

- ✓ Assessing the risks
- ✓ Protecting employees
- ✓ Maintaining and equipment use

- ✓ Training and sensitising of workers
- ✓ Health surveillance
- ✓ Work reviews

Assessing of noise risks involves identification of noise hazards at the work place and developing the appropriate action plans. Employee protection involves elimination or controlling noise risks to acceptable legal limits by use good practice, appropriate engineering controls and employee protection. Equipment use and maintenance involves appropriate use of all noise control equipment and appropriate use of hearing protection. Training and sensitization of workers involves employee accessing information and training on noise risks, control measures and hearing protection. Health surveillance involves hearing checks for exposed workers and using result to improve on protection of the workers. Work reviews involve constant review of work practice, changes in noise exposure and new ways to reduce risks. The figure below is a schematic flow chart that summarises how to manage noise risks.

Figure 16: schematic flow chart for managing noise risks



13.4.4 Proposed measures to mitigate against solid waste generation

Measures that can be put in place to mitigate solid waste generation may include appropriate management practices and deliberate innervations aimed at minimization of waste generation.

Management practices

Some of the management practices that can be put in pace to mitigate waste generation include:-

⇒ Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences.

⇒ Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.

⇒ Avoiding or minimizing the generation waste materials, as far as practicable.

⇒ Where waste generation cannot be avoided but has been minimized, recovering and reusing waste.

⇒ Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner.

⇒ Collection of data and information about the process and waste streams in existing facilities, including characterization of waste streams by type, quantities, and potential use/disposition.

⇒ Establishment of priorities based on a risk analysis that takes into account the potential EHS risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally sound manner.

⇒ Definition of opportunities for source reduction, as well as reuse and recycling.

⇒ Definition of procedures and operational controls for onsite storage.

⇒ Definition of options / procedures / operational controls for treatment and final disposal.

Waste generation prevention

The cement production processes should be designed and operated to prevent, or minimize, the quantities of wastes generated and hazards associated with the wastes generated in accordance with the following strategy:

✓ Substituting raw materials or inputs with less hazardous or toxic materials, or with those where processing generates lower waste volumes.

✓ Applying manufacturing process that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls.

- ✓ Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off specification, contaminated, damaged, or excess to plant needs.

13.4.5 Proposed measures to mitigate wastewater generation

Utilities operations wastewater management

Utility operations such as cooling tower and demineralization systems may result in high rates of water consumption, as well as the potential release of high temperature water containing high dissolved solids, residues of biocides, residues of other cooling system and anti-fouling agents. Recommended water management strategies for utility operations include:

- ⇒ Adoption of water conservation opportunities for facility cooling systems.
- ⇒ Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations.
- ⇒ Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local regulatory requirements and manufacturer recommendations.
- ⇒ Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

Sanitary Wastewater management

Sanitary wastewater includes effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories, medical infirmaries, water softening plant. Recommended sanitary wastewater management strategies include:

- ⇒ Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage).
- ⇒ Segregation and pretreatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into the environment.
- ⇒ Treatment to meet national standards for sanitary wastewater discharges .
- ⇒ Sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet Environmental Management and Coordination (Water Quality) Regulations, 2006, standards for sanitary wastewater discharges.
- ⇒ Sludge from sanitary wastewater treatment systems should be disposed in compliance with Environmental Management and Coordination (Water Quality) Regulations, 2006.

Storm water management

Storm water includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically storm water runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, etc. Rapid runoff, even of uncontaminated storm water, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for storm water treatment, the following principles should be applied.

- ✓ Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.
- ✓ Surface runoff from process areas or potential sources of contamination should be prevented.
- ✓ Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff;
- ✓ Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds).

- ✓ Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present.
- ✓ When water quality criteria allow, storm water should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility.
- ✓ Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.
- ✓ Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with the Environmental Management and Coordination (Water Quality) Regulations, 2006.

13.4.6 Proposed mitigation measures of occupational injuries and accidents

Methods to prevent and control exposure to dust include the following:-

- ⇒ Control of dust through implementation of good housekeeping and maintenance.
- ⇒ Use of air–conditioned, closed cabins.
- ⇒ Use of dust extraction and recycling systems to remove dust from work areas, especially in grinding mills.
- ⇒ Use of air ventilation (suction) in cement-bagging areas.
- ⇒ Use of PPE, as appropriate (e.g. masks and respirators) to address residual exposures following adoption of the above-referenced process and engineering controls.
- ⇒ Use of mobile vacuum cleaning systems to prevent dust buildup on paved areas.

Recommended prevention and control techniques against exposure to heat include the following:

- ✓ Shielding surfaces where workers' proximity and close contact with hot equipment is expected.
- ✓ Using personal protective equipment (PPE), as needed (e.g. insulated gloves and shoes).
- ✓ Minimizing the work time required in high temperature environments by implementing shorter shifts at these locations.
- ✓ Making available and using, as needed, air- or oxygen supplied respirators.

- ✓ Implementing specific personal protection safety procedures in the process to avoid potential exposure to exothermic reactions.

Control of noise emissions may include the following:

- Use of silencers for fans.
- Room enclosures for mill operators.
- Noise barriers and attenuators.
- Personal hearing protection.

The potential accidental contact with chemicals such as CaO / CaOH on skin / eyes / mucous membranes is a specific hazard in clinker/ cement production that needs to be assessed, prevented, and mitigated through emergency procedures and equipment. The presence of moisture may result in burns. Facilities for immediate washing of the affected body surface should be available, including eyewash facilities. The handling areas should be covered and enclosed, if possible, to avoid generation of a dust hazard.

13.5 Action Plans

The following action plans are proposed in line with the predicted potential negative impacts of the proposed project.

- ✓ Sulphur dioxide emission action plan
- ✓ Nitrogen oxides emissions action plan
- ✓ Carbon monoxide emission action plan
- ✓ Carbon dioxide emission action plan
- ✓ Ammonia emission action plan
- ✓ Clinker and cement dust management action plan
- ✓ Noise management action plan
- ✓ Solid waste management action plan
- ✓ Liquid waste management action plan
- ✓ Occupational safety and health management action plan
- ✓ Traffic management action plan

Table 35: Sulphur dioxide Emission Action Plan

Activity	Potential Environmental and Health Impacts	Proposed Mitigation measures	Monitoring	Actors	Timeframe	Cost estimate (KSh)
Release of sulphur gases SO_x	• Pollution of upper atmosphere that result in the formation of smog • Acid rain effect on plant, wildlife and property • Precursor of fine particulate soot, which	• inherent scrubbing, oxygen control (increase), fuel substitution (lower total sulfur), raw material substitution (lower sulfide sulfur), raw material	• monitoring of atmospheric SO2 using UV fluorescence or other sensors • Measurement of emission standards • Continuous checking of clinker and cement	• Plant Head MCL Vipingo	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	500,000

	poses a significant health threat • Respiratory illness, alterations in the lungs' defences and aggravation of existing cardiovascul ar disease.	alkali/sulfur balance, in-line raw mill, peheater upper stage hydrated lime injection, calcined feed recirculation, cement kiln dust internal scrubber, preheater upper stage trona injection and calcium-based internal scrubber	production technology and related processes			

Table 36: Nitrogen Oxides Emissions Action Plan

Activity	Potential Environmental and Health Impacts	Proposed Mitigation measures	Monitoring	Actors	Timeframe	Cost estimate (KSh)
NO_x Emissions	• formation acid rain which may negatively plant and animal life • visibility impairment through formation of " brown cities" • eutrophication that is, explosive algae growth which can	• oxygen control (decrease), indirect firing, low-NOX burner, mid-kiln firing, process improvements, process control improvements, low-NOX calciner,	• compliance with international national ambient air quality, emission standards and meeting of NO_x air quality index	• Plant Head MCL Vipingo	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	150,000

	deplete oxygen in water bodies • It contributes to global warming • respiratory illness in young children and harm lung function in people with existing respiratory illnesses • increased susceptibility to respiratory infection and alterations in the lung,	staged combustion, semi-direct firing, mixing air fan and cement kiln dust insufflation				

	nausea, irritated eyes and/or nose, fluid forming in lungs and shortness of breath • formation of ozone of fine particulate soot in the lower atmosphere					

Table 37: Carbon Monoxide emission Action Plan

Activity	**Potential Environmental and Health Impacts**	**Proposed Mitigation measures**	**Monitoring**	**Actors**	**Timeframe**	**Cost estimate (KSh)**
CO emission	• CO contributes to the formation of smog, ground-level ozone, which can trigger serious respiratory problems. • Greenhouse gas hence contribution	• Good combustion practice, excess air (increase), raw material substitution, preprocessing system design and mixing air fan.	• Adopting Direct control Carbon monoxide (CO) monitor • Using NEMA accredited laboratories to measure emission standards	• Plant Head MCL Vipingo •	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	150,000

	to global warming • Formation of acid rain potentially damaging to plants, animals and property • harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues		• Continuous checking of coal production technology and related processes			

	• Central Nervous System Effects					

Table 38: Carbon dioxide Emission Action Plan

Activity	**Potential Environmental and Health Impacts**	**Proposed Mitigation measures**	**Monitoring**	**Actors**	**Timeframe**	**Cost estimate (KSh)**
CO_2 Emission	• Formation of acid rain, weak carbonic acid • Major source of green house gas • Causes	• improved thermal efficiency, Clinker substitution, improved electrical efficiency, raw material substitution and	• Continuous checking of production technology and related processes	• Plant Head MCL Vipingo	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous	150,000

	global warming	mineralizers			improvement	

Table 39: Ammonia Emission Action Plan

Activity	**Potential Environmental Impacts**	**Proposed Mitigation measures**	**Monitoring**	**Actors**	**Timeframe**	**Cost estimate (KSh)**
Ammonia emission	• Both gaseous and particulate ammonia contribute to eutrophication of surface waters, • soil acidification	raw material substitution and tailpipe scrubber technologies	• Regular checking of tailpipe scrubber • ammonia gas detector • ammonia sensors • ammonia test kits • dissolved	• Plant Head MCL Vipingo	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	150,000

	• fertilization of vegetation • changes in ecosystems and • smog and decreased visibility in cities and pristine areas. • Irritation of respiratory track		ammonia monitoring			

Table 40: Clinker and cement dust management action plan

Issue/concern	Potential negative environmental impacts	Proposed mitigation measures	Environmental Monitoring	Responsible actors	Time frame	Cost estimate (KSH)
Clinker and cement dust pollution	-Occupational illness (lung infection, itching skin, eye irritation, coughing, to workers and other people exposed to the cement dust; - Reduced visibility; Chocking of plants	-Ensure de-dusting system is always efficient; -workers to use appropriate PPE; -Strict enforcement on PPE use; -Ventilation at workplace to be sufficient;	-Dust surveys Results of periodic dust surveys within the production line, packaging line and the neighbourhood of the facility to determine dust levels from time to time; - Medical severance Results of medical tests of	Plant Head MCL Vipingo -MCL workers - County Occupational Safety and Health Officer -District Environmental Officer; -Neighbours;	-Dust surveys should be carried preferable every six month; -Medical severance should be carried out every twelve months	500,000

Issue/concern	Potential negative environmental impacts	Proposed mitigation measures	Environmental Monitoring	Responsible actors	Time frame	Cost estimate (KSH)
			workers likely to be exposed to cement dust	and -The general public		

Table 41: Noise management action plan

Issue/Concern	**Potential Negative Impacts**	**Proposed Mitigation Measures**	**Responsible Actors**	**Monitoring Indicators**	**Timeframe**	**Approximate Cost (KSH)**
High noise level at the workplace	-Noise induced hearing loss -Poor concentration at the	➢ Developing and implementing an effective noise control and hearing conservation programme; ➢ Carrying out periodic noise measurements;	-Plant Head MCL Vipingo MCL staff	Reduction of noise levels at the workplace to the stipulated	The proposed mitigation measures to be implemented from the beginning of the	450,000

Issue/Concern	Potential Negative Impacts	Proposed Mitigation Measures	Responsible Actors	Monitoring Indicators	Timeframe	Approximate Cost (KSH)
	workplace -Reduced productivity	➢ Fitting noise machines with noise reduction devices; ➢ Providing suitable hearing protection to all workers exposed to noise levels above 85dB(A); ➢ Posting notices and signs in noisy areas; ➢ Carrying out audiometric test by a designated medical practitioner to all workers exposed to noise levels above 85dB(A); ➢ Educating all workers on importance of marking correct		legal limits	implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	

Issue/Concern	Potential Negative Impacts	Proposed Mitigation Measures	Responsible Actors	Monitoring Indicators	Timeframe	Approximate Cost (KSH)
		use of PPE provided to protect them against high noise levels.				

Table 42: Solid waste management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH0
Process solid waste management and disposal	- Air pollution especially from kiln dust; - Skin irritation when in contact; - Water	- Recycle and reuse where applicable; - Segregate for appropriate disposal; - Process improvement to minimize	Quantity of process waste generated	Plant Head MCL Vipingo	From the onset of the production process and then throughout the operational life of the plant	500,000 per year

	pollution, - Production loss, - Irritation of eyes; - Chocking of plants	waste generations. - Material substitution to minimize waste generation. - Technological improvement to minimize waste generation				
Domestic waste management and disposal	- Odor from decomposing food leftovers; - Blockage of drainage system	- Sorting of waste at source; - Waste disposal as provided for in the Environmenta l	- Regular checking of handling areas; - Waste disposal records.	MCL top management, other workers, the general public,.	From the onset of the production process and then throughout the operational life of the plant	250,000 per year

		Management and Coordination (Waste Management) Regulations, 2006. - Provide appropriate waste handling receptacles.				
Office waste management and disposal	Some electronic office waste such as used tonner cartridges and absolute office electronic equipment container hazardous	- Absolute electronic equipment and other electronic waste to be returned to manufacturers for safe	Records of disposal	MCL top management, other workers, the general public, h	From starting of operation of the plant and then be sustained throughout the operational life of the plant	100,000 per year

	substances	disposal				

Table 43: Liquid waste management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
Utilities operations wastewater	- Water shortage due to high use - Water contamination due to high dissolved solids and other contaminants	- Adaption of water conservation opportunities - Minimizing use of antifouling and corrosion inhibiting chemicals; - Testing for residual biocides and other	Sampling and testing for conformity with Water quality standards before discharge	Plant Head MCL Vipingo	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous	1,000,000 per year

		pollutants of concern. - pH adjustment; - Sedimentation for suspended solids reduction using settling basins or clarifiers; - Multimedia filtration for reduction in non settleable suspended solids.			improvement	
Sanitary Wastewater	- Contamination of ground water; - Odor	- Segregation of wastewater streams; - Treatment to	Sampling and testing for conformity with Water quality	MCL top management, MCL, employees,	The proposed mitigation measures to be implemented	1,000,000 per year

		meet national standards for sanitary wastewater discharge	standards before discharge	NEMA, Public Health	from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	
Storm water	- Degradation of the quality of water of the receiving water body. - Contamination of soils; - Erosion	- Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of	Sampling and testing for conformity with Water quality standards before discharge	MCL top management, MCL, employees, NEMA, WRMA, Public Health	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained	2,000,000 per year

		wastewater to be treated prior to discharge; ✓ Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using			throughout the project cycle ensuring continuous improvement	

		vegetated swales and retention ponds); - Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.				

Table 44: Occupational safety and health management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
Dust	- Lung infection, - Itching skin, - Eye irritation, - Coughing, to workers and other people exposed to the cement dust.	- good housekeeping and maintenance; - Use of air–conditioned, closed cabins; - dust extraction and recycling systems - air ventilation (suction)	- Dust survey every six months; - Visual observations; - Medical examination of workers exposed to dust	MCL top management Workers General public	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	5,000,000 per year
Heat	- Physical	- Shielding	- Periodic Heat	MCL top	Proposed	500,000 per

	burns of workers exposed to heat; - Burning and damage to process equipment.	surfaces; - using personal protective equipment; - Minimizing the work time required in high temperature environments by implementing shorter shifts; - Use of air- or oxygen supplied respirators.	measurement	management Workers	mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	year
Noise and vibrations	- Noise induced	- Use of silencers for	- Noise survey at the workplace	MCL top management	Proposed mitigation	1,000,000 per year

	hearing loss; - Poor concentration at workplace; - Reduced productivity.	fans; - Room enclosures for mill operators; - Noise barriers; - Personal hearing protection	every twelve months; - Audiometric test for workers exposed to high noise levels	Workers	measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	
Physical hazards,	- Slip; - Trips; - Falls; - Contact will falling/moving parts	- Good housekeeping; - Ensure surfaces are not slippery; - Clearly mark all uneven surfaces; - Guarding of	- Physical checking/inspections of all workplaces at short intervals	MCL top management Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional	500,000 per year

		machine moving parts; - Provide and mark safe passages and exits; - Spills to be promptly cleaned.			life of the plant	
Radiation	- Exposure to radiations	- Implementation of ionizing radiation protection measures	- Periodic radiation survey of affected areas	MCL top management DOSH NEMA Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional	500,000 per year

					life of the plant	
Chemical hazards and other industrial hygiene issues	- Physical burns; - Sickness/ - disease/ill health	- PPE use; - Appropriate handling as per material safety data sheets; - Training and sensitizations. - Medical examination of exposed workers	- Sport checks at workplaces on appropriate handling	MCL top management DOSH NEMA Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	500,000

Table 45: Traffic management action plan

Issue/Concern	Potential negative impacts	Proposed mitigation measures	Responsible actors	Monitoring	Timeframe	Cost estimates KSH
Increased vehicular traffic along Mombasa Kilifi Road at the junction of Mombasa Cement Vipingo	✓ Potential delays at the junction as traffic enters and exits the highway ✓ More traffic on the said road may translate to increased use of the road and hence increased wear and tear.	✓ Liaise with the Kenya National Highway Authority for permission to construction an acceleration/deceleration lane for safe entry and exit of the highway. ✓ Liaise with Kenya National Highway Authority to ensure that appropriate road signs before the exit/entry junction	Plant Head Mombasa Cement Limited Vipingo Unit	✓ Records of traffic number in and out of the project site. ✓ Flow of traffic in and out of the plant during construction phase. ✓ Record of vehicular	Implementation of the proposed mitigation measures to be put in place during the proposed project implementation phase and to be sustained and improved on throughout the lifecycle of the project	2,000,000 for construction of an acceleration/ decoration lane

Issue/Concern	Potential negative impacts	Proposed mitigation measures	Responsible actors	Monitoring	Timeframe	Cost estimates KSH
	✓ Likelihood of accidents, incidents and mere misses at the said turnoff from the highway	are erected ✓ Drivers to strictly observe the Highway Code. ✓ Speed limits to be strictly observed.		accidents and incidents.		
Parking of lorries outside MCL premises	✓ Inconvenience to other motorists and other road users	✓ Provide sufficient space for internal parking of lorries awaiting to deliver material or to collect material	Plant Head Mombasa Cement Limited Vipingo	Checking of available space provided for parking of lorries within the plant premises	Provision of internal parking of lorries should be implemented within the first six months of project implementation	500,000 for construction and paving of lorry parking yard internally

13.6 Environmental Monitoring, Auditing and Community basic grievanve redress mechanism

13.6.1 Environmental Monitoring, Auditing

In order to ensure good environmental management over the life of the MCL Vipingo Cement plants management should undertake the monitoring and auditing of the quality of key environmental parameters and the environmental management plan as a whole. Monitoring should involve measuring, observing, recording, evaluation and recording of physical, social and economic variables associated with the development impacts such as:

1. Air quality
2. Occupational health and safety
3. Soil contamination
4. Water quality
5. Waste management
6. Quarry rehabilitation

13.6.1.1 Ambient Air Quality

Identified potential emissions from clinker and cement manufacturing are airborne pollutants, primarily as exhaust gases and dust. There are three main sources of gaseous emissions from a cement kiln system namely raw materials, the fuel, and the process itself. Typical pollutants include oxides of sulfur, nitrogen (SOx and NOx), Carbon, Ammonia and particulates from a variety of solids processing and handling operations. To promote a clean a healthy environment for both the workers and surrounding communities monitoring of air quality at both the factory and the quarries were raw material will be sourced will be carried out as prescribed in the Environmental

Management and Coordination (Air Quality) Regulations 2009. The table below is an extract from the said regulations of the prescribed air quality tolerant limits.

Table 46: Ambient Air Quality Tolerance Limits

	Pollutant	**Time weighted Average**			
			Industrial area	**Residential, Rural & Other area**	**Controlled areas*** **
1.	Sulphur oxides (SOX);	Annual Average*	80µg/m³	60 µg/m³	15µg/m³
		24 hours**	125 µg/m³	80µg/m³	30 µg/m³
		Annual Average		0.019 ppm/50 µg/m³	
		Month Average			
		24 Hours		0.048ppm /125µg/m³	
		One Hour			
		Instant Peak		500 µg/m³	
		Instant Peak (10 min)		0.191 ppm	
2.	Oxides of Nitrogen (NOX);	Annual Average*	80µg/m³	60 µg/m³	15 µg/m³

		24 hours**	150 µg/m³	80µg/m³	30 µg/m³
		8 hours			
		Annual Average		0.2 ppm	
		Month Average		0.3 ppm	
		24 Hours		0.4 ppm	
		One Hour		0.8 ppm	
		Instant Peak		1.4 ppm	
3.	Nitrogen Dioxide	Annual Average	150 µg/m³	0.05 ppm	
		Month Average		0.08 ppm	
		24 Hours	100µg/m³	0.1 ppm	
		One Hour		0.2 ppm	
		Instant Peak		0.5 ppm	
4.	Suspended particulate matter (SPM)	Annual Average*	360 µg/m³	360 µg/m³	70 µg/m³
		24 hours**	500 µg/m³	200 µg/m³	100 µg/m³
		Annual Average****		100 µg/m³	
		24 hours***		180 µg/m³	

5.	Respirable particulate matter (<10 m) (RPM)	Annual Average*	70µg/m³	50 µg/m³	50 µg/m³
		24 hours**	150µg/Nm³	100µg/Nm³	75µg/Nm³
6.	PM2.5	Annual Average	35µg/m³		
	24 hours	75 g/m3			
7.	Lead (Pb)	Annual Average*	1.0 µg/Nm³	0.75 µg/Nm³	0.50 µg/m³
		24 hours**	1.5µg/m³	1.00 µg/m³	0.75µg/m³
		Month Average		2.5	
8.	Carbon monoxide (CO)/ carbon dioxide (CO2)	8 hours**	5.0 mg/m³	2.0 mg/m³	1.0 mg/m³
		1 hour	10.0 mg/m³	4.0 mg/m³	2.0 mg/m³
		24 hours**			
9.	Hydrogen Sulphide	24 hours**	150 µg/m³		
10.	Non-methane				

	hydrocarbons				
		instant Peak	700ppb		
11.	Total VOC	24 hours**	600 µg/m³		
12.	Ozone	1-Hour	200 µg/m³	0.12 ppm	
		8 hour (instant Peak)	120 µg/m³	1.25 ppm	

Legend

a) µg- microgram

b) m³ – cubic metre

c) ppm – parts per million

d) ppb – parts per billion

e) Values at Standard Temperature and Pressure (STP)

f) Conversion factors from ppm to mg/m³ and mg/m³ to ppm are stipulated under the Eleventh

Schedule

g) * Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

h) ** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

i) Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.

j) the 24-hour limit may not be exceeded more than three times in one year;

k) ** 24-hour limit may not be exceeded more than three times in one year micrograms/m3

l) *** Not to be exceeded more than once per year average concentration m)***In conversion of units from ppm to mg/m3 and vice versa shall use guidelines set out under Part II of the Fifth Schedule.

Source: Environmental Management and Coordination (Air Quality) Regulations 2009

Table 47: Ambient Air Quality at Property Boundary for General Pollutants

	Pollutant	**Time weighted Average**	**Property Boundary**
1.	Particulate matter (PM)	Annual Average*	50 µg/m3
		24 hours**	70 µg/m3
2.	Oxides of Nitrogen (NOX);	Annual Average*	80 µg/m3
		24 hours**	150 µg/m3
3.	Sulphur oxides (SOX);	Annual Average*	50 µg/m3
		24 hours**	125 µg/m3
4.	Hydrogen Suphide	24 hours**	50 µg/m3
5.	Ammonia	24 hours**	100 µg/m3

Note.

a) For residential premises in designated industrial areas, the above standards do not apply.

b) For industries in designated residential areas, standards for residential areas shall apply.

Source: Environmental Management and Coordination (Air Quality) Regulations 2009

13.6.1.2 Occupational Health and Safety

Occupational health and safety of employees is of paramount importance in safeguarding their overall health and ensuring the increased productivity. Towards this end monitoring of health and safety of employees will be undertaken as part of the project core activities. This will involve an annual comprehensive medical examination of workers by a Designated Medical Practitioner and analysis and reporting of results in the annual Environmental Audits. Noise level survey at the work environment will be undertaken and corrective actions to be undertaken as need arise on a continuous basis.

MCL Vipingo will:

(1) Incorporating safety into the working culture of the organization though continuous reinforcement of safe working practices, use of safety awards, and senior executive attention.

(2) Initiate a systematic program for tracking, reporting, and analyzing all safety related incidents at the inception of the project.

3) Undertake an ongoing analysis of incidents, responses and progress to provide information and focus on continuous improvement in the working environment.

13.6.1.3 Soil Contamination

Potential soil pollution through oil and fuel spill in the maintenance workshop, yards and garages within the plant area will need to be monitored**.** Soil sampling should be undertaken from these potential oil spill areas be analyzed for concentrations of hydrocarbons, lead (Pb), Cd and soil pH.

13.6.1.4 Water Quality

Water quality management will involve monitoring of key pollutants that serve as indicators of acceptability of water for other uses. Monitoring of water quality for human consumption will include: measurements of fecal coliform; toxic organics such as benzene, trichloroethane, tetrachloroethene, chlorophenols; polynuclear aromatics such as benzo(a)pyrene, carbon tetrachloride, polychlorinated biphenyls (PCBs), dioxins, and furans; oil and grease; pH; toxic metals, including arsenic, cadmium, chromium, copper, lead, and mercury; and cyanides, as well as color, taste, odor, turbidity, and hardness.

Table 48: Summary of parameters to be monitored

PHYSICAL PARAMETERS	Frequency
pH	quarterly
Color	quarterly
CHEMICAL PARAMETERS	
COD – Chemical Oxygen Demand	quarterly
TDS Total dissolved solids	quarterly
TSS Total Soluble solids	quarterly
Sulfide	quarterly
Oil and grease	quarterly
ORGANIC COMPOUNDS	
Total Organic Carbon	quarterly
PAHs	quarterly

METALS	
Arsenic	quarterly
Cadmium	annually
Chromium	annually
Lead	annually
Mercury	annually
BIOLOGICAL PARAMETERS	
Total plate count	
Total Coliform Count	quarterly
Faecal coliform count	quarterly
Streptococcus faecalis	quarterly
Pseudomomas aeruginosa	quarterly

13.6.1.5 Waste management and Disposal

Solid waste that will be generated from the entire production process must be handled carefully especially if not recycled back into the system. This waste must be weighed and accurate records of disposal kept. Liquid waste particularly used oil will be inventoried and accurate records of disposal be properly maintained.

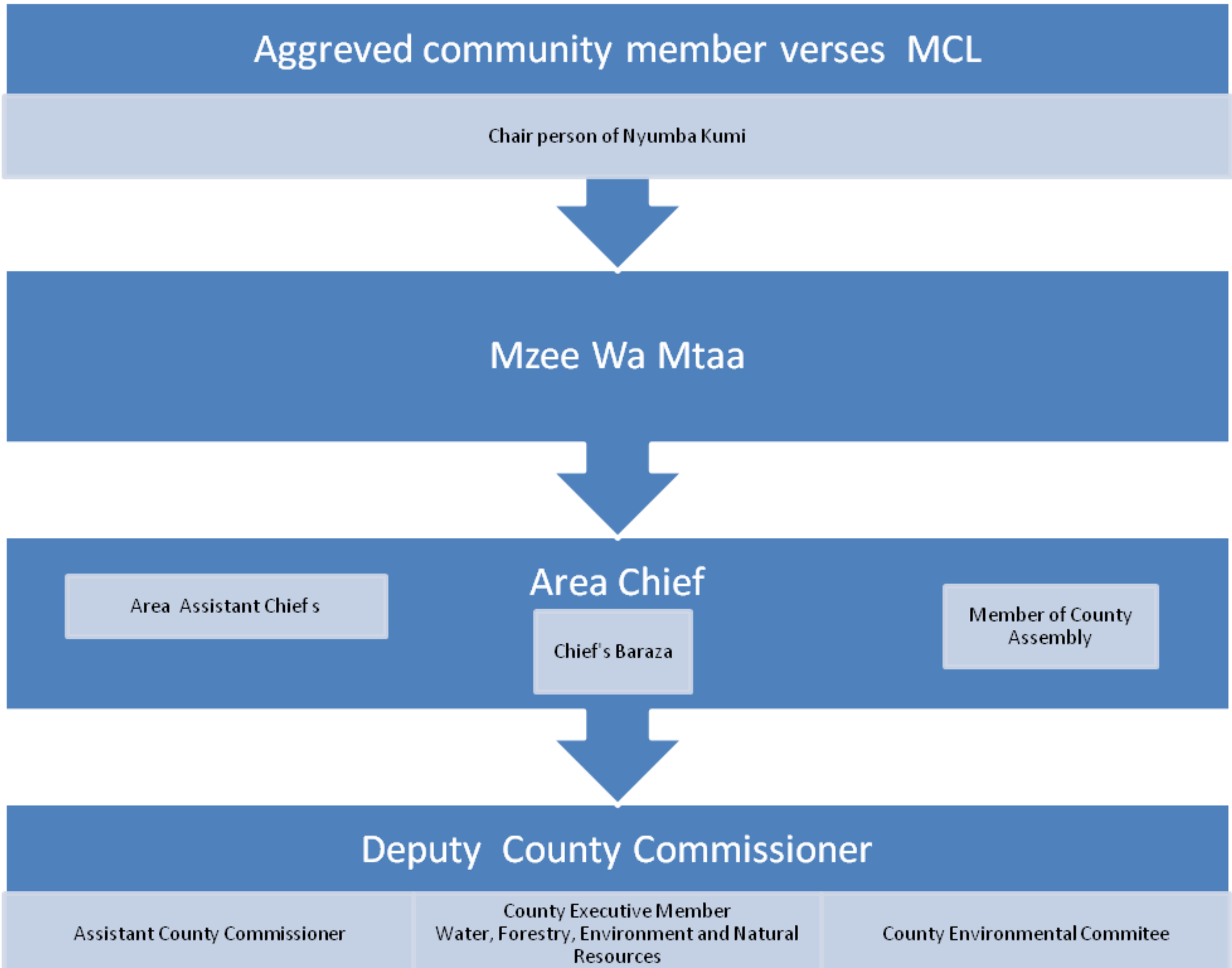
13.6.2 Community basic grievance and redress mechanism

Community grievances that may arise from implementation of the proposed project can be addressed through existing community leadership structures in place from the grassroots level of Nyumba Kumi through to the Deputy County Commissioner and or from the grassroots (Ward) political leadership representation (Member of County Assembly)through to the County Assembly.

13.6.2.1 Combined Administrative and political leadership route

The aggrieved community member can register the grievances to the Chair Person of his or her NyumbaKumi who will intern notify the MzeeWaMtaa for that cluster of NyumbaKumi on the matter the two of them together with the aggrieved person can hold joint discussion to address the issues and concerns raised. These issues can be resolved at this level. However if the issues is not resolved at this level then the matter moves to the next level where it is reported by the MzeeWaMtaa to the area Assistant Chief who will in turn inform the area chief and the local Ward Representative (Member of County Assembly) . All these parties can have a joint seating and discuss the matter with the aim of resolving the matter. The Area Chief can call a Chief's Baraza to include more members of the community to discuss the matter. The matter can be resolved at this level. However if no solution is reached then the Area Chief can report the matter to the Assistant County Commissioner who will in turn report the matter to the Deputy County Commissioner and the County Executive Member Water, Forestry, Environment and Natural Resources all these parties together with the aggrieved person can have joint seating to address the complaint with the aim of reaching an amicable solution. If the matter is no resolved at this level then the Deputy County Commissioner and the County Executive Member Water, Forestry, Environment and Natural Resources can report the report the matter to the County Commissioner and the Chair Person County Environmental Committee respectively for redress.

Figure 17: Flow chart of proposed community basic grievance redress mechanism



14. DECOMMISSIONING PLAN

14.1 Introduction

Decommissioning is the last phase of the life of the project. This will involve terminating the operations of the MCL Vipingo. However, situations and circumstances may arise that may force terminating a project before its actual lifespan expires. In such a case decommissioning of the project will come much earlier than expected. Termination of project operations can be due to varied reasons which may include the following:

- ✓ Expire of project life;
- ✓ If project operations are no longer profitable to undertake;
- ✓ Stoppage order from government;
- ✓ Change of company investment interest in the sector or/and in the area;
- ✓ Natural calamities and other unforeseen circumstances; and
- ✓ Lack of crucial process inputs (raw materials, power, water)

14.1.1 Expire of project life

All developments project have got an economic life within which it will be profitable to operate. Within project life, it is projected that there will be sufficient and economically exploitable raw materials necessary for the project; there should be sufficient economic labour and a market for the product. The cost of production during the project life should be economically affordable. Once the projected economic life of a project comes to an end, operating the project may not be viable unless new machinery and equipment are put in place. It will involve putting a new phase to the project. Otherwise the project comes to an end.

14.1.2 Non-profitability

When setting-up an economic venture like a clinker plant, the ultimate goal is to make profit. Unit cost of production should not be higher than unit cost of the product at the shelf. In a case where the cost of production becomes to higher that no profit can be realised from the investment, then such a project can be terminated.

14.1.3 Stoppage Order

All projects operating in a given country are guided by laws and regulations of that country. If a project contravenes the legal requirements and the government finds it a threat to the environment, its citizens and the security of the country, then such a project may be issued with a stoppage order. This may include denial of operating licences among others. In such a case the project has to be terminated.

14.1.4 Change of company investment interests

A company may also change its investment interest in a particular sector of the economy, in a particular locality, country or region. Change In investment interest may be necessitated by change in political climate, security situation, and state of infrastructure, market availability and access, legal requirements among others. Such changes may result in termination of the project before it lifespan expires.

14.1.5 Natural calamities

Occurrence of natural calamities in an area can result to an abrupt end of a project much before its economic life expires. Such calamities may include severe earthquakes, volcanic eruptions and floods. Such calamities results in much loss in terms of property and investment and human life.

14.1.6 Lack of process inputs

A project may be forced to come to an end due to acute shortage of major inputs and other utilities. This can be occasioned by poor planning, lack of sufficient reserves in this case exhaustion of limestone coral reserve, significant change in prices, increased demand relative to supply, change in government policies and insecurity. In either of these, the cost of raw materials and other inputs may either be too costly or totally unavailable thus necessitating closure of the project.

14.2 Components of Decommissioning Plan

This decommissioning plan presents a conceptual programme for dismantling of clinker production plant, disposal of machinery, buildings, support infrastructure and land; and handling of employees and the local community.

14.2.1 Dismantling and Disposal of Clinker and Cement production Plants

At the completion of the proposed expansion, MCL Vipingo will be having three clinker and cement manufacturing plants with the following components; limestone crusher, raw material hoppers, Raw mill, Bag house, blending silos, pre-heater tower , kiln, Central Control Room, silos and storage shade, cement mill, cement silos. Other include electricity sub-station, electrical generators, bulk water storage, workshops, office block, staff canteen an assortment of plant and equipment and office equipments. At the end of lifespan of the clinker plant different components of the plant will be of different economic value. The value of each component will vary depending on the following among others:-

- ✓ If replacement were done during the operational period;
- ✓ What proportion of useful economic life of the component was utilised during the entire time of operation; and

- ✓ Efficiency of servicing during the entire life of operation.

Plant dismantling should be planned with the above factors in mind. When preparing to dismantle the plant the following should be taken into considerations:-

- ✓ Safety of workers involved in the dismantling, this is because dismantling will involved working at height and in some cases in enclosed environment;
- ✓ Protection from inhalation of dust, it is expected that dust will be produced when dismantling, mechanisms should be put in place to ensure that the dust is contained and that it does not become a nuances to the surrounding;
- ✓ Handling and disposal of debris and scrub that may arise from the dismantling should be well planned and executed;
- ✓ Rehabilitation of the site after dismantling should be thought out and well executed well in time. Site rehabilitation should include.
    - Clearing all debris and scrap;
    - Ground levelling;
    - Planting of trees and grasses; and
    - Making arrangements to ensure the trees and grasses are well attended to especially in the early stage to ensure they do not wither. Tendering should include regular watering especially when rains are poor, wedding and protection from animal destruction.
    - Appropriate arrangement for disposal of rehabilitated site should be made.

Disposal of clinker and cement production plant components can either be by:-

- Selling usable parts of the plant if the company will not be having further interests in clinker or cement production elsewhere;
- Relocating usable parts of the plant to another site where the company could be having similar interests. Evaluation should be done on the cost of relocation visa avis selling them and obtaining new ones to ascertain which option is more cost effective;
- Selling the entire plant to an interested party for refurbishment;
- Refurbishing the entire plant and continuing with cement production activities

14.2.2 Disposal of Machines and Equipment

There will be different types of machinery to be disposed at the end of the lifespan of the cement plant. The machines will be in different usable conditions.

- ✓ There will be those which will be out of use;
- ✓ There will be those which will be serviceable; and
- ✓ There will be those acquired recently.

Depending on size, type and uses, condition at time of disposal and company policy on machine and equipment disposal; MCL Vipingo can adopt different ways on how to dispose the machines and equipment.

14.2.3 Disposal according to condition

- o If the company will still be having similar interests elsewhere, then machines and equipment still with an economic life can be retained for use;
- o Machines which will be out of order can have spare parts removed and sold together with any resulting scrap; and

- Also, some machines can be donated to local authorities. Such machines should be in good working condition and should be able to be of use to the Authority. Such can include tractors and dump trucks.

14.2.4 Disposal according to size

- ✓ Small company vehicles still in sound condition can either be donated to long serving employees as a sign of appreciation, be donated to local learning institutions;
- ✓ Some company vehicles still in good working condition can also be donated to local community organised group as a sign of appreciation for a good working relationship that prevailed during the company's operations in the community;
- ✓ Unserviceable company vehicles can have parts removed and sold and scrap generated can also be sold to scrap dealers or recyclers;
- ✓ Specialised equipments can be retained for future use if in good working condition, or be sold out to similar concerns;
- ✓ Unserviceable heavy machinery and equipment can have parts dismantled and used to repair other machines which can then be sold.

14.2.5 Disposal according to type and use

- Capital equipments in sound working condition can either be retained for future use, or sold out to similar concerns;
- Capital equipment and heavy machinery out of use can be disposed as scrap after removal of usable parts;
- Specialized equipment still in sound working conditions can be reused elsewhere or sold out all together,

14.3 Disposal of Buildings and Other Structures

Building and structures on site will include:-

- Electricity sub-station
- Bulk water storage tanks
- Office blocks
- Stores
- Shades
- Structures housing coal mill
- Structures housing clinker plant
- Structures housing cement mill
- Silos
- Workshops.

Decision on how to dispose these structures will depend on Kenya Power and lighting company for decommissioning of the electricity sub-station, decommissioning of other structures will depend on MCL Vipingo policy, needs, requests and proposals from local community, local authority and government in general. Different alternatives are available. This include:-

- Company retaining the buildings for its own use;
- The company can donate the buildings to be part of a local institution;
- The buildings can also be sold at market price;
- MCL can donate the buildings to a government department or local authority;
- Some income generating activities can be started at the site by organised local groups which can utilise the buildings;

- The company can decide to lease out some of the buildings or all of them;
- The company can decided to make alterations in the building to suite company investment interests as at that time.

14.4 Disposal of Land

Disposal of the land guided by Lands Act 2012 and Government policy on such land.

14. 5 Disposal of Supportive Infrastructure

The company will be having a number of supportive infrastructure which will include; boreholes, diesel pumps, electricity lines, telephone lines, water tanks. Disposal of these supportive infrastructures should be in a manner that benefit to the local community is realised with minimum environmental impacts. Options available include:-

- ✓ Water tanks and boreholes can be donated to the local community. A committee should be put in place which will manage and control the use of these facilities in a sustainable manner. The committee should also see to it that maintenance of the facility is done at the required times. It should come up with a strategy by which money will be raised to meet maintenance costs of the facilities.
- ✓ Kenya Power and Lighting Company should handle disposal of all electrical power lines and transformers that may not be required by the local community;
- ✓ Telecom Kenya should handle dismantling of all telephone related facilities that will not be required on site after winding of company activities;

14.6 Termination of Project/Closure

Closure of the clinker and cement production plants is the last stage of decommissioning. Complete closure of the project will have an impact on former employees, local community, local economy, business community and the general society at large. All the likely parties to be affected should be prepared well in advance psychologically, socially and financially.

14.7 Handling of employees

Former employees will be the most affected by closure of the project. Proper mechanisms should be put in place well in advance to inform them of impending closure and to prepare them in adapting to a new way of life. The company should also look for possible ways it can help the employees wherever possible.

Available options include:-

- ✓ Skilled employees still within productive age can be absorbed by sister companies if there will be vacant positions;
- ✓ All employees to be terminated should be given all their benefits;
- ✓ The company should hold training seminars targeting staff to be terminated on prudent financial management and available investment opportunities; and
- ✓ Company employees who will not be absorbed elsewhere should be informed one year in advance to prepare them psychologically.

14.8 Local community

Closure of the project will have an impact on the local community. This includes reduced purchasing power of local people as employees will be laid off; closure and/or relocation of businesses and services that were drawing clientele from the project; termination of certain services to the community such as community water points, health services among others. In order to plan for the possible impacts, the company should put the following in place in advance before closure time:-

- ✓ Transfer management of community services such as water points to the hands of locals at list six months in advance; and
- ✓ Organise locals into responsible groups and train them on ways to manage community projects transferred to them.

15. APPENDICES

Appendix 1: Certificate of land titles, certificates of postal search, letters of confirmation of deed plans, change of user from agricultural to industrial and letters from the National Land Commission confirming ownership of the two parcels of land.

Appendix 2 Copy of certificate of incorporation and copy of personal identification number certificate

Appendix 3 Proposed layout plan

Appendix 4 Copy of letter of acknowledgement from NEMA of receipt of the Project Report

Appendix 5 Copy of the letter of the initial review of the Project Report from NEMA.

Appendix 6 ToR approval letter from NEMA

Appendix 7 Registration certificates and practicing licence of EIA/EA Lead Experts

Appendix 8 Ten reasons why birds are very good indicators for state of biodiversity

Appendix 9 Copies of the two EIA licences for MCL limestone quarries

Appendix 10 Copy of EIA licence for MCL shale quarry

Appendix 11 List of suppliers of pozzolana to MCL

Appendix 12 NEMA receipt acknowledging of payment of the 0.1% of the project cost

Appendix 13 Questionnaire survey responses

Appendix 14 Minutes of proceedings from first baraza and list of attendees

Appendix 15 Minutes of proceedings from second baraza and list of attendees

Appendix 16 Minutes of proceedings from third baraza and list of attendees

Appendix 17 Dust survey report

Appendix 18 Stuck emission report

Appendix 19 Noise assessment report

16. REFERENCES

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