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PROPOSED GENERATION OF 20 MW OF ELECTRICITY FROM CEMENT PLANT WASTE FLUE GASSES AND FUELS

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

Compiled by:-
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2024

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Submitted by:

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HASMUKH K. PATEL, OGW

DIRECTOR

2024

EXECUTIVE SUMMARY

This report presents findings of an environmental impact assessment study of a proposed captive power plant to generate 20 MW of electricity. The proposed power plant is to generate 10MW of electricity using waste heat recovery system and 10MW from solid fuels. The waste heat to be used in power generation will be recovered from waste flue gasses that are emitted during clinkerization and cement production at Mombasa Cement Limited (MCL) Vipingo Unit. To generate electricity from solid fuels, the proposed project proposes will utilise circulating fluidized bed combustion boiler technology.

Location

The proposed power plant will be embedded within the existing MCL Vipingo cement factory. MCL Vipingo factory is located in Kilifi County, Kilifi South Sub-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.

Project Proponent

The Proponent of the proposed projects is Mombasa Cement Limited; a private company incorporated with limited liabilities in the Republic of Kenya is the project proponent.

Scope

The scope of the proposed project covers generation of 20 MW of electricity, 10MW from waste heat recovery system and 10MW from solid fuels using circulating fluidized bed combustion technology.

Policy and legal framework

National policies, laws and legislation relevant to the proposed project were revived. Policies that were reviewed included; Kenya's Vision 2030, National Environment Policy 2013, National Sustainable Waste Management Policy 2021, National Energy Policy 2018, Sessional Paper 01 of 2021 on National Water Policy, Integrated National Transport Policy 2024, Kenya Youth Development Policy 2019, Sessional Paper no. 4 of 2013 on the Employment Policy and Strategy for Kenya, Sessional Paper No. 01 of 2017 on National Land Use Policy, National Climate Change Framework Policy Sessional Paper No. 5 of 2016 and Sessional Paper No.13 of 2014 on Integrated Coastal Zone Management (ICZM) Policy.

Reviewed national laws included, Constitution of Kenya, 2010, Environmental Management and Coordination Act (EMCA), 1999, Sustainable Waste Management Act 2022, Land Act 2012, Water Act, 2016, Physical and Land Use Planning Act Cap 303, Energy Act 2019, Occupational Safety and Health Act, 2007, Employment Act, 2007, HIV and AIDS Prevention and Control Act 2006, Public Health Act Cap 242 and Work Injuries Benefits Act 2007. Relevant national legislation reviewed included, Environmental (Impact Assessment and Audit) Regulations, 2003 Legal Notice No.101, Environmental Impact Assessment Guidelines and Administrative Procedures, 2002, Environmental Management & Coordination (Air Quality) Regulations, 2014 (Legal Notice No.34), Environmental Management & Coordination (Water Quality) Regulations, 2006 (Legal Notice No.120), Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulation, 2009 Legal Notice No.61, Environmental Management & Coordination (Waste Management) Regulations, 2006 Legal Notice No.121 and Building Operations and Works of Engineering Construction Rules, 1984.

Baseline studies

To understand and document the prevailing environmental condition, various baseline studies were carried out. They included aambient acoustic emission, carbon emission, air quality dispersion modeling, geotechnical investigations; groundwater quality and aambient greenhouse gases.

Analysis of alternatives

Alternatives analysed in relation to the proposed project include the yes project alternative, the no project alternative, alternative fuels, and technology alternatives.

Occupational safety and health

Health and safety concerns during operation of captive power plant that were covered include non-ionizing radiation, heat, noise, confined spaces electrical hazards, fire and explosion hazards, chemical hazards and dust.

Stakeholder consultation and public participation

Stakeholder consultation and public participation involved consultation with stakeholders and the public that are likely to be affected and those that are likely to have an interest in the proposed project. The consultation and participation was through a questionnaire survey and public barazas. Most of the stakeholders welcomed the proposed project citing its ability to reduce emissions while at the same time create employment opportunities to the local people

while at the same time addressing energy reliability and sufficiency for the company. However the stakeholders stressed the importance of the immediate local community tangibly benefiting positively from the proposed project while emphasizing the need for appropriate measures to be put in place to address and effectively mitigate any negative impacts that might arise during project implementation and operation phases.

Potential positive impacts

During the construction phase, it is envisaged that the proposed project will result to various positive impacts including; employment opportunities for the local community, support to existing local businesses, on job training opportunities for local people, revenue to County Government of Kilifi, revenue to the national government and technology transfer. During the operational phase potential positive impacts will include; business opportunities to local community and other stakeholders through supply of agricultural biomass and other waste that will be required. Others will include, reducing greenhouse gas emissions from cement production, efficient utilization of energy resources by MCL, reuse of waste, reduction of quantity of waste to be disposed in landfills, lowering MCL carbon footprint, reduction on reliance on non-renewable energy sources, reliable power supply to MCL, cost savings for the company, enhancement of energy security for the company, faster return on investment, and enhancement of the resilience and reliability of energy supply to MCL.

Potential negative impacts

Potential negative impacts during the construction phase will include noise and vibration disturbance, fugitive dust emission, injuries and accidents to construction workers and waste generation. Potential negative impacts during operation phase will include, emission of toxic pollutants, increase in demand of process water, waste generation impacts, bed agglomeration and de-fluidization, boiler explosion and positive pressure boiler risks.

Project cost

The proposed project is estimated to cost KSH 2, 500, 000, 000.00 (two billion, five hundred million). The proponent will be required to pay to the National Environment Management Authority (NEMA) 0.1% of the total project cost being the applicable EIA processing and monitoring fees.

Proposed mitigation measures of potential negative impacts

Potential negative impact	Proposed mitigation measure
CONSTRUCTION PHASE	
Noise and vibration disturbance	○ Use noise reduction technologies such as acoustic covers ○ Training & education on risks of noise exposure ○ Appropriate use of Personal Protective Equipment (PPEs) ○ Maintenance & inspections of machinery & equipment ○ Technical controls to reduce noise at the source ○ Limit workers' exposure time & rotation to less noisy tasks
Fugitive dust	▪ Limit amount of exposed soil ▪ Construct wind barriers or install cover tarps ▪ Apply water to suppress dust ▪ Apply chemical dust suppressants ▪ Use vacuum controls on equipment to keep surfaces clean of debris. ▪ Apply soil stabilizers ▪ Establish vegetative cover.
Injuries and accidents	○ Always utilize safety gear (PPEs) ○ Timely & proper equipment service & maintenance ○ Develop & follow safety protocols while on site ○ Schedule regular safety meetings ○ Take regular breaks

	○ sufficient signage to warn of dangers & hazards ○ Conduct worksite inspections daily to identify any potential dangers or hazards ○ Mandatory safety training for all employees ○ Proper material storage and handling ○ Fall protection protocols and fall protection equipment
Waste generation	• Proper planning to reduce generation of construction waste • Effective material management to reduce generation of construction waste • Recycling materials such as concrete, steel, and wood • Implementing composting as a waste reduction strategy • Purchasing materials in bulk to reduce waste from individually packaged materials
PRODUCTION PHASE	
Emission of toxic pollutants	➢ Capture and recover all flue gases and waste heat generated and reuse it to generate electricity. ➢ Deploy emission control technologies such as electrostatic precipitators, scrubbers, and bag-house filters. ➢ Operate at optimal temperature to achieve complete combustion. ➢ Minimise flue gasses emission by appropriate fuel selection, burner modifications, appropriate air firing, flue gas recirculation and constant water stream injection.
Increase in demand of process water Waste generation impacts	❖ Maximise extraction, recovery and reuse of condensate by recirculating ❖ Increase intercepted natural groundwater recharge through increase in vegetation cover. ❖ Increase induced groundwater recharge using treated wastewater ❖ Increase artificial aquifer recharge

	❖ Reduce water abstraction by reuse process after cooling in cooling tower ❖ Fix any leakages in the system to eliminate steam and water loss.
Bed agglomeration and de-fluidization	• Decrease the operating temperature of the reactor. • Increase the gas velocity. • Replace the bed material. • Pre-treatment of solid fuels to remove alkali metals • Use bed additives such as kaolin, dolomite and olivine. • Replace bed material.
Boiler explosion	✓ Regular boiler inspection & maintenance. ✓ Have robust safety protocols in place. ✓ Inspection of pump inlets and fixing loose connections. ✓ Avoid ash accumulation in the furnace. ✓ Regular checking of safety valves.
Positive pressure boiler risks	⇒ Ensure no blockage of fuel due to ash accumulation. ⇒ Ensure no air leakage from boiler. ⇒ Ensure sufficient air volume & pressure of induced draft fan

Conclusion

Waste heat recovery and use of solid wastes in electricity generation is a sustainable practice that will contribute to achieving energy efficiency, reducing emissions and enhancing sustainability. By recovering and recycling waste heat and reusing solid waste to generate electricity, MCL will be environmentally responsible and sustainable. Capturing and reusing waste heat to generate electricity will significantly reduce MCL's energy consumption and associated costs. This will result in a more efficient use of resources and a reduced environmental footprint for the company.

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1. BACKGROUND OF THE PROJECT

1.1 Introduction

This is an Environmental Impact Assessment (EIA) Study Report for a proposed Captive Power Plant (CPP) to generate 20 MW of electricity from two systems namely; Waste Heat Recovery (WHR) system and second from solid fuels using Circulating Fluidized Bed Combustion (CFBC) boiler technology. The waste heat to be used in power generation will be recovered from waste flue gasses that are emitted during clinkerization and cement production at Mombasa Cement Limited (MCL) Vipingo Unit. Thus the proposed power plant will be embedded within the existing MCL Vipingo cement factory (Plate 1) to be able to tap and utilize waste heat from the plant to generate electricity. The envisaged power generation will be 10 MW from WHR and 10 MW from solid fuels. Power generation plants are classified as high risk projects in the second schedule of the Environmental Management and Coordination Act (EMCA) 1999 Legal Notice number 31 of 2019 category 3 (10) (a). The proposed project underwent a full environmental impact assessment study as provided for in the Environmental Management and Coordination Act, 1999 and the Environmental (Impact Assessment and Audit Regulations), 2003.

1.2 Definition of the proposed project

The existing Mombasa Cement Vipingo Factory has two Clinkerization lines (L1 and L2). During clinkerization to produce clinker that is used in production of cement heat is generated. The available heat from the two production lines is; Preheater (PH) side, Line 1: ~200, 000 at 265^{o}C & Line 2: ~330, 000 Nm3/hr 240^{o}C. Cooler side, Line 1: ~95,828 at 120^{o}C & Line 2: ~197, 270 at 120^{o}C. This waste heat is what is being proposed to be utilized for generation of power using WHR system technology.

1.2.1 Power Generation from Waste Hear Recovery system

10 MW will be generated from Waste Heat Recovery System. Power generation from WHR system will involve tapping flue gas from cement plant Pre-Heater (PH) and produce steam in PH boilers; tapping flue gas from cement plant Cooler and produce steam in Air Quench Combustion (AQC) boilers and then use the steam to run turbine for Generating Power.

1.2.2 Power Generation from Solid Fuels

10MW will be generated from solid fuels using Circulating Fluidized Bed Combustion (CFBC) technology. Solid fuels of Good Calorific Value (GCV) varying between 3400kcal/Kg to 5200kcal/kg will be used for CFBC Boiler. Generation of electricity from

solid fuels will thus be utilizing circulating fluidized bed combustion (CFBC) boilers with dedicated Turbine Generator (TG) and fuel feeding system.

1.3 Location

The proposed project will be located at Mombasa Cement Limited (MCL) Vipingo factory. MCL Vipingo factory is located in Kilifi County, Kilifi South Sub-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 project site are $3^0$43'38.15"S $39^0$50'12.66"E. Appendix 1 is the land documents of the proposed project site while Figure 1 is Pictorial view of the proposed power plant incorporated in the satellite map showing how it will be embedded within the existing MCL Vipingo cement factory.

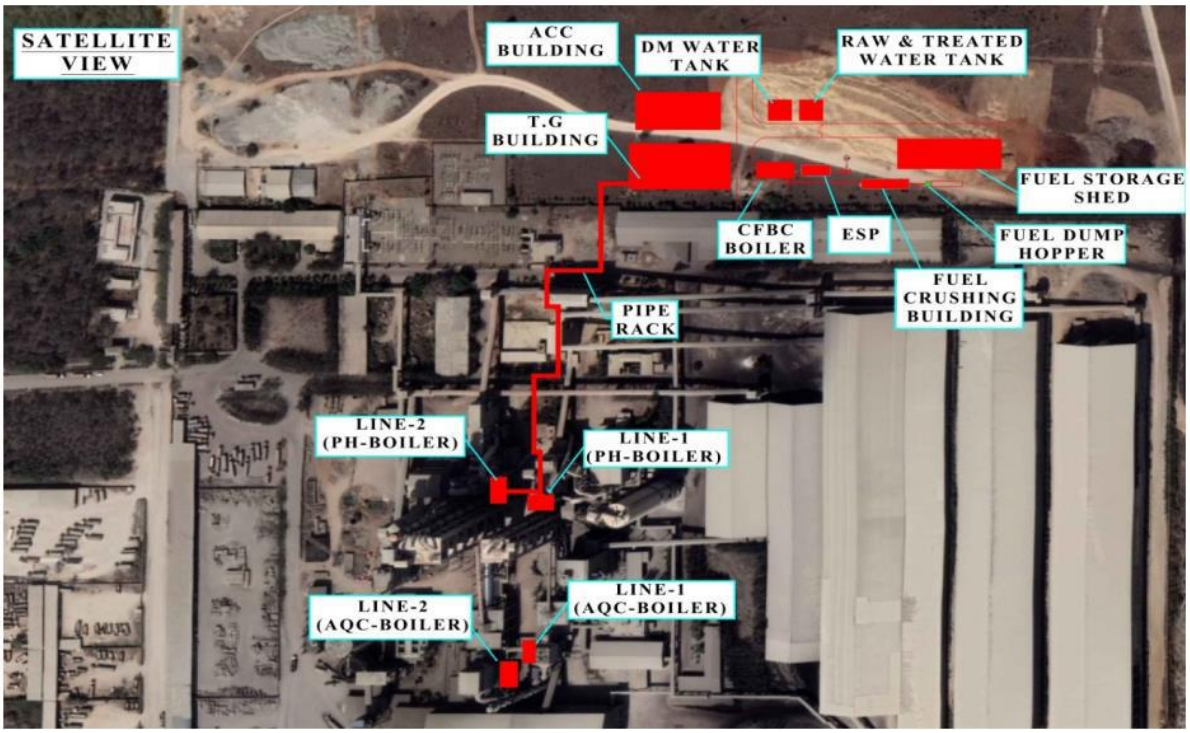

Figure 1 Pictorial view of the proposed power plant incorporated in the satellite map of MCL Vipingo Unit

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.

Plate 1 Section were waste heat will be tapped from within MCL Vipingo plant

1.5 Project Objective and Scope

1.5.1 Objective

The objective of the proposed project is to generate electricity internally that will be used onsite in cement production at Mombasa Cement Vipingo factory.

1.5.2 Scope

The scope of the proposed project covers generation of 20 MW of electricity, 10MW from waste heat recovery (WHR) system and 10MW from solid fuels using Circulating Fluidized Bed Combustion (CFBC) technology.

1.6 Terms of Reference

Terms of reference (ToR) for the EIA study were prepared and submitted to the National Environment Management Authority (NEMA) for approval. The ToR was approved by NEMA appendix 3 is copy of the ToR approval from NEMA

1.7 Definition of Terminologies

Captive Power Plant also known as auto producers or embedded generation facilities is a power plant set up by any person, cooperative society an association of persons or a

company for generating electricity primarily for their own use. A generation plant is considered captive only if more than 51% of its electricity generated is used by the owner(s) for their own consumption and the minimum aggregate ownership (or individual ownership as the case may be) of the captive generating plant is at least 26%.

Circulating Fluidized Bed Combustion system is an intriguing combustion system that suspends solid particles in an upward flow of gas or air. The process of "fluidization" characterizes the behavior of solid particles, which resemble the characteristics of a fluid due to the upward velocity induced by the gas stream. This results in a highly efficient combustion process, facilitating a superior combination of fuel and air.

Waste Heat Recovery is the process of "heat integration", that is, reusing heat energy that would otherwise be disposed of or simply released into the atmosphere. By recovering waste heat, manufacturing plants reduce both energy costs and CO_2 emissions, while simultaneously increasing energy efficiency.

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 and Sewell (1981) 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

2.2.4 An instrument for sustainable Development

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)and development process.

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 Key elements in the EIA process

The environmental impact assessment process comprises of various interactive steps such as screening, scoping, consideration of alternatives, action design, preparation of the EIA report, reviewing or evaluating the report, decision making, and post decision activities such as monitoring and auditing (Glasson et al., 1994; Wood, 1995). According to UNEP (2002) key elements in the EIA process are screening, scoping, impact analysis, mitigation, reporting, review, decision-making, follow up and public involvement. Figure 2 is the schematic presentation of general EIA process.

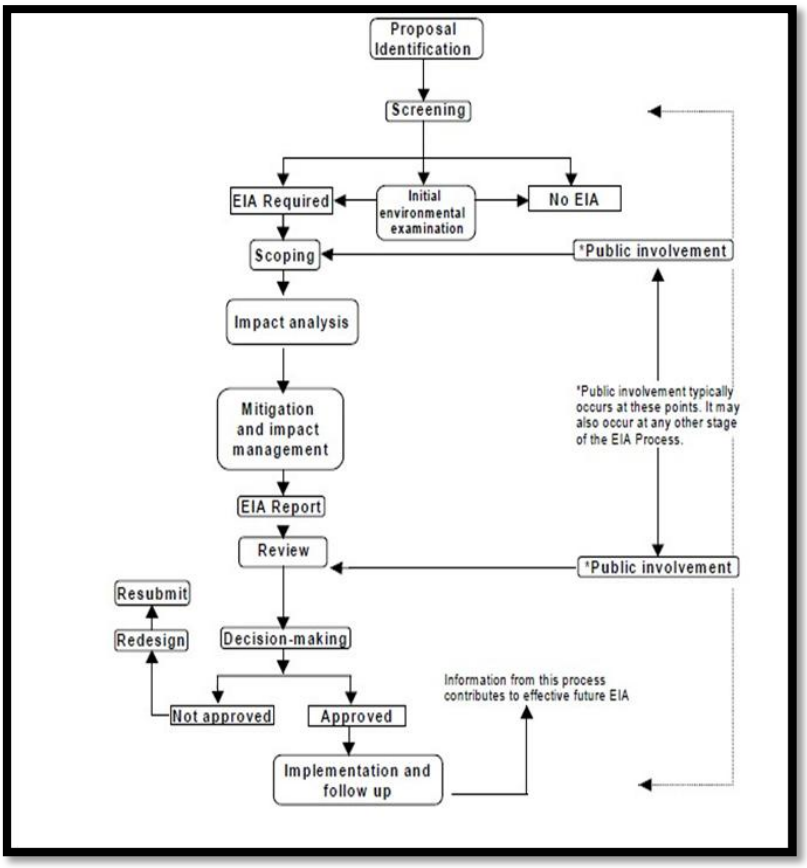

Figure 2 Generalized EIA process flowchart. Adapted from UNEP 2002

2.4.1 Screening

Screening determines whether or not a proposal requires an EIA and, if so, what level of analysis is necessary. This process brings clarity and certainty to the implementation of EIA, ensuring that it neither entails excessive review nor overlooks proposals that warrant examination. Legal Notice No. 31 of 30th April 2019, that amended the second schedule of the Environmental Management and Coordination Act, 1999 categorizes power generation plants under high-risk projects in section category 3 (10) (a) of the amended second schedule of the Act. Based on this, it is required that an environmental impact assessment study report be submitted for the proposed project. Regulation 11 (1) of the Environmental (Impact Assessment and Audit) Regulations, 2003 require that an environmental impact assessment study be conducted in accordance with the terms of reference developed during the scoping exercise by the proponent and approved by the Authority.

2.4.2 Scoping

Scoping identifies the important issues in readiness for preparation of terms of reference; it is a critical, early step in the preparation of an EIA (UNEP. 2002). The scoping process identified the issues that are likely to be of most importance during the EIA and eliminated those that are of little concern. In this way, the EIA study was focused on the significant effects and time and money are not wasted on unnecessary investigations (Glasson et al., 2012). The following were the key issues identified to be focused on during the EIA study.

- Impacts on local air quality
- Noise and vibration impacts
- Traffic related impacts
- Waste related impacts
- Occupational injuries and accidents
- Increase demand and use of water

2.4.3 Impact analysis

Impact analysis is carried out in the detailed phase of the EIA; it involved identifying the impacts more specifically, predicting the characteristics of the main impacts and evaluating the significance of the residual impacts (UNEP, 2002).

2.4.4 Impact Mitigation

Mitigation is the stage of the EIA process when measures are identified to avoid, minimize or remedy impacts. These measures are implemented as part of the process of impact management, together with any necessary adjustments to respond to unforeseen

impacts. Both elements are integral to ensuring that the EIA process leads to practical action to offset the adverse environmental impacts of proposed developments (UNEP, 2002). Mitigation recommends feasible and cost–effective measures to prevent or reduce significant negative impacts to acceptable levels.

2.4.5 Reporting

Reporting involves compiling all the information obtained into an EIA report which is a keystone document. It assembles the information that assists the proponent in managing the impacts of the proposal, the responsible authority in decision-making and condition setting; and the public in understanding the likely impacts of the proposal (UNEP, 2002).

2.4.6 Report review

The review stage of the EIA report is one of the main 'checks and balances' built into the EIA process to establish the quality of an EIA. It helps to ensure the information submitted is credible and sufficient for decision-making purposes (UNEP, 2002) by verifying the accuracy and comprehensiveness of the report (Glasson et al., 2012). The decision-making element of the EIA process involves approving or rejecting the proposal and setting conditions. Decision making stage provides for incorporation of environmental considerations into proposed development (Glasson et al., 2012). Once the proposed project is approved, implementation and follow up complete the EIA process (UNEP, 2002).

2.4.7 Monitoring and auditing

Monitoring, auditing and other tools are used to 'close the loop' of impact prediction and condition setting (Sadler, 1996). Monitoring and auditing is vital as it is used to identify the impacts that occur; to check that these are within the levels predicted and required by legislation; determine that mitigation measures are properly implemented and work effectively; ensure the environmental benefits expected are being achieved; and provide feedback to improve future applications of the EIA process (Arts, 1998).

3. APPROACH AND METHODOLOGY

3.1 Approach

At the beginning of the assignment inception meetings were held between the Proponent representative and the Consulting Team Leader in the proponent's office first and latter at the proposed project site. The meetings served as formal introduction for clarification of Terms of Reference (ToR) for the study team and physically show the team the proposed project site. A ToR for the EIA study was then developed and submitted to NEMA for approval.

3.2 Methodology

The following methodology was used in undertaking the Environmental Impact Assessment:

- Scoping and development of Terms of Reference
- Desk review of relevant project documents including project design documents, relevant policy and legislative documents including relevant international conventions, agreements and protocols ratified by Kenya.
- Field visits for detailed documentation of site conditions and actual site assessment.
- Baseline studies
- Public participation
- Impact prediction and mitigation measures determination
- Reporting

3.2.1 Scoping

Scoping identified the important issues in readiness for preparation of terms of reference; it was a critical, early step in the preparation of an EIA study report. The scoping process identified the issues that are likely to be of most importance during the EIA and eliminated those that were of no concern.

3.2.2 Desk review

Desktop review included review of National Policies applicable to the proposed project including Kenya's Vision 2030, The Kenya Youth Development Policy 2019, National Energy Policy 2018, Sessional Paper no. 4 of 2013 on the Employment Policy and Strategy for Kenya, National Climate Change Framework Policy 2018, Climate Risk Management Framework (2017), National Climate Change Response Strategy 2010

among others. The review also include review of national laws including, Environmental Management and Co-ordination Act (EMCA) 1999, The Sustainable Waste Management Act, 2022, The Environmental Management and Coordination (Water Quality) Regulations, 2006, The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009; Physical planning Act, The Public Health act, the Environmental Management and Coordination (Water Quality) Regulations, 2006, The Environmental Management and Coordination (Waste Management) Regulations, 2006, The Employment Act 2007, The Labour Institutions Act 2007, The Work Injuries Benefits Act 2007, The Occupational Safety and Health Act 2007, The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009, The Lands Act 2012, The Energy Act, National Construction Authority Act No. 41 of 2011, The Environmental (Impact Assessment and Audit) Regulations 2003.

3.2.3 Field assessment

Field assessment involved visiting the proposed project site and documenting the current condition on the site. This involved documenting existing structures onsite and neighboring facilities. Also the location where the proposed project will be constructed was assessed in relation to the existing structures. The assessment also included the existing access road to the proposed project site and available of vacant space to meet needs of the proposed project. The site was assessed for any flora and fauna and observations recorded. GPS coordinates for the site were taken by a handheld GPS and photographs of site observation were taken. Site office meetings were held between the Lead Consultant and team, the Project Engineers, the Company Environmental and Safety Officer who collectively responded to questions and clarified emerging issues during site assessment.

3.2.3 Public participation

Public participation involved conducting three public meetings (barazas) in three different locations adjacent to the proposed project site as was suggested by the local leadership. The meetings were also publicized locally through the Assistant County Commissioner's Office which was cascaded to the Chief-Sub-Chief- Mzee wa Mtaa-Nyumba Kumi administrative channel to ensure the information reached each housed within every Nyumba Kumi cluster of the project catchment. To supplement the local meetings a detailed questionnaire survey was carried out, the questionnaire survey

targeted various groups/ institutions including local leaders, civil society groups operating in the area, local learning institutions, and local faith based institutions and local health institutions.

3.2.4 Baseline Studies

Various baseline studies were carried out to document and at the same time understand the current environmental situation before any changes occur. The baseline studies were vital as they provided variable data and information that aided in potential impact identification and proposal of feasible mitigation measures. The following baseline studies were carried out:

- Ambient acoustic emission
- Carbon emission
- Air quality dispersion modeling
- Geotechnical investigations
- Groundwater quality
- Ambient greenhouse gases

3.2.5 Reporting

All the information and data collected from scoping exercise, the desk top document review, field assessments, baseline studies and stakeholder consultation and participation was compiled into two reports namely:-

- ❖ Terms of Reference Report; and
- ❖ Environmental Impact assessment (EIA) Study Report.

Terms of Reference Report was submitted to NEMA as specified in Regulation 11 (1) and 11(2) of the Environmental (Impact Assessment and Audit) Regulations, 2003. The Environmental Impact assessment (EIA) Study Report was prepared as specified in Regulation 18 of the Environmental (Impact Assessment and Audit) Regulations, 2003 and submitted to NEMA as specified in Regulation 19 of the Environmental (Impact Assessment and Audit) Regulations, 2003.

3.3 Study team

Sigtuna Consultancy Limited, a registered and licensed EIA/EA Firm of Experts registration number 9582, which was contracted by Mombasa Cement Limited to carry out the environmental impact assessment study for the project and prepare an environmental impact assessment study report undertook the lead role in the EIA assessment. Geotechnical investigations were carried out by Rockmass Geosurvey and

Engineering, groundwater quality baseline was undertaken by Bureau Veritas Kenya Limited a NEMA accredited laboratory, ambient air quality, carbon footprint and ambient acoustic emission were carried out by Lahvens Limited Laboratory, a NEMA Designated Laboratory while project's Bills of Quantity were prepared by Ndibui S.K and Associates a Registered Quantity Surveyor. Appendix 4 is copy of practicing licenses of the firm of experts and Lead Expert.

4. RELEVANT POLICIES LAWS AND REGULATIONS

4.1 National policies

The following National Policies are relevant to the project.

- ⇒ Kenya's Vision 2030
- ⇒ National Environment Policy 2013
- ⇒ National Sustainable Waste Management Policy 2021
- ⇒ National Energy Policy 2018
- ⇒ Sessional Paper 01 of 2021 on National Water Policy
- ⇒ Integrated National Transport Policy 2024
- ⇒ The Kenya Youth Development Policy 2019
- ⇒ Sessional Paper no. 4 of 2013 on the Employment Policy and Strategy for Kenya
- ⇒ Sessional Paper No. 01 of 2017 on National Land Use Policy
- ⇒ National Climate Change Framework Policy Sessional Paper No. 5 of 2016
- ⇒ Sessional Paper No.13 of 2014 on Integrated Coastal Zone Management (ICZM) Policy

4.1.1 Kenya's Vision 2030,

Kenya's Vision 2030 is the Country's development blueprint that aims to transform Kenya into a newly- industrializing, middle income country providing a high quality of life to all its citizens in a clean and secure environment by the year 2030.

4.1.2 National Environment Policy 2013

The National Environment Policy 2013 aims to provide a framework for an integrated approach to sustainable management of Kenya's environment and natural resources.

4.1.3 National Sustainable Waste Management Policy 2021

The National Sustainable Waste Management Policy of 2021 aims to establish an enabling regulatory environment that prioritizes waste minimization and contributes to a circular economy. It also supports County Governments' mandate to provide sustainable waste management services and provides a framework for coordinated action at the national level. The policy proposes a waste hierarchy that includes reducing waste generation, reusing materials, effective and affordable waste collection, and proper treatment and disposal of residual waste in well-engineered and regulated landfills.

4.1.4 National Energy Policy 2018

The National Energy Policy of 2018's overall objective is to ensure sustainable, adequate, affordable, competitive, secure and reliable supply of energy at the least cost geared to meet national and county needs while protecting and conserving the environment.

4.1.5 Sessional Paper 01 of 2021 on National Water Policy

Sessional Paper 01 of 2021 on National Water Policy aim is to guide the achievement of sustainable management, development and use of water resources in Kenya. It provides a framework for sustainable management and financing of water resources; water harvesting and storage; and for equitable, efficient, and universal access to water supply and reasonable standards of sanitation, for domestic, economic use and ecosystem sustenance.

4.1.6 Integrated National Transport Policy 2024

Integrated National Transport Policy 2024 aims to provide an enabling road; rail; maritime; air; and pipeline transport environment for the stimulation of rapid development and efficient management of a safe, widely accessible transport system that, responds to modern technological advancement in a rapidly changing and globalized environment.

4.1.7 The Kenya Youth Development Policy 2019

The Kenya Youth Development Policy 2019 promotes holistic empowerment and participation of the youth in socio-economic and political development for themselves, the country and the future. Ensure adequate youth development and empowerment while harnessing their potential for productive engagement at local, County, National and International levels.

4.1.8 Sessional Paper no. 4 of 2013 on the Employment Policy and Strategy for Kenya

Sessional Paper no. 4 of 2013 on the Employment Policy and Strategy for Kenya promote full employment as a priority in national, economic and social policy and to enable the economically active population to attain and secure sustainable livelihood through productive and freely chosen employment by the year 2030.

4.1.9 Sessional Paper No. 01 of 2017 on National Land Use Policy

Sessional Paper No. 01 of 2017 on National Land Use Policy overall goal is to provide legal, administrative, institutional and technological framework for optimal utilization and productivity of land and land related resources in a sustainable and desirable manner at National, County and local level.

4.1.10 National Climate Change Framework Policy Sessional Paper No. 5 of 2016

The Policy aims to enhance adaptive capacity and build resilience to climate variability and change, while promoting a low carbon development pathway. The response to climate change in Kenya must adhere to the constitutional governance framework and commitment to sustainable development, while addressing the goal of attaining low carbon climate resilient development. To attain the latter, the policy focuses on appropriate mechanisms to enhance climate resilience and adaptive capacity, and the transition to low carbon growth.

4.1.11 Sessional Paper No.13 of 2014 on Integrated Coastal Zone Management Policy

The vision of the Integrated Coastal Zone Management (ICZM) Policy is "A coastal zone with health ecosystem and resources that sustain the socio- economic development and well-being the current and future generations". It seeks to promote sustainable development in the coastal zone in line with the principles of the constitution and objectives of Vision 2030.

4.2 Legal framework

The following national laws are relevant to the proposed project;

- Constitution of Kenya, 2010
- Environmental Management and Coordination Act (EMCA), 1999
- The Sustainable Waste Management Act 2022
- Land Act 2012
- Water Act, 2016
- Physical and Land Use Planning Act Cap 303
- The Energy Act 2019
- Occupational Safety and Health Act, 2007
- Employment Act, 2007
- HIV and AIDS Prevention and Control Act 2006
- The Public Health Act Cap 242
- Work Injuries Benefits Act 2007

4.2.1 Constitution of Kenya, 2010

The Constitution of Kenya 2010 established a system of devolved government based on counties. The key constitutional provisions relevant to the project are:

- ✓ Article 10 on national values and principles of governance including 10(2a) on democracy and participation of people.
- ✓ Fourth Schedule Article 10 on implementation of specific national government policies on natural resources and environmental conservation.

- ✓ Fourth Schedule Article22 under national government on the protection of th e environment and natural resources with a view to establishing a durable and sustainable system of development.
- ✓ Bill of rights Article 42 which states that every person has the right to a clean and healthy environment.
- ✓ Article 196 on public participation.

The Kenya Constitution is the first to recognize the need for cultural heritage conservation. It commits the citizens to respect and recognize environment as a national heritage and asks them to promise to sustain it for the benefit of posterity. In Section 69(2) the Constitution assigns everyone the duty to cooperate with state organs and other persons to protect and conserve environment and ensure sustainability in development and use of natural resources.

4.2.2 Environmental Management and Coordination Act (EMCA), 1999

This is an Act of Parliament to provide for the establishment of an appropriate legal an d institutional framework for the management of the environment. The Act established theNational Environment Management Authority (NEMA) as the regulatory authority in charge of environmental matters.

Relevant Provisions include mandates given to NEMA such as:

- ✓ Section 2(a): Coordination of environmental management activities and promotion and integration of environmental considerations into development projects.
- ✓ Section 2(d): Examination of land use patterns to determine their impact on the quality and quantity of natural resources.
- ✓ 2(e): Carry out surveys to assist in the proper management and conservation of the environment.
- ✓ 2(I): Monitor and assess activities carried out by proponents in order to ensure tnat the environment is not degraded by such activities, that environmental management objectives are adhered to, and adequate early warning on impending environmental emergencies is given.

EMCA 1999, as amended in 2015 is the main national statute that governs environmental protection in Kenya, including waste management. The following are some of the important requirements for waste generators stipulated under the EMCA:

- ✓ No person shall transport any waste other than in accordance with a valid license to transport wastes issued by the Authority (Section 87 (2))

- ✓ No person shall transport any waste other than to a waste disposal site established in accordance with a license issue by the Authority (Article 87 (2)).
- ✓ Every person whose activities generate wastes shall employ measures essential to minimize wastes through treatment, reclamation and recycling (Article 87 (5)).
- ✓ No hazardous waste shall be exported to any country from Kenya without a valid permit granted by the Authority and written consent given by a competent authority of the receiving country (Article 91 (4)).
- ✓ No hazardous waste shall be transported within or through Kenya without a valid permit granted by the Authority (Article 91 (5)).

4.2.3 The Sustainable Waste Management Act 2022

The Sustainable Waste Management Act, 2022 provides for the sustainable management of waste by creation of extended producer responsibility schemes as well as a circular economy for the reduction of waste. The Act provides for take back schemes and the labelling of products that may cause pollution. It provides for the creation of material recovery facilities in every County as well as the creation of incentives to encourage recycling. The purpose of the Act is thus to establish the legal and institutional framework for sustainable waste management and the realization of the constitutional provision on the right to a clean and healthy environment.

4.2.4 Land Act 2012

This is an Act of Parliament to give effect to Article 68 of the Constitution, to revise, consolidate and ra1ionalize land laws; to provide for the sustainable administration and management of land and land-based resources. It has repealed the Way leaves Act, Cap 292 and the Land Acquisition Act, Cap 295 and therefore provides for land acquisition for various purposes. Section 5 (1) of this Act provides the following forms of land tenure:

- ✓ Freehold
- ✓ Leasehold
- ✓ Such forms of partial interest as may be defined under this Act and other law, including but not limited to easements.
- ✓ Customary land rights, where consistent with the Constitution.

The Act specifies that there shall be equal recognition and enforcement of land rights arising under all tenure systems and non-discrimination in ownership of, and access to land under all tenure systems.

4.2.5 Water Act, 2016

The Water Act 2016 makes provision for the conservation, control and use of water resources in Kenya and for incidental and connected purposes. This Act aims at providing for harmonized and streamlined management of water resources, water supply and sewerage services. The Water Resource Authority was established under this Act to regulate and protect resources from adverse impacts. The Water Act provides for the conservation and controlled use of water resources in Kenya. Under the Ministry of Water the Act prohibits pollution of water resources and controls the discharge of industrial and municipal effluents into the ocean and other water bodies.

4.2.6 Physical and Land Use Planning Act Cap 303

The Physical and Land Use Planning Act Cap 303 is an Act of Parliament that makes provision for the planning, use, regulation and development of land and for connected purposes. The Act provides the principles, procedures and standards for the preparation and implementation of physical and land use development plans at the national, county, urban, and rural and cities level. It provides the administration and management of physical and land use planning in country with clear procedures and standards for development control and the regulation of physical planning and land use. It also provides a framework for the co-ordination of physical and land use planning by County Governments, a mechanism for dispute resolution with respect to physical and land use planning, a framework for equitable and sustainable use, planning and management of land.

4.2.7 The Energy Act 2019

An Act of Parliament to consolidate the laws relating to energy, to provide for National and County Government functions in relation to energy, to provide for the establishment, powers and functions of the energy sector entities; promotion of renewable energy; exploration, recovery and commercial utilization of geothermal energy; regulation of midstream and downstream petroleum and coal activities; regulation, production, supply and use of electricity and other energy forms; and for connected purposes.

4.2.8 Occupational Safety and Health Act, 2007

This is an Act of Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces. The provisions of the Act relevant to engineering construction works are contained in the Abstract of the Act for Building Operations and Works of Engineering Construction Rules. These rules specify the minimum safety and health measures to be taken during construction works which include that the proponent

should:

- Give notice of particular operations or works;
- Such notice should be sent in writing to the Occupational Health and Safety Officer, not later than seven days after commencement of construction;
- Post printed copies or prescribed abstracts of the Occupational Safety and Health Act at the site of operations or works;
- Provide sufficient and suitable sanitary conveniences for persons employed. These must be kept clean and well lit.

The purpose of the Act is to secure the safety, health and welfare of persons at work; and protect persons other than persons at work against risks to safety and health arising out of activities of persons at work.

4.2.9 Employment Act, 2007

This is an Act of Parliament to declare and define the fundamental rights of employees, to provide basic conditions of employment of employees, to regulate employment of children, and to provide for connected matters. In accordance with the Act it shall be the duty of the Minister, labour officers and the Industrial Court to promote equality of opportunity in employment in order to eliminate discrimination in employment; and to 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. The Act states that no employer shall discriminate directly or indirectly, against an employee or prospective employee or harass an employee or prospective employee on grounds of race, colour, sex, language, religion, political or other opinion, nationality, ethnic or social origin, disability, pregnancy, mental status or HIV status.

4.2.10 HIV and AIDS Prevention and Control Act 2006

The object and purpose of this Act is to (a) Promote public awareness about the causes, modes of transmission, consequences, means of prevention and control of HIV and AIDS; (b) Extend to every person suspected or known to be infected with HIV and AIDS full protection of his human rights and civil liberties by - (i) Prohibiting compulsory HIV testing save as provided in this Act; (ii) Guaranteeing the right to privacy of the individual; (iii) Outlawing discrimination in all its forms and subtleties against persons with or persons perceived or suspected of having HIV and AIDS; (iv) Ensuring the provision of basic health care and social services for persons infected with HIV and AIDS; (c) Promote utmost safety and universal precautions in practices and procedures that carry the risk of HIV transmission; and

(d) Positively address and seek to eradicate conditions that aggravate the spread of HIV infection.

3.2.11 Public Health Act Cap 242

An Act of Parliament to make provision for securing and maintaining health. The Public Health Act regulates the maintenance, repair and inspection of drains, latrines, cesspool or septic tanks. It spells out requirements for the construction of drains in connection with buildings and prohibits nuisances that may cause injury or health hazards.

3.2.12 Work Injuries Benefits Act 2007

Work Injuries Benefits Act is an Act of Parliament that provides for compensation to employees for work related injuries and diseases contracted in the course of their employment and for connected purposes. The Act stipulates that every employer shall obtain and maintain an insurance policy with an insurance company approved by the Minister in respect of any liability that the employer may incur under this Act to any of his employees. An employee who is involved in an accident resulting in the employees' disability or death is subject to the provisions of the Act, and entitled to benefits provided for under the Act. The Act however states that no employee shall be entitled to compensation if an accident, not resulting to serious disability or death, is caused by the deliberate and wilful misconduct of the employee.

4.3 Regulatory framework

Relevant National Regulations

- The Environmental (Impact Assessment and Audit) Regulations, 2003 Legal Notice No.101
- Environmental Impact Assessment Guidelines and Administrative Procedures, 2002
- Environmental Management & Coordination (Air Quality) Regulations, 2014 (Legal Notice No.34)
- Environmental Management & Coordination (Water Quality) Regulations, 2006 (Legal Notice No.120)
- The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulation, 2009 Legal Notice No.61
- Environmental Management & Coordination (Waste Management) Regulations, 2006 Legal Notice No.121
- Building Operations and Works of Engineering Construction Rules, 1984

4.3.1 The Environmental (Impact Assessment and Audit) Regulations

These Regulations give effect to EMCA, 1999 by providing guidance on the procedure for conducting EIA studies and detailing the issues to be addressed during the study, as well as the parameters to be evaluated and guidelines for development of environmental management and monitoring plans. In addition the regulations provide guidelines for conducting annual environmental audits.

4.3.2 Environmental Impact Assessment Guidelines and Administrative Procedures, 2002

These guidelines support the Environmental Impact Assessment (EIA) and Environmental Audit (EA) processes and assist in the integration of environmental and social concerns in economic development to foster sustainable development in Kenya.

4.3.3 Environmental Management & Coordination (Air Quality) Regulations, 2014

These regulations provide for prevention, control and abatement of air pollution from premises, processes, operations or works, and prescribe exposure limits of air pollutants and emission levels of hazardous substances.

4.3.4 Environmental Management & Coordination (Water Quality) Regulations, 2006

These regulations provide for protection of ground and surface water from pollution, quality standards for sources of domestic water and the limits and parameters of pollutants in treated waste water which can be discharged into the aquatic environment.

4.3.5 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulation, 2009

These regulations apply to operation of equipment or machinery and engagement in commercial or industrial activity that is likely to emit noise or excessive vibrations. The regulations specify the limits or levels within which these shall be undertaken. The Regulations also stipulate in the second schedule that construction activities undertaken during the night should not emit excessive noise beyond the permissible levels.

4.3.6 Environmental Management & Coordination (Waste Management) Regulations 2006

These regulations outline the responsibility of the waste generator and prescribe proper mechanisms for handling all waste through segregation, recycling and reuse.

4.3.7 Building Operations and Works of Engineering Construction Rules, 1984

The provisions of the Factories Act relevant to building operations and engineering construction works are contained in the Abstract of the Act for Building Operations and

Works of Engineering Construction Rules. These rules specify the minimum safety and health measures to be taken during construction works which include that the proponent should:

- ✓ Give notice of particular operations or works;
- ✓ Such notice should be sent in writing to the Occupational Health and Safety Officer, not later than seven days after commencement of construction;
- ✓ Post printed copies or prescribed abstracts of the Occupational Safety and Health Act at the site of operations or works (Section 61 of the Act);
- ✓ Provide sufficient and suitable sanitary conveniences for persons employed. These must be kept clean and well lit.

5. BASELINE INFORMATION

5.1 Ambient Acoustic Emissions Baseline

The proposed project site has built cement and clinker processing facility. Cement plant noise comes mainly from crushers, mills, kiln burners, and compressors. The overall aim of establishing baseline noise levels is to quantify the quality of existing acoustic environment at the proposed project site and its environs. A baseline noise survey consisting of an operator attended noise measurements (OANM) was performed on the proposed project site in Vipingo, Kilifi County. Lahvens Limited operated seventeen (17) mobile stations along the proposed project corridors as part of its noise levels monitoring networks on the 4th April 2024. Acoustic / Noise emission survey was achieved via initial examination of existing noise sources of significance. Noise levels were evaluated using a Sound Level Meter Model UT – 351, C150107874 class 2. SLM was mounted on at 2.0m above ground level and at least 3.5m away from any sound reflecting surfaces and measurements taken at timed intervals of 15 minutes every one-hour period and stored in SLM's memory. The sound level meter was placed on the microphone to reduce any wind interference during measurements. The sound level meters, were within their calibration period, at the time of monitoring.

5.1.1 Sensitive Receptors

The geographical scope of the baseline assessment was defined as per the proposed project site and its environs. The most immediate neighbors of Mombasa Cement Limited-Vipingo Unit are the Indian ocean to the East and the Rea Vipingo Sisal Plantation to the West. The most immediate learning institution is Vuma Primary school. Other learning institutions in the neighborhood include; Mkwajuni Youth Polytechnic (Vocational Training Centre), Takaungu Secondary School, Shariani Secondary School, Kilifi High Vision Secondary School, Mnarani Secondary School, Vutakaka Junior School, Takaungu Primary School, Mkwajuni Primary School, Shauri Moyo Primary School, Shariani Primary School, Kapecha Primary School, Mtwapa Elite Academy-Shariani, Timboni Primary School, Kadzinuni Primary School, Mkomani Primary School , Creek View School and the Zawadi Star Junior School. Health institutions within the vicinity of the proposed project site include Kadzinuni Dispensary, Rayman Medical Clinic and Takaungu Dispensary. Religious institutions within the vicinity of the proposed project site include Mwakujuni Mosque-Masjid Safina, Mkomani-Masjid Hudaa and Bethel Temple of Christ. There are various homesteads, subsistence farm lands and business developments within the neighborhood of the proposed project site.

5.1.2 Existing Acoustic Environment

The existing acoustic environment in the vicinity of the site is influenced primarily by noise emissions from the cement and clinker manufacturing activities, loading activities, mining activities and transportation activities. Acoustic emissions occur mainly from crushers, mills, kiln burners, and compressors.

5.1.3 Ambient Acoustic Emissions Baseline Results

Baseline diurnal noise equivalent levels (Leq) measured and recorded across all the seventeen survey locations exceeded limits provided for in the Environmental Management and Coordination (Noise and Excessive Vibration) (Control) Regulations 2009 maximum Noise Level Permitted (Leq) during the day. Baseline results obtained across all the seventeen survey locations showed that the survey locations were a noise significant area. From the results of determination of significance, there is no threat to the noise receivers (residential homes, learning institutions and the dispensary) since the noise is controlled from within and does not spillover to the receptors. The distance between the receptor and the proposed site is vast. Mechanical noise from production machines (crushers, mills, kiln burners, and compressors), Wind breeze and noise from trucks were the main sources of noise emissions.

The highest diurnal noise emissions recorded at raw mill silo 2 extended to levels of 86.9 dBA while the lowest diurnal noise emission recorded furthest from CSP extended to levels of 60.1 dBA. The average Leq noise levels at the proposed project site averaged 77.41 dBA. The average noise levels along all the survey locations exceeded limits provided in the Environmental Management and Coordination (Noise and Excessive Vibration) (Control) Regulations 2009. Table 1 presents baseline noise levels at each of the measurement location, Table 2 is a Summary results for diurnal noise equivalents while Appendix 5 is the detailed environmental baseline study report for ambient acoustic emissions levels for the proposed project.

Table 1 Diurnal singular noise measurement results

Measured Sound Pressure Level (Noise) (dBA)				**EMC Noise Regulation 2009**	**Site Notes / Remarks**
4th April 2024.				**Day time**	
Locations	**Leq**	**Lmax**	**Lmin**	**Leq**	
Between Raw mill 1&2	79.6	88.3	71.2	55	The prevailing weather was sunny. Wind speed averaged about 22 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and raw mill machine noise were the likely sources of noise emissions.
Between Raw mill hoppers 1&2	73.0	79.4	66.3	55	The prevailing weather was sunny. Wind speed averaged about 22 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and hopper machines noise were the likely sources of noise emissions.

Between pre heater 1&2	81.4	88.4	77.4	55	The prevailing weather was sunny. Wind speed averaged about 21 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and pre-heater machines were the likely sources of noise emissions.
Between kiln 1&2	84.1	87.7	79.0	55	The prevailing weather was sunny. Wind speed averaged about 22 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and kiln burners noise were the likely sources of noise emissions.
Between cooler 1&2	83.8	88.2	80.3	55	The prevailing weather was sunny. Wind speed averaged about 23 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and cooler machines noise were the likely sources of noise emissions.
Between DPC & CSP	73.8	78.2	69.9	55	The prevailing weather was sunny. Wind speed averaged about 20 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and traffic noise were the likely sources of noise emissions.
Furthest from DPC	64.1	73.7	60.4	55	The prevailing weather was sunny. Wind speed averaged about 21 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and traffic noise were the likely sources of noise emissions.
Furthest from CSP	60.1	63.3	55.3	55	The prevailing weather was sunny. Wind speed averaged about 23 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and traffic noise were the likely sources of noise emissions.
Clinker weigh bridge	77.4	81.8	71.7	55	The prevailing weather was sunny. Wind speed averaged about 24 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and traffic / truck noises were the likely sources of noise emissions.
Silo (cement) line 3	84.8	88.8	79.6	55	The prevailing weather was sunny. Wind speed averaged about 23 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and crushers noise were the likely sources of noise emissions.
Coal mill 2	81.1	85.0	76.1	55	The prevailing weather was sunny. Wind speed averaged about 22 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and operating coal mill noise were the likely sources of noise emissions.
Raw mill silo 2	86.9	89.1	80.8	55	The prevailing weather was sunny. Wind speed averaged about 23 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and operating raw mill noise were the likely sources of noise emissions.
Coal mill 1	81.5	86.3	77.5	55	The prevailing weather was sunny. Wind speed averaged about 21 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and operating coal mill noise were the likely sources of noise emissions.
Raw mill silo 1	94.1	96.6	90.1	55	The prevailing weather was sunny. Wind speed averaged about 21 km/hr North East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and operating raw mill noise were the likely sources of noise emissions.
Coal shade 2	76.9	82.5	70.5	55	The prevailing weather was sunny. Wind speed averaged about 19 km/hr East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and traffic / truck noise were the likely sources of noise emissions.
Coal shade 1	61.8	68.9	56.7	55	The prevailing weather was sunny. Wind speed averaged about 20 km/hr East wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and traffic / trucks noise were the likely sources of noise emissions.
Silo (cement) line 2	71.6	79.8	66.7	55	The prevailing weather was sunny. Wind speed averaged about 21 km/hr North wind. Measurements are taken to quantify prevailing ambient acoustic levels. Environmental noise including Wind breeze and cement milling machine were the likely sources of noise emissions.

Table 2 Summary results for diurnal noise equivalents

Monitoring locations	Diurnal LAeq average results	Maximum noise level permitted (Leq) in dB (A) Day (0601-2000) hrs	Comments
Between Raw mill 1&2	79.6	**55**	Exceeds limits
Between Raw mill hoppers 1&2	73.0	**55**	Exceeds limits
Between pre heater 1&2	81.4	**55**	Exceeds limits
Between kiln 1&2	84.1	**55**	Exceeds limits
Between cooler 1&2	83.8	**55**	Exceeds limits
Between DPC & CSP	73.8	**55**	Exceeds limits
Furthest from DPC	64.1	**55**	Exceeds limits
Furthest from CSP	60.1	**55**	Exceeds limits
Clinker weigh bridge	77.4	**55**	Exceeds limits
Silo (cement) line 3	84.8	**55**	Exceeds limits
Coal mill 2	81.1	**55**	Exceeds limits
Raw mill silo 2	86.9	**55**	Exceeds limits
Coal mill 1	81.5	**55**	Exceeds limits
Raw mill silo 1	94.1	**55**	Exceeds limits

Coal shade 2	76.9	**55**	Exceeds limits
Coal shade 1	61.8	**55**	Exceeds limits
Silo (cement) line 2	71.6	**55**	Exceeds limits

5.2 Carbon Footprint Baseline

The baseline carbon footprint for the proposed project is based on the Green House Gases (GHGs) emission potential which is a function of existing cement manufacturing operations and activities which range from delivery and transportation of raw materials out of the port (involves marine vessels and trucks), transportation of personnel in a similar manner (both on road and air), use of energy resources (mainly fossil fuels - coal) for powering machinery and equipment, import of energy into the project's operations from the national grid, emissions from vehicular traffic by visitors, suppliers, and refrigeration among others.

5.2.1 Objectives

The objectives of establishing a carbon emission footprint for the proposed project was:

- To provide a basis for managing, and reducing, GHG emissions at all levels of the proposed waste heat recovery project cycle and inform future monitoring.
- To adhere to government and industry best practice guidelines and hence improve environmental performance of the proposed waste heat recovery.
- To provide a figure to inform the greening policies of the company
- To provide information that may be requested by stakeholders especially with requirements to comply with global standards in reducing emissions and fostering sustainable development

5.2.2 Carbon Footprint Analysis

Carbon footprint analysis was undertaken to calculate the carbon footprint for the proposed waste heat recovery plants (including electricity generation plant of 20 MW, 10MW from waste heat recovery of its two clinker plants and another extra 10MW from burning of industrial, agricultural, and municipal waste) at operational phase and provide comprehensive Greenhouse Gases (GHGs) mitigation and offset plan measure to lower the project carbon footprint and climate proof of the project.

5.2.3 Carbon Footprint calculation

A carbon footprint is the total amount of greenhouse gases (including carbon dioxide and methane) that are generated from a particular activity. A carbon footprint is a calculated value or index that makes it possible to compare the total amount of greenhouse gases that an activity, product, company or country adds to the atmosphere. Carbon footprints are usually reported in tons of emissions per unit of comparison. Carbon dioxide (CO_2) emissions (often referred to by the shorthand of "carbon emissions") from anthropogenic sources are contributing to global warming. The carbon footprint baseline assessment identified baseline information relating to greenhouse emissions potential and the CO_2 equivalent within MCL facility in Kilifi County. The assessment considers estimates of baseline ('do minimum') and future waste heat recovery boilers ('do something') emissions as far as is possible given the detail available at this stage. The baseline assumed the 'do minimum' base case defined as 'how the waste heat recovery facility will develop in the absence of the MCL existing cement manufacturing facility to deliver an additional WHR facility'. Carbon calculation is aimed at minimizing carbon emissions during construction and operation of the waste heat recovery plants. This will be achieved through calculation of the existing carbon footprint and providing comprehensive greenhouse gases mitigation and offset plan.

5.2.4 Carbon Footprint Baseline Results

The emission sources at MCL were classified under Scope 1, Scope 2, and Scope 3. The baseline carbon emissions were calculated based on raw materials, energy consumption and fuel of the various sources between January 2023 and December 2023. The facility depicted an overall annual carbon footprint of 931,978,558 kgCO2e over the baseline period.

Scope 1 emissions contributed to the highest carbon footprint at 891,981,437.95 kgCO2e representing 95.71% of the total carbon emissions. **Scope 2** contributed to 38,525,436.20 kgCO2e representing 4.13% of the total carbon emissions and **Scope 3** contributed to 2,826,702.51 kgCO2e translating to 0.16% of the total carbon emissions. **Scope I** emissions were mainly a consequence of equipment (kilns) that are directly owned or controlled by MCL. The emissions were a result of fuel consumption of both mobile and non-mobile equipment which were categorized as Mobile and Stationary Combustion, Clinker and Cement Production (calcination), Kiln Fuel Consumption (Aggregate), Non-Kiln Fuel Consumption. Under Scope 1, Kiln Fuel (coal) Consumption (Aggregate) contributed to the highest carbon emissions extending up to 879,155,856.76 kgCO2e and forms 99% of scope 1 emissions.

Combustion Emission from mobile and Stationary sources contributes to approximately 10,487,650.99 kgCO2e carbon emissions representing about 1% of the total Scope 1,605,271.00 kgCO2e translating to 0.18% while fugitive emissions refrigerants account for 0.08 % that is 732,659.20 kgCO2e.

Fugitive emissions were mainly due to refrigerant leakages as applied to the 150 air conditioning units installed at various sections of MCL with the majority being the offices. The AC sizes vary and use Gas type – R410a. Maintenance of the AC's is scheduled on quarterly basis. The main refrigerants used in the air conditioning units include R410A. The baseline carbon emissions over the baseline period as a result of refrigerant leakages stood at 732,659.20 kgCO2e of R410A.

Scope 2 emissions are resultant of the electricity consumption at the facility. Electricity is supplied by the utility (Kenya Power) and utilized to run various equipment including lighting systems, plug loads, air conditioning systems, and other electrically operated machinery. The total consumption of electricity within the baseline period (January 2023 – December 2023) was 186,023,352 kWh contributing to an equivalent carbon emission of 38,525,436.20 kgCO2e. The monthly average electrical consumption was 15,501,946 kWh which was equivalent to 3,210,453.02 kgCO2e of carbon emissions.

Under **scope 3**, the major part of the carbon emissions resulted from purchase of raw materials (limestone, clay, Limestone, Shale, River sand, Gypsum and Iron ore. The annual net weight of the raw materials purchased in 2023 extended to weights of 4,590,407.00 Tons. When the net weight in tonnage is converted to the carbon dioxide equivalent, a total of 1,430,942.00 kgCO2e is emitted. It is also evident that water consumption in the study year (2023) extended to volumes of 230,178 cubic meter which in return translates to 40,741.51 kgCO2e emitted that year. Table 3 is tabulated results of baseline carbon emission, the detailed Baseline Carbon Emission Footprint report is in Appendix 6.

Table 3 MCL proposed WHRP Baseline Carbon Emissions

Scope	Category	Quantities	Units	MCL VIPINGO KgCO2e
SCOPE 1	**CO2 from raw materials' calcination**			
	From cement produced	498,408.41	Tons	250,252.00
	From Clinker produced	2,667,884.00	Tons	1,355,019.00
	CO2 from fuel combustion			879,155,856.76
	Fossil fuels (Coal): kiln	366,853.00	Tons	
	Fossil fuels: non-kiln	-	-	
	CO2 from mobile and stationary sources			
	Fossil fuels (PETROL)	40,853.00	Liters	10,391,646.44
	Fossil fuels (DIESEL)	3,906,634.00	Liters	96,004.55
	Fugitive Emissions	380.80	Kgs	732,659.20

Scope	Category	Quantities	Units	MCL VIPINGO KgCO2e
TOTAL SCOPE I				**891,981,437.95**
SCOPE 2	Electricity	186,023,352	KWh	38,525,436.20
TOTAL SCOPE II				**38,525,436.20**
SCOPE 3	**Purchased goods and services**			
	Clinker imports / offsite supply	-	Tons	-
	Raw materials (limestone, clay, Limestone, Shale, River sand, Gypsum, Iron ore)	4,590,407.00	Tons	1,430,942.00
	Upstream transportation and distribution			
	Transportation of clinker to company		Litres	
	Transportation of raw materials (limestone, clay, Limestone, Shale, River sand, Gypsum, Iron ore) to processing plant.		Litres	
	Business travel All business travels related		Litres	
	Employee commuting All employee commuting travel to or from Home / offices		Litres	
	Downstream transportation and distribution:			
	Transportation of clinker to another company		Litres	
	Transportation of cement to retailers		Litres	
	Transportation of waste away from MCL - Vipingo		Litres	
	Waste (Refuse) Commercial and industrial	-	Kgs.	-
	Water Consumption	230,178.00	M^3	40,741.51
TOTAL SCOPE III				**1,471,683.51**
TOTAL CARBON FOOTPRINT				**931,978,557.66**

5.2.5 Carbon Footprint Baseline Conclusion

Analysis of the MCL Vipingo baseline carbon emissions is based on the Do Minimum waste heat recovery forecasts developed from the existing situations at proposed facility. There is significant built up construction / infrastructure during this period under the do minimum scenario, as the proposed waste heat recovery plant intends to be configured in order to make effort in reducing carbon footprint and cut its overall greenhouse gases. Heat recovery will be achieved from the flue and waste gas streams from the pre-heater tower and the clinker cooler.

The most significant volume of emissions (95%) is related to use of fossil fuels during cement and clinker production in the kiln combustion but these are projected to decrease over the period, linked to changes to the alternative fuels to coal or bioenergy that will be adopted during the waste heat recovery operations.

Electricity consumption remains the second largest (4%) source of CO_2 emissions. The emissions are projected to reduce through use of renewable sources of energy such as solar to reduce carbon foot print during the production process. MCL Vipingo is expected to develop

and implement an energy monitoring plan to track consumption patterns and identify opportunities for improvement when the waste heat recovery plant operations get underway.
Surface access emissions remain the third and top three carbon emissions sources at <1%. Diesel and petrol are mostly used for the MCL Vipingo fleet. MCL Vipingo is expected to develop and implement a policy on condition of vehicles and trucks accessing the facility.
Emissions from fuel kiln combustion, raw materials calcination i.e. cement and clinker processing, mobile and stationary source, fugitive emissions, purchased electricity, purchased raw materials, upstream transportation and distribution, downstream transportation and distribution and water consumption were reported as CO_2e. The carbon emissions from WHR infrastructure construction for the baseline do minimum scenario from the existing facility is 931,978,557.66 CO2e in total. There are no emissions associated with the proposed infrastructure.

5.3 Air Quality Dispersion Modeling

5.3.1 Objectives

The aim of this assessment is to predict the contribution from the proposed waste heat recovery plant to the air quality. The main objectives of this Air Dispersion Modeling report are to provide quantitative information and a better understanding of the potential impacts from pollutants emitted from the cement processing under normal operations of the Vipingo facility, for which the following sources were modeled as air pollutant emitters:

- Two (2) ESP stacks located within the vicinity of the proposed waste heat recovery plant.
- Two (2) Coal mill stacks located within the vicinity of the proposed waste heat recovery plant.
- Two (2) RABH stacks located within the vicinity of the proposed waste heat recovery plant.

5.3.2 Aerial Dispersion of Contaminants Calculation

To accomplish these objectives, the aerial dispersion of contaminants during the normal operations “as is scenario” was calculated using the steady-state Gaussian plume dispersion model AERMOD, based on the emission characteristics of the emitting facilities at MCL Vipingo during the normal operation scenario. The results were compared with the applicable national and international Ambient Air Quality Standards. The criteria used to evaluate the measured and simulated values are derived from EMCA (Air Quality) Regulations 2014, IFC and the WHO ambient air quality standards. This assessment modeled contributions from the

proposed waste heat recovery plant to verify compliance with applicable national legal standards (EMCA) and international guidelines for air quality limits, and calculated cumulative impacts of the facility emissions on the air quality of the area by combining the modeled contributions from the proposed waste heat recovery facility with background levels measured in the area.

5.3.3 Scenario Impact Determination

The air quality modeling is intended to determine the scenario impact (before implementation) to the existing environment, nearby residents / receivers and sensitive receptors. The study used emissions monitoring data from 2023, quarter 4 which involved modeling of potential pollutants air dispersion with the planned changes in the plant operations. The modeled concentration of the pollutants was then added to existing background ambient air quality conditions to determine their cumulative impact. This cumulative impact was then compared to the applicable air quality criteria based on the EMC (Air Quality) Regulations, 2014. To provide the worst-case results, the emission parameters used in the air quality assessment for both the ambient air results and the source emission results were based on conservative emission rates with the ESP, Coal mill and RABH stacks at line one and two being at maximum production rates. If any of modeled results showed cumulative concentrations greater than the ambient air quality criteria, an additional model was run showing normal or average emission parameters.

5.3.4 Contaminant of Potential Concern

Contaminant of Potential Concern (COPC) for the purposes of this air dispersion model was the primary air pollutant to ambient air quality from manufacturing facility which are particulates. Secondary air pollutants included NOx, SO2, CO. An air dispersion modelling exercise involving the AERMOD air dispersion model was conducted to predict the impact of the emissions on ambient air quality from the MCL Cement Plant in Vipingo, Kilifi County before implementation of the waste heat recovery. An air dispersion modelling assessment was completed to estimate the maximum modelled concentrations of particulate than 10 micrometers (PM10), carbon monoxide (CO), nitrogen oxides (NOx) and sulphur dioxide (SO2). The emissions associated with the existing and proposed waste heat recovery operations have been modelled as per Environmental Management Coordination (EMC) (Air Quality) Regulations 2014, International Finance Corporation (IFC) and the World Health Organization (WHO) ambient air quality standards. The maximum modelled concentrations

were then compared to the (EMC) (Air Quality) Regulations 2014, IFC and WHO thresholds as a means to evaluate the air quality impacts.

The Air Dispersion Model considered the different components of the proposed waste heat recovery together with cumulative approach taking into account existing conditions of the ambient air quality.

5.3.5 Air Quality Dispersion Modeling Results

The findings of this spatial model of air emission model are based on actual source measurement results that were conducted in 2023 monitoring. Results of the study show that under normal operation the 24-hour average PM concentrations modelled across the entire study area are predicted to reach a maximum 13.5 ug/m3. These concentrations are within the allowable national and international applicable limits. It is important to note that these are simulated for purposes of the baseline studies, and as such for monitoring actual measurements and modelling will be done to establish compliance. This means that with the planned changes, if proper mitigation measures are implemented:

⇒ The 24 hours' average PM_{10}, Contaminant of Potential Concern (COPC) concentrations modeled across the entire study area are predicted to extend to a maximum concentration of 13.5 µg/m^3 and a minimum concentration of 0.1 µg/m^3, which are within recommended standard by both the national regulatory authority (NEMA- EMCA (Air Quality Regulations 2014 ;50 µg/m^3) and WHO 45 µg/m^3).

⇒ The annual average PM_{10}, Contaminant of Potential Concern (COPC) concentrations modeled across the entire study area are predicted to extend to a maximum concentration of 3.38 µg/m^3 and a minimum concentration of 0.03 µg/m^3 which are below recommended standard by both the national regulatory authority (NEMA- EMCA (Air Quality) Regulations 2014 ;50 µg/m^3) and WHO 15 µg/m^3);

⇒ The potential particulate fallout area with the planned changes in the plant operation will include but not limited Sokoke, Kilifi town, Jaribuni, Takaungu, Mkomani Dindini, Mkongoni, Gongoni, Mbuyuni, Galanema among others.

⇒ The 24 hours' average SO_2, Contaminant of Potential Concern (COPC) concentrations modeled across the entire study area are predicted to extend to a maximum concentration of 7.6 µg/m^3 and a minimum concentration of 0.08 µg/m^3, which are within recommended standard by both the national regulatory authority (NEMA- EMCA (Air Quality) Regulations 2014; 125 µg/m^3) and WHO 40µg/m^3).

⇒ The annual average SO_2, Contaminant of Potential Concern (COPC) concentrations modeled across the entire study area are predicted extend to a maximum concentration of 1.97 µg/m^3 and a minimum concentration of 0.02 µg/m^3, which are below recommended standard by both the national regulatory authority (NEMA- EMCA (Air Quality) Regulations 2014; 125 µg/m^3) and WHO 40µg/m^3).

⇒ The 24 hours' average NO_x Contaminant of Potential Concern (COPC) concentrations modeled across the entire study area are predicted to extend to a maximum concentration of 163 µg/m^3 and a minimum concentration of 2 µg/m^3, which are above recommended standard by both the national regulatory authority (NEMA- EMCA (Air Quality) Regulations 2014; 150 µg/m^3) and WHO 40 µg/m^3).

⇒ The annual average NO_x, Contaminant of Potential Concern (COPC) concentrations modeled across the entire study area are predicted to extend to a maximum concentration of 41.8 µg/m^3 and a minimum concentration of 0.4 µg/m^3 which are below 80 µg/m^3 recommended standard by both the national regulatory authority (NEMA- EMCA (Air Quality) Regulations 2014), but above WHO 10 µg/m^3).

⇒ The potential gaseous fallout areas with the planned changes in the plant operation will include but not limited Sokoke, Kilifi town, Jaribuni, Takaungu, Mkomani Dindini, Mkongoni, Gongoni, Mbuyuni, Galanema among others.

The potential recipient properties within the neighbourhood of Mombasa Cement Limited-Vipingo Unit include:

- Commercial development such as Rea Vipingo Sisal Plantation to the West.
- Learning institution such as Vuma Primary school, Mkwajuni Youth Polytechnic (Vocational Training Centre), Takaungu Secondary School, Shariani Secondary School, Kilifi High Vision Secondary School, Mnarani Secondary School, Vutakaka Junior School, Takaungu Primary School, Mkwajuni Primary School, Shauri Moyo Primary School, Shariani Primary School, Kapecha Primary School, Mtwapa Elite Academy-Shariani, Timboni Primary School, Kadzinuni Primary School, Mkomani Primary School , Creek View School and the Zawadi Star Junior School.
- Health institutions such as Kadzinuni Dispensary, Rayman Medical Clinic and Takaungu Dispensary.
- Religious institutions such as Mwakujuni Mosque-Masjid Safina, Mkomani-Masjid Hudaa and Bethel Temple of Christ.

5.3.6 Recommendations

The following are measures that will be put in place to safeguard the health of persons within the fallout zones:

- Cleaner production

For production processes, cleaner production involves one or a combination of the following: conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; reducing the quantity and toxicity of emissions and wastes at source during the production process. The client will implement waste heat recovery boiler plants that eliminate toxic and dangerous raw materials that is the primary source of pollution. Once the boilers (WHR – PH#1- 10 TPH, PH#2- 22TPH, AQC #1 – 22 TPH and AQC#2 – 42 TPH. CFBC Boiler – 45 TPH) will be in operations, an alternative cleaner fuel to coal should be considered.

- Administrative controls

Carry out quarterly (every three months) monitoring of local air quality as provided for in the Environmental Management and Coordination (Air Quality) Regulations 2014 both at the source and the fallout zones. The results of the assignment at any given time especially when the emissions surpass the regulatory limits will determine the actions taken. MCL will ensure the emissions are within the regulatory limits.

- Engineering controls

MCL shall ensure the minimum stack height is 15 meters above ground level and 2 meters above roof level in general. MCL shall provide a proper Port Hole and Platform along with Ladder shall be provided to facilitate the monitoring of the emissions from the proposed boilers.

- End of pipe treatment

MCL shall install a functional and efficient Air Pollution Control Device (APCD) / Emission Control System (ECS) to ensure air quality standards prescribed in the Environmental Management and Coordination (Air Quality) Regulations 2014 are strictly adhered to. If appropriate APCD / ECS will be properly operated & maintained, the prescribed standards will be achieved.

The Detailed Air Quality Dispersal Modeling Report is in Appendix 7.

5.4 Geotechnical Investigations

The geotechnical technical investigation data and information used for the proposed project was derived from geotechnical investigations carried out in 2017 for the expansion of Mombasa Cement Limited Vipingo site. This is the geotechnical data that advised the construction of the second clinkerization plant including electrostatic precipitators stack (ESP), coal mill stacks and RABH stacks. It is from these stacks the waste heat that is to be used in electricity generation will be recovered from Since the site remains the same the geotechnical report carried in 2017 was found sufficient for the proposed project.

5.4.1 Field procedure

The field investigation of the site was conducted by drilling and sampling fourteen (14) exploratory boreholes. Each borehole (BH01- BH14) was advanced to a maximum depth of 6 m below existing grade.

5.4.2 Stratigraphy and General Description

In general, the subsurface soil encountered was primarily sand with significant portions (up to 40%) of clay and/or silt. Clayey sand exhibited a dark red hue while silty sand was light brown in colour. The red clayey sand was slightly remoldable thus confirming plastic characteristics, albeit low. On the other hand, the light brown soil samples could not be remolded and quickly lost moisture thus confirming silt content. Standard Penetration Tests (SPT) in the soil layers revealed compact to very dense insitu conditions. It should be noted that the topsoil thicknesses presented in the logs pertain to the estimated values at the respective borehole locations only and may vary between and beyond the boreholes. Further, the data presented in this report may not be sufficient for the purposes of estimating topsoil quantities across the site or for the associated stripping costs. Finally, in a majority of the boreholes, the surficial soil layers are underlain by white, highly weathered coral stratum. The coral core samples had numerous voids implying highly porous bedrock conditions.

5.4.3 Ground water

No water rest levels were observed in the boreholes during and at the completion of the drilling process.

5.4.4 Geotechnical Investigation Results

⇒ The SPT number (‘N’ Values) within the silty/clayey sand soil deposit varied from 10 blows for per 300 mm to complete refusal. Owing to the expansive nature of clayey soils, no foundations are recommended on clayey sand strata unless the ground is stabilised with lime (10% by weight) and cement (20% by weight). Some sandy soils may require

inordinately high percentages of cement, because of organics or other deleterious materials. This may be corrected by adding normally reacting materials such as crushed rock.

⇒ Only two of the six tested samples yielded plastic index (PI) values averaging at 7.43 (see appended results for precise values). The two samples are generally of low plasticity (Carter M. and Bentley S. P. 1991). The rest of the samples were nonplastic hence could not be rolled for PI.

⇒ Majority of the tested samples were silty sand. This classification is based on PI values, percentage fines and overall grain size distribution.

Detailed geotechnical investigation report is in Appendix 8.

5.5 Groundwater

5.5.1 Occurrence

MCL Vipingo site has groundwater resources; groundwater in the area occurs in confined and unconfined aquifers in sedimentary formations of fluvial and lacustrine origin. Groundwater flow direction is generally eastward with recharge rate decreasing westward. The geology of the area plays an important role in determining occurrence of the groundwater. Whereas coral limestone is permeable, the Magarini Formation and Quaternary alluvial sands have layers of clay that help trap water. Therefore over the entire Coastal Belt, occurrence of groundwater is characteristic of the dune sands lying behind the coral limestone. Given that MCL Vipingo site is within the Reef Complex which was formed from accumulation of corals along the coast, limestone cavens allow sea-water intrusion inland where there are no faults causing little drawdown in boreholes even with continuous large-scale abstraction. As there are no sandy beaches on the coastline adjacent to MCL Vipingo site, there is constant interaction of seawater and the rugged coral limestone cliffs. The interaction increases and reduces during high and low tide, respectively. Therefore the coral limestone forms an important medium for interface of the fresh groundwater and seawater at the site.

During drilling of boreholes and digging of wells at the site, subsurface formations are encountered into Pleistocene and Magarini sands. Magarini sands comprise of fluviatile pebble beds of gravels and sands deposited in fresh water environment while Pleistocene sands were formed from blowing up of Magarini sands during the Pleistocene times. Water suitable for domestic purposes is encountered in unconfined aquifers at depths between 22 and 32 m. Caving of the sands during borehole drilling through these aquifers is possible. At depths of 41 m to 50 m, the borehole water is mainly saline in coral and clay bands. The

presence of displaced faults in parts of the site restricts lateral influx of saline water; further the presence of faults with throws to the coast restricts the inland movement of sea water. The wells on the other hand provide water for domestic use. Further there are shallow water wells in the neighborhood of the company used by the local community

5.5.2 Groundwater quality

- ✓ Physical & Chemical properties of ground water sampled and analysed from existing wells at MCL Vipingo conformed to National standards.
- ✓ Faecal Coliform Count was not detected in sampled and analysed water from existing wells at MCL Vipingo.

  Appendix 9 is the detailed well water sampled from MCL Vipingo site analysis report

5.6 Ambient Greenhouses Gases Baseline

5.6.1 Assessment criteria for gaseous and particulate parameters

Active and Continuous Sampling for gaseous and particulate parameters was achieved. Sampling of gases was done using a 24-hour AQM-09 is a device which can monitor the air quality via the value of O3, SO2, NO2, CO, CH4, PM2.5, PM10, etc. The target value is converted into voltage signal by operational amplifier circuit, and then filtered through high-precision AD data acquisition system. Finally, the gas concentration is calculated by CPU. Particulates mainly use laser scattering method to produce different scattering light according to different particle diameters under laser scattering conditions. The scattered light intensity is collected by a response device, and the particle 4 concentration is obtained after amplification, filtering and AD acquisition. The obtained gas concentration and particulate matter concentration can be displayed on LCD screen in real time, and can also be transmitted to cloud platform or environmental protection platform through GPRS, 4G LTE and other network signals, so as to realize the monitoring of regional environmental quality. The gas meters were mounted at about 1 – 2 M above the ground surface. The laboratory results and sampling duration information were used to calculate the gaseous concentrations.

5.6.2 Carbon monoxide (CO)

CO monitoring instruments were predominantly gas filter correlation infrared (GFC-IR) absorption analyzers and the electrochemical sensor systems. Ambient air was continuously sampled using a pump unit and the CO concentration in the sample air was measured by the absorption of infrared radiation at 4.5 to 4.9 nanometers (nm) wavelength. A reference detection system was used to alternately measure absorption due to CO in the ambient air stream and absorption by interfering species. An infrared detector and amplification system

produced output voltages proportional to the CO concentration. The concentration was derived from the Beer–Lambert relation:

$I1 = I0\ e\text{-}alc$

Where; the sample was passed through a cell tube of length 'l'. The analyzer alternately measured the absorption I0 of the air path with no CO present and the absorption I1 of the ambient sample, with 'a' being the absorption coefficient, to provide the CO concentration, 'c'.

5.6.3 Nitrogen dioxide (NO2)

Nitric oxide (NO) in the sample air stream was reacted with ozone (O3) in an evacuated chamber to produce activated NO2:

$NO + O3 \rightarrow NO2 + O2 \rightarrow NO2 + O2 + h\nu$

The intensity of the chemiluminescent radiation (hv) produced is measured using a photomultiplier tube (PMT) or photodiode detector. The detector output voltage is proportional to the NO concentration. The ambient air sample is divided into two streams; in one, ambient NO2 is reduced to NO using a molybdenum catalyst before reaction. The molybdenum converter should be at least 95 per cent efficient at converting NO2 to NO. This gas stream gives total NOx. The second stream measures NO directly by not passing through the molybdenum converter.

Separate measurements are made of total oxides of nitrogen NOx (= NO + NO2) and NO. The ambient NO2 concentration is calculated from the difference (NO2= NOx – NO). This is an important point to remember because the contaminant of interest (NO2), is actually measured by inference rather than directly, and the efficiency of the molybdenum converter should be checked on a regular basis.

In a chemiluminescent analyzer, ambient air is drawn through the system via a pump and permapure drier unit. NOx analyzers are equipped with either a single or a double reaction chamber and PMT system. A solenoid valve is used to alternately switch between NO and NOx measurements, typically at 15-second intervals.

5.6.4 Sulphur dioxide (SO2)

SO2 monitoring instruments are predominantly molecular UV fluorescence analyzers. This is the recommended SO2 monitoring method. UV fluorescence systems operate on the principle

that an ambient air sample stream exposed to UV light excites SO2 molecules in the sample to higher, but unstable, excited states. These excited states decay, giving rise to the emission of secondary (fluorescent) radiation:

$SO2 + h\nu \rightarrow SO2 \rightarrow SO2 + h\nu$ (fluorescence).

The fluorescent radiation is detected by a PMT, causing an output voltage proportional to the SO2 concentration. A permeable membrane 'kicker' is used to remove interfering hydrocarbons (aromatic hydrocarbons also fluoresce) before reaction. Ambient air is drawn through the system via a pump unit, and the analyzer continuously displays current SO2 concentrations.

5.6.5 Ozone (O3)

Ozone was measured using a direct reading using the flame-ionisation detector (FID). In the FID, an organic compound is burned in a hydrogen flame giving rise to ions which are attracted to a collector electrode. The resulting electric current is amplified and recorded. The intensity of the signal depends primarily on the number of carbon atoms of the molecule, but to some extent it is also influenced by the character or structure of the chemical. Therefore, the same number of molecules of two different ozone with the same number of carbon atoms can give rise to two different signals. The FID is very stable.

5.6.6 Methane (CH4)

Optical gas detection using absorption spectroscopy is based on the Lambert–Beer law (1,2):

$(\lambda)=I0(\lambda)\exp[-a(\lambda C)\bullet L]$ a[cm−1]

$(\lambda)=I0(\lambda)\exp[-\alpha(\lambda)\bullet C\bullet L]$ α[ppm•cm−1]

Where: I—light intensity transmitted by the medium with the gas, I0—intensity of light incident on the medium, C—concentration, a, α—absorption coefficients, and L—optical path length, gas concentration.

The optical methods for methane detection use its absorption characteristics in the infrared range. The strongest bands occur in the area of deformation vibrations and then valence; they are weaker in the range of overtones.

5.6.7 Results

Table 4 Summary results for air quality and environmental measurements

Monitoring Locations	$PM_{2.5}$ µg/m^3	PM_{10} µg/m^3	CO_2 mg/m^3	SO_2 ppm	NO_2 ppm	NO ppm	O_3 ppm	CH_4 µg/m^3	HUMIDITY %	TEMPS ^{0}C
Between Raw meal 1&2 hoppers	29.7	210	397	0.515	0.0409	<0.001	0.0130	<0.001	51	37.0
Coal yard	16	125	410	0.623	0.0393	<0.001	0.0109	<0.001	58	34.9
Coal mill 1 & RMS 1	27	158	422	0.495	0.0280	<0.001	0.0146	<0.001	54	35.7
Cooler 1 & 2 area	25	136	428	0.469	0.0244	<0.001	0.0123	<0.001	40	44.2
Between kiln 1 & 2	26	158	521	0.471	0.0242	<0.001	0.0121	<0.001	59	40.2
Between pre heater 1 & 2	17	84	505	0.332	0.0089	<0.001	0.0087	<0.001	57	35.1
Between Raw mill 1 & 2	19	123	430	0.282	0.0171	<0.001	0.0273	<0.001	62	33.1
Coal mill 2 & RMS 2	18	111	474	0.204	0.0629	<0.001	0.0148	<0.001	72	30.4
Cement silos	26	166	409	0.153	0.0792	<0.001	0.0091	<0.001	68	31.6
Clinker weigh bridge	229	998	530	0.149	0.0693	<0.001	0.0094	<0.001	69	30.9
Between DPC & CSP	70	428	488	0.143	0.0777	<0.001	0.0129	<0.001	71	30.9
Furthest from DPC	78	427	462	0.142	0.0736	<0.001	0.0133	<0.001	72	30.4
Furthest from ESP	72	369	459	0.121	0.0614	<0.001	0.0132	<0.001	70	30.0

Table 5 Average results for gaseous parameters

Monitoring Locations	*NO_X*		*SO_2*		*CO_2*		*Ozone*		*Methane*		*REMARKS*
	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (mg/m^3)	EMC AQR guide 2014 (mg/m^3)	Conc. (ppm)	EMC AQR guide 2014 (ppm)	Conc. (ppm)	EMC AQR guide 2014 (ppm)	
Between Raw meal 1&2 hoppers	0.0409	0.8	0.515	0.191	397	-	0.0130	0.12	<0.001	-	

Coal yard	0.0393	0.8	0.623	0.191	410	-	0.0109	0.12	<0.001	-	
Coal mill 1 & RMS 1	0.0280	0.8	0.495	0.191	422	-	0.0146	0.12	<0.001	-	
Cooler 1 & 2 area	0.0244	0.8	0.469	0.191	428	-	0.0123	0.12	<0.001	-	
Between kiln 1 & 2	0.0242	0.8	0.471	0.191	521	-	0.0121	0.12	<0.001	-	
Between pre heater 1 & 2	0.0089	0.8	0.332	0.191	505	-	0.0087	0.12	<0.001	-	
Between Raw mill 1 & 2	0.0171	0.8	0.282	0.191	430	-	0.0273	0.12	<0.001	-	
Coal mill 2 & RMS 2	0.0629	0.8	0.204	0.191	474	-	0.0148	0.12	<0.001	-	
Cement silos	0.0792	0.8	0.153	0.191	409	-	0.0091	0.12	<0.001	-	
Clinker weigh bridge	0.0693	0.8	0.149	0.191	530	-	0.0094	0.12	<0.001	-	
Between DPC & CSP	0.0777	0.8	0.143	0.191	488	-	0.0129	0.12	<0.001	-	
Furthest from DPC	0.0736	0.8	0.142	0.191	462	-	0.0133	0.12	<0.001	-	
Furthest from ESP	0.0614	0.8	0.121	0.191	459	-	0.0132	0.12	<0.001	-	

Table 6 Results for Particulate matter (<10 microns)

Monitoring Locations	*PARTICULATE MATTER ≤10 (PM_{10})*			
	Sampling time	Concentration ($\mu g/m^3$)	Guideline ($\mu g/m^3$)	Remarks
Between Raw meal 1&2 hoppers	1 hour	210	-	No guideline for short term emissions
Coal yard	1 hour	125	-	No guideline for short term emissions
Coal mill 1 & RMS 1	1 hour	158	-	No guideline for short term emissions
Cooler 1 & 2 area	1 hour	136	-	No guideline for short term emissions
Between kiln 1 & 2	1 hour	158	-	No guideline for short term emissions
Between pre heater 1 & 2	1 hour	84	-	No guideline for short term emissions
Between Raw mill 1 & 2	1 hour	123	-	No guideline for short term emissions
Coal mill 2 & RMS 2	1 hour	111	-	No guideline for short term emissions
Cement silos	1 hour	166	-	No guideline for short term emissions
Clinker weigh bridge	1 hour	998	-	No guideline for short term emissions
Between DPC & CSP	1 hour	428	-	No guideline for short term emissions
Furthest from DPC	1 hour	427	-	No guideline for short term emissions
Furthest from ESP	1 hour	369	-	No guideline for short term emissions

Table 7 Results for Particulate matter (<2.5 microns)

Monitoring Locations	*PARTICULATE MATTER ≤2.5 ($PM_{2.5}$)*			
	Sampling time	Concentration ($\mu g/m^3$)	Guideline ($\mu g/m^3$)	Remarks
Between Raw meal 1&2	1 hour	29.7	-	No guideline for short term

hoppers				emissions
Coal yard	1 hour	16	-	No guideline for short term emissions
Coal mill 1 & RMS 1	1 hour	27	-	No guideline for short term emissions
Cooler 1 & 2 area	1 hour	25	-	No guideline for short term emissions
Between kiln 1 & 2	1 hour	26	-	No guideline for short term emissions
Between pre heater 1 & 2	1 hour	17	-	No guideline for short term emissions
Between Raw mill 1 & 2	1 hour	19	-	No guideline for short term emissions
Coal mill 2 & RMS 2	1 hour	18	-	No guideline for short term emissions
Cement silos	1 hour	26	-	No guideline for short term emissions
Clinker weigh bridge	1 hour	229	-	No guideline for short term emissions
Between DPC & CSP	1 hour	70	-	No guideline for short term emissions
Furthest from DPC	1 hour	78	-	No guideline for short term emissions
Furthest from ESP	1 hour	72	-	No guideline for short term emissions

Table 8 Results for Environmental parameters

Monitoring Locations	Environmental parameters				*Remarks*
	Air temps °C	Pressure hPa	Humidity %	Wind Speed km/hr	
Between Raw meal 1&2 hoppers	37.0	1012	51	17 Km/hr South wind	Ambient conditions present
Coal yard	34.9	1012	58	18 Km/hr South wind	Ambient conditions present
Coal mill 1 & RMS 1	35.7	1012	54	18 Km/hr South wind	Ambient conditions present
Cooler 1 & 2 area	44.2	1012	40	17 Km/hr South wind	Ambient conditions present

Between kiln 1 & 2	40.2	1012	59	19 Km/hr South East wind	Ambient conditions present
Between pre heater 1 & 2	35.1	1012	57	21 Km/hr South East wind	Ambient conditions present
Between Raw mill 1 & 2	33.1	1011	62	19 Km/hr South East wind	Ambient conditions present
Coal mill 2 & RMS 2	30.4	1011	72	22 Km/hr South East wind	Ambient conditions present
Cement silos	31.6	1011	68	21 Km/hr South East wind	Ambient conditions present
Clinker weigh bridge	30.9	1011	69	22 Km/hr South East wind	Ambient conditions present
Between DPC & CSP	30.9	1011	71	21 Km/hr South East wind	Ambient conditions present
Furthest from DPC	30.4	1011	72	21 Km/hr South East wind	Ambient conditions present
Furthest from ESP	30.0	1011	70	21 Km/hr South East wind	Ambient conditions present

Appendix 10 is the detailed ambient baseline greenhouses gasses report

6. PROPOSED PROJECT DESIGN

6.1 Introduction

The proposed project is a Captive Power Plant (CPP) that will be embedded within the existing MCL Vipingo cement factory (Figure 3) to be able to utilize cement plant waste flue gas through Waste Heat Recovery (WHR) system and solid fuels using Circulating Fluidized Bed Combustion (CFBC) Boiler technology to generate electricity. The power generation envisaged are from WHR 10MW and from solid fuels CFBC Boiler 10MW. The Gross Power Generation thus from WHR and solid fuels shall be 20 MW.

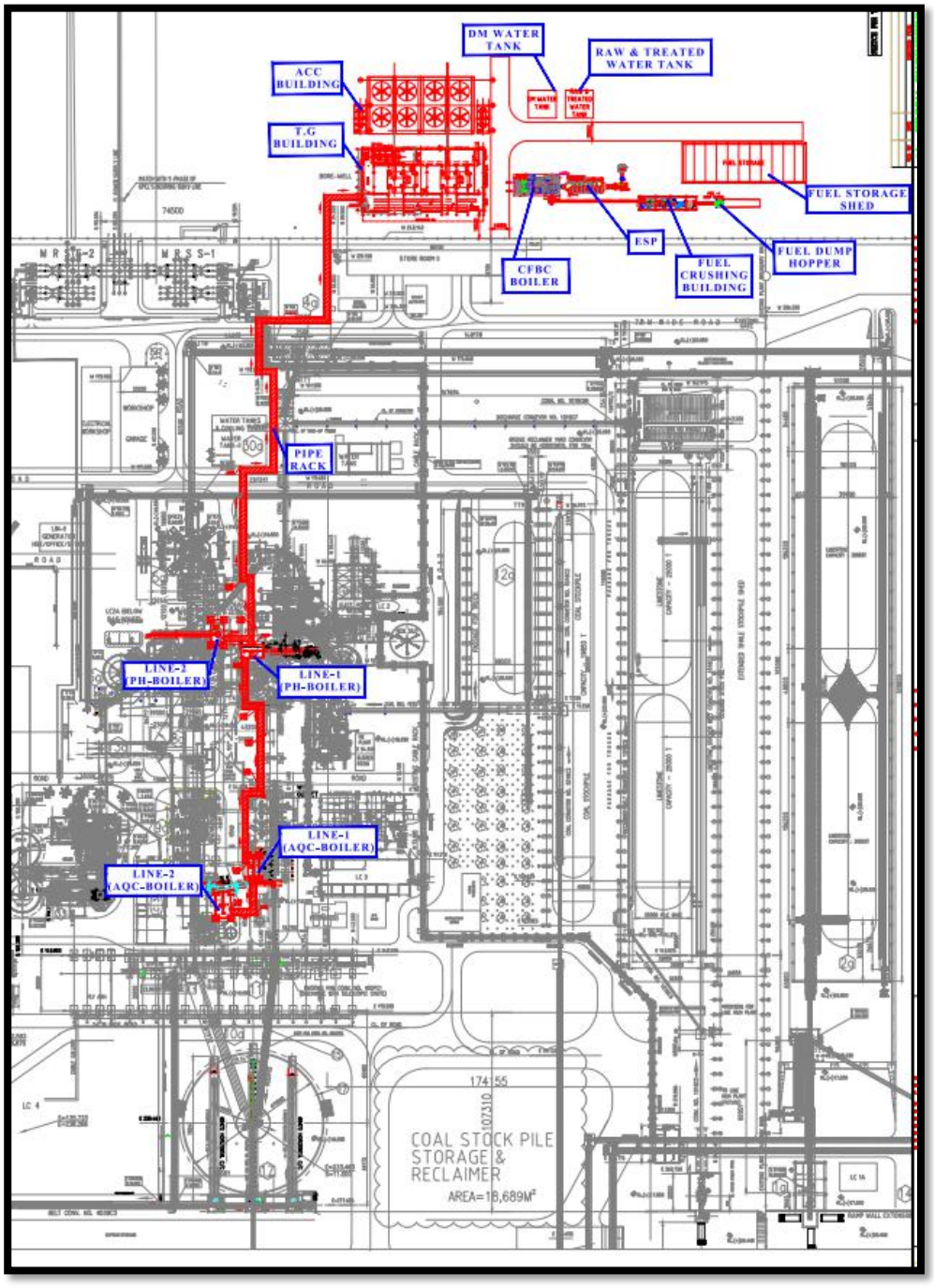

Figure 3 Layout of the proposed power plant embedded within MCL Vipingo

6.1.1 Waste Heat Recovery System

MCL Vipingo plant has two clinker lines (L1 and L2) and the available heat from these lines is; Preheater (PH) side, L1: ~2, 00,000 at 265°C & L2: ~3, 30,000 Nm3/hr 240°C. Cooler side, L1: ~95,828 at 120°C & L2: ~1, 97,270 at 120°C. This waste heat is being utilised for generation of power by WHR system.

6.1.2 Circulating Fluidized Bed Combustion Boiler technology

Generation of power from solid waste will be by means of Circulating Fluidized Bed Combustion Boiler (CFBCB) technology using solid waste fuels of Good Calorific Value (GCV) varying between 3400kcal/Kg to 5200kcal/kg. The solid waste fuels will mainly be industrial, agricultural, and municipal waste. The volume of fuels that will be required per day will be determined by their calorific value. On average about 125 Metric Tons (MT) of fuels whose calorific value is between 3400kcal/Kg to 5200kcal/kg will be required per day.

6.2 System Description

The proposed system shall have the following main components:

- ⇒ WHR boilers with dedicated Turbine Generator (TG).
- ⇒ CPP by circulating fluidised bed combustion (CFBC) boilers with dedicated TG and fuel feeding system.

6.2.1 WHR Boilers with dedicated Turbine Generator

The major sections of a typical arrangement of the major parts in WHR system are as follows:

- ⇒ Tapping flue gas from cement plant PH and produce steam in PH boilers
- ⇒ Tapping flue gas from cement plant Cooler and produce steam in Air Quench Combustion (AQC) boilers.
- ⇒ Use the steam to run turbine for Generating Power.

The hot flue gas of the existing PH and Cooler from each line shall be tapped and taken to dedicated boilers as shown in Figure 4. In PH side the hot flue gas will be tapped at top from existing down comer duct. Boilers which are basically a heat exchanger shall utilise the heat in the flue gas to produce steam out of the pressurised demineralised water running inside the tubes of the boilers. The flue gases at the outlet of the boilers are taken out to put it back to the existing cement plant system as shown in Figure 4. The dust in flue gas that is deposited at the bed of the boilers is connected back to cement plant circuit for using in the cement process. Steam generated from the boilers is taken though the steam pipes to TG building for generating power (Figure 5).

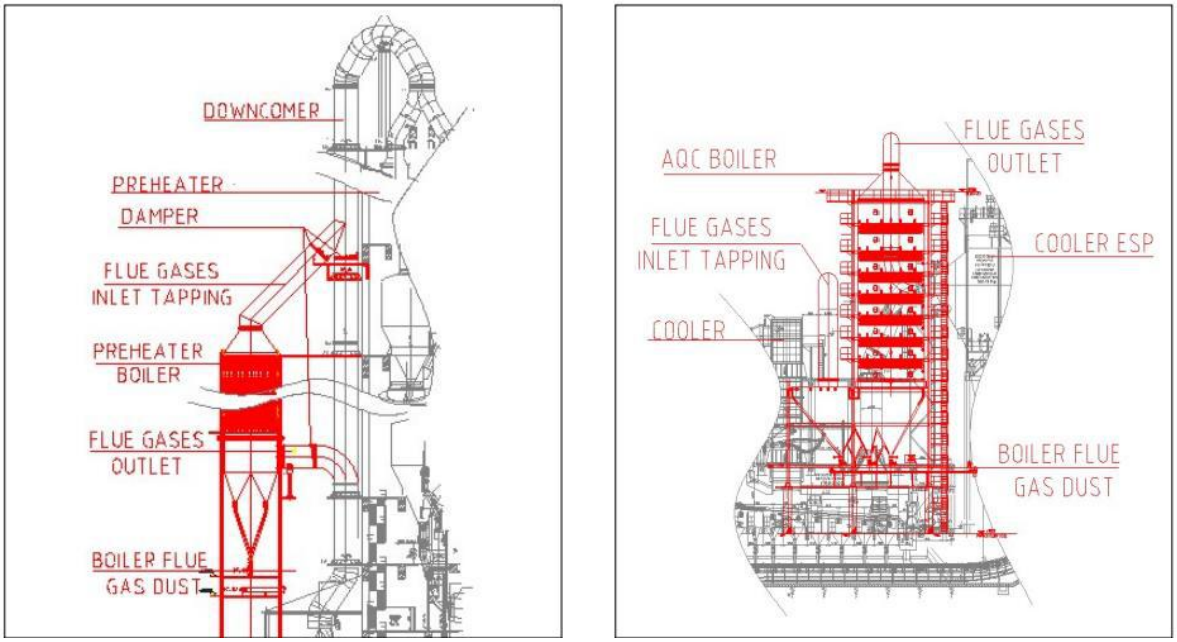

Figure 4 Hot gas tapping from PH side boiler (left) & Cooler side AQC boiler (right)

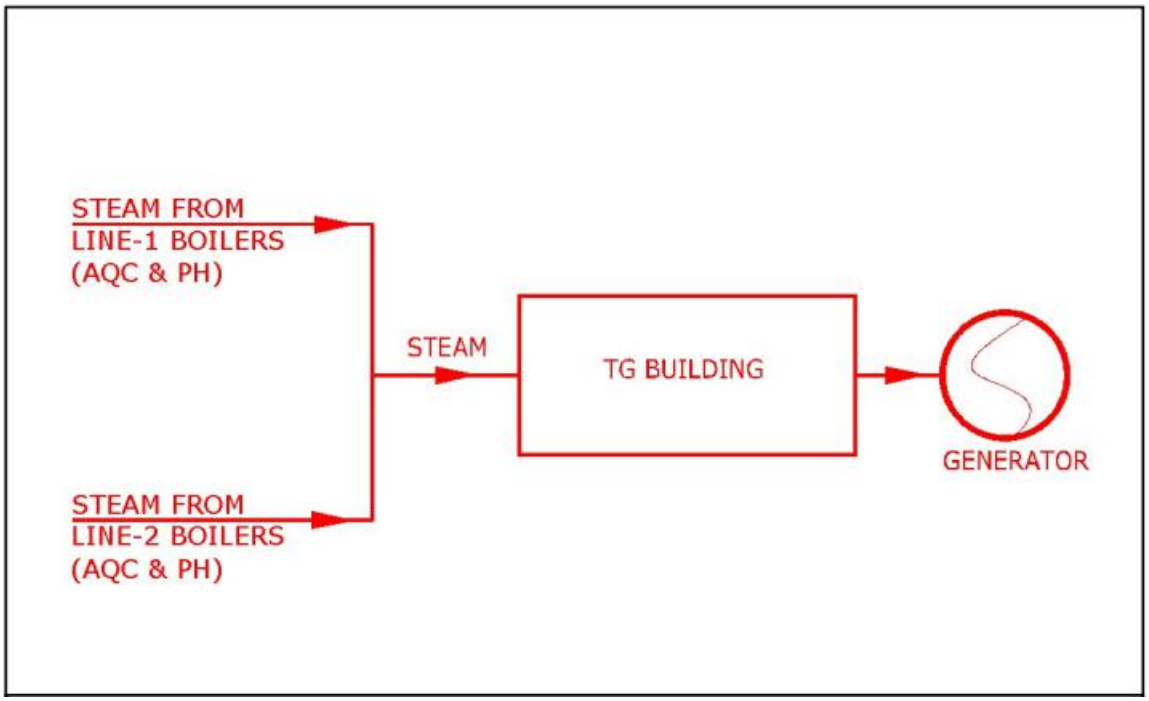

Figure 5 Turbine Generator for Waste Heat Recovery

In cooler side, flue gases are tapped from cooler. Here, boilers are also provided with pre-collector to separate the dust in flue gas. The hot flue gas exchange heat to the water running inside the tubes in boiler. Flue gas is connected back to existing Electrostatic Precipitators (ESP) of the cement plant. Dust collected in pre-collector and boiler bed are connected back to deep pan conveyor coming from the cooler to use in the cement process. Steam generated is taken though steam pipes to TG building for generating power (Figure 5).

6.2.2 CFBC boilers dedicated TG and fuel feeding system

Unlike WHR, in CFBC external fuels are used to burn in the boilers bed and produce heat.

The major sections are:

⇒ Fuel handling system and feeding to boilers

⇒ Boiler

⇒ Use the steam to run turbine for Generating Power

Fuel mix from yard will be manually unloaded using bulldozers / front-end loaders as applicable into the ground dump hoppers for onward conveying to the crushing/ chipping house. Fuel chipping will be in different sizes depending on the requirement of boilers (-) 8mm or/and (-) 25mm. The chopping will also be subject to the raw fuel received. The received raw material shall be screened, crushed and chipped using a chipper (Chipper can be also mobile and installed in the storage yard). The chipped raw material is then, conveyed to boiler bunkers (Figure 6).

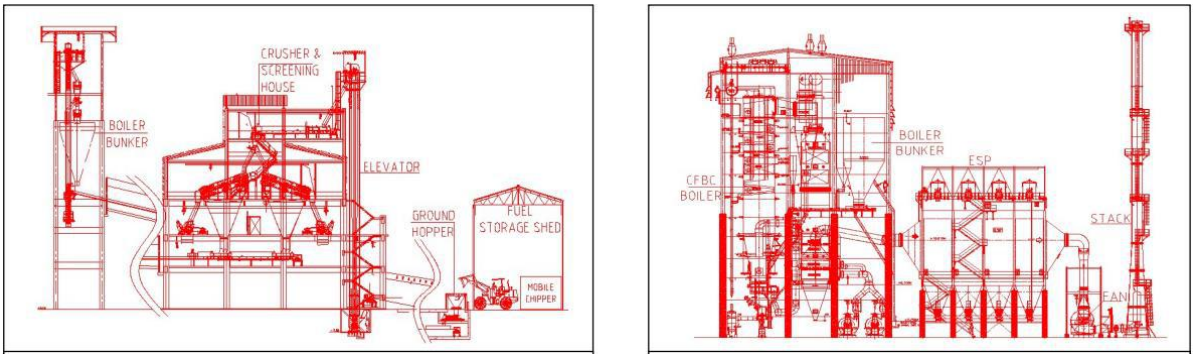

Figure 6 Fuel handling system (left) CFBC Boiler (right)

From the bunkers the fuels are extracted in regulated quantity and fed to boiler bed where it is burned to produce heat and exchanged the heat with the demineralised water running in the tubes. The process produces steam which is taken to the turbine through steam pipes for generating power (Figure 7). Boilers that will be installed will be four for the WHR plant and one for the CFBC. The capacity of the boilers will be WHR – PH#1- 10 TPH, PH#2- 22TPH, AQC #1 – 22 TPH and AQC#2 – 42 TPH and CFBC Boiler – 45 TPH.

6.2.3 Turbine Generator

The turbine Generator in both WHR and CFBC mainly comprises of;

⇒ Turbine Generator (TG)

⇒ Air cooled condenser (ACC)

⇒ Deaerator (DE)

⇒ Boiler Feed Pumps (BFP)

Steam generated from boilers is injected into the blades of Turbine. This rotates the turbine which in turns moves the generator and produces power. Steam while rotating the turbine drops its pressure & heat and finally fed to ACC for condensation process. The condensate then passes through the DE and fed to respective boilers by BFP at increased pressure. At DE the dissolved harmful gases are eliminated and protect the steam system from the effects of corrosive gases. WHR and CFBC shall have dedicated TG and ACC while DE shall be common. However, DE will be connected to separate sets of BFP meant for WHR and CFB. Appendix 11 is the process flow diagram for WHR and CPP.

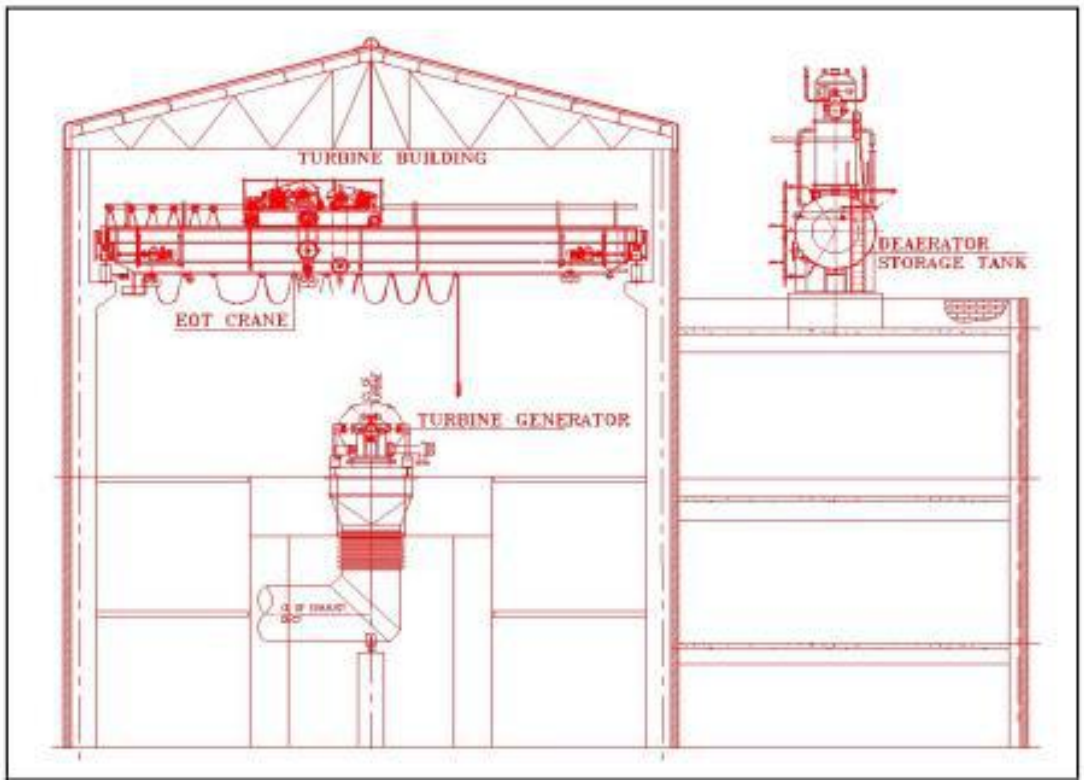

Figure 7 Turbine Generator for Circulating Fluidised Bed Combustion

6.3 Water source for steam generation in boilers

Pressurised demineralised water will be required to run inside tubes of the boilers to produce steam which will be taken though the steam pipes to turbine generator for generating electricity. The source of the water will be from existing boreholes that are currently supplying process water for cooling of equipment and plant in the existing MCL Vipingo clinkerization and cement plant. The raw water will first be processed through an existing Reverse Osmosis (RO) plant for demineralization. The WHR and CFBC boilers will each require 200 cubic meters of water per day. Initial abstraction and processing of the said volume will be done, thereafter it is envisaged that only top-up water will be abstracted and added to the system to maintain the required volume in the system. Condensate will be

extracted from the system by help of condensate extraction pumps which will be sent to a condensate return tank from where the condensate will recirculate back to the system. Capturing and recirculating condensate will reduce the quantity of water that will be required as top-ups and overall reduce the quantity of water that will be abstracted significantly reducing pressure on local ground water resources. Appendix 12 is borehole water analysis report after demineralization treatment in the RO plant.

6.4 Cost of the proposed project

Approximate costs of the proposed power generation plant cover the following items:

- ⇒ Concrete works for Fuel Storage Shed, Fuel Dump Hopper, Fuel Crushing Building, CFBC boiler, Raw and Treated water tank, DM water tank, ACC building, TG building, Pipe rack, Line 1 & 2 PH boilers and Line 1 & 2 AQC boilers.
- ⇒ Structural components, site fabrication, and equipment.

Bills of Quantities of the proposed project were prepared by Ndibui S.K and Associates a Registered Quantity Surveyor. As per the BQ, the proposed project is estimated to cost KSH 2, 500, 000, 000.00 (two billion, five hundred million). The proponent (MCL) will be required to pay to the National Environment Management Authority (NEMA) 0.1% of the total project cost being the applicable EIA processing and monitoring fees. Appendix 13 is the detailed Bills of Quantities.

7. ANALYSIS OF ALTERNATIVES

7.1 The Yes-project alternative

The Yes-project alternative means that the proposed project be implemented as currently proposed without alterations. This implies that the proposed project location, proposed project design to be implemented as currently proposed. The yes project alternative implies the proposed project of electricity generation from waste heat recovery system and captive power from fuels derived from industrial, agricultural, and municipal waste to be implemented as currently proposed. The design of the proposed project to be implemented as currently proposed. The said design embeds the proposed project within the layout design of the existing MCL Vipingo plant. Similarly the location of the proposed project to remain as currently proposed.

7.2 The No-project alternative

The no project alternative means that the project be rejected in its entirety as currently proposed. This means that implementation of the proposed project as currently proposed will not be realized. This implies that the current design of the project be rejected, the proposed location and the proposed technology all be rejected. Considering that the proposed project is an environmental mitigation measure project from the point of view that the projects seeks to utilize waste heat being emitted from a cement plant as a raw material to generate electricity the no project alternative will deny environmental gains that will be realized from the project.

7.3 Proposed fuel materials

The proposed project proposes to utilise industrial waste, municipal waste and agricultural waste as fuel material that will be burnt to provide required heat energy for heating water to generate required steam that will be directed to a turbine to generate electricity. The calorific value to the fuels that will be used will be important in selecting the fuel sources. Selection of alternative fuels sources will also be supported by their calorific value. Calorific value refers to the heating power of the waste. A material can burn without supporting fuel when it has a calorific value of min. 14.4 MJ/kg, this is approximately dry wood. Waste can be incinerated without the need for additional fuel when it has a caloric value of 14.4 MJ/kg or higher. To know the overall calorific value of the waste, you need to measure the calorific value or estimate by analysing the composition.

7.3.1 Municipal waste

One of the proposed fuels is use of municipal waste. Municipal solid waste is an energy resource with sufficient energy/calorific value, making it a suitable substitute for fuel. Calorific value is an important parameter to determine the refuse-derived fuel quality of municipal solid waste. The Calorific Value of the waste depends on the composition of the waste. Waste with a lot of PVC has a higher calorific value than waste with less PVC and more paper. The challenge with calculating the calorific value of waste is that different materials have different calorific values. PVC plastic has a value of 41MJ/kg whereas paper only has a value of 13.5 MJ/kg.

7.3.2 Agricultural waste

The proposed project also intends to utilise agricultural residues as fuel to generate electricity. Agricultural residues that are proposed include coconut shells and husks, cashew-nut shells, rice husks, corn/maize cobs among others. Coconut shells and husks and cashew-nut shells will be sourced first from Kilifi County and then thereafter Kwale and Mombasa Counties. Rice husks will be sourced from Kwale County and Kirinyaga County (Mwea rice irrigation scheme) and Kisumu County (Ahero rice irrigation scheme) among other areas. Corn/maize cobs will be sourced from around the country. The calorific values of coconut shells and husks have been estimated to be approximately 17.40 MJ/kg and 10.01 MJ/kg respectively. Cashew-nut shells typically contain: 10.8% water and 2.6% ash. Cashew-nut shells have a net calorific value of 18.9 MJ/kg, placing them right in the middle of the biomass fuel mean range (14 - 21 MJ/kg). The calorific value of Rice husk is 2938.86 Kcal/kg, while that of corn cobs is 3227.78 KcaI/kg. When maize cob is burned, it has calorific value is approximately 17,000 kJ/kg, and it takes a long time to burn before becoming the ash.

7.3.3 Industrial waste

Industrial waste is an all-encompassing term used to describe material considered to be no longer of use after a manufacturing process has been completed. Industrial solid waste refers to any type of solid by-product of an industrial process. It can include organic matter such as wood, cardboard, or paper and inorganic materials such as scrap metal, plastic, and construction debris. Industrial waste falls into two main categories: non-hazardous waste and hazardous waste. Industrial waste that will be considered in the proposed project will be non-hazardous. Calorific value of calorific value of cardboard and paper waste averages 15.8

MJ/kg, The calorific value of plastic waste varies depending on the type of plastic it averages 5500 kCal/kg to 11500 kCal/kg.

7.3.4 Alternative fuels to be considered

Sawdust (or wood dust) is a by-product or waste product of woodworking operations such as sawing, sanding, milling and routing. It is composed of very small chips of wood. The calorific value of Sawdust is 3155.30 Kcal/kg. *Prosopis juliflora* is a thorny shrub 3-5 m or tree growing up to 15 m height. It has a thick rough grey-green bark that becomes scaly with age. The plants are often multi-stemmed and furnished with abundant large and very sharp thorns measuring up to 5 cm. The tree is deeply rooted. The stems are shaped in a "mild zigzag" way with one or two stout thorns at each turn of the stem. This is an invasive species common in arid and semi-arid areas in Kenya. Due to its abundance it can be harvested for fuel. Wood of *Prosopis juliflora* has a very good heat of combustion due to its high carbon and lignin contents, yielding charcoal of a high calorific value ranging between 24 and 33 MJ kg -1.

7.4 Technology Alternatives

Fluidized Bed Combustion (FBC) is of two types namely Bubbling Fluidized Bed Combustion (BFBC) and Circulating Fluidized Bed Combustion (CFBC). Fluidized bed combustion (FBC) is a combustion technology used to burn solid fuels. A bed of solid particles is said to be fluidized when the pressurized fluid (liquid or gas) is passed through the medium and causes the solid particles to behave like a fluid under certain conditions. Fluidization causes the transformation of the state of solid particles from static to dynamic. In fluidized bed combustion, rapid mixing ensures uniformity of temperature. The main advantage of fluidized bed combustion system is that municipal waste, sewage plant sludge, biomass, agricultural waste and other high moisture fuels can be used for heat generation.

The proposed project proposes to use Circulating Fluidized Bed Combustion (CFBC) Boiler.

7.4.1 Proposed Technology - Circulating Fluidized Bed Combustion

Circulating Fluidized Bed Combustion (CFB) boilers are normally used in larger applications. CFB has enhanced flexibility over BFBs for firing multi-fuels with high moisture content and significantly higher efficiency up to 95% Circulating fluidized bed (CFB) boilers use all kinds of solid fuels, from biomass to refuse derived fuel (RDF), to produce reliable and efficient clean energy. Fuel flexibility is at the core of CFB technology, contributing to fossil fuel and CO_2 emissions reduction while using local alternative renewable fuels. Circulating fluidized bed (CFB) boilers are a type of boiler technology that

offers several advantages and disadvantages. CFB configuration includes solid separators that separate the entrained particles from the flue gas stream and recycles them to the lower furnace. The collected particles are returned to the furnace via the loop seal. The addition of the solid separators as well as other measures as the INTREXTM superheater allows CFB technology to reach the higher values regarding efficiency and availability and provides excellent fuel flexibility.

Advantages of Circulating Fluidized Bed Boilers:

- ⇒ Fuel Flexibility: CFB boilers can burn a wide range of fuels including coal, biomass, and various waste materials. This flexibility in fuel choice can help reduce fuel costs and increase energy security.
- ⇒ High Efficiency: CFB boilers typically have high combustion efficiency due to the intense mixing and recirculation of bed material and fuel in the combustion chamber. This can lead to lower fuel consumption and reduced emissions.
- ⇒ Lower Emissions: The combustion process in CFB boilers is well controlled, which can result in lower emissions of pollutants such as sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter compared to conventional boilers.
- ⇒ Good Heat Transfer: The fluidized bed technology in CFB boilers allows for efficient heat transfer between the combustion gases and the boiler tubes, leading to high thermal efficiency.
- ⇒ Ability to Capture and Control Pollutants: CFB boilers can be equipped with additional systems for capturing and controlling pollutants such as sulfur dioxide and nitrogen oxides, making them suitable for meeting stringent environmental regulations.

Disadvantages of Circulating Fluidized Bed Boilers:

- ⇒ High Capital Costs: CFB boilers generally have higher initial capital costs compared to traditional pulverized coal boilers, primarily due to the complex design and the need for specialized equipment.
- ⇒ Operational Complexity: CFB boilers require careful control of bed temperature, pressure, and circulation rates to maintain optimal performance. This can make operation and maintenance more complex compared to other boiler types.

⇒ Bed Material Attrition: The continuous recirculation of bed material in a CFB boiler can lead to attrition and erosion of the boiler components, which may require frequent maintenance and replacement of parts.

⇒ Bed Agglomeration and Fouling: In some cases, CFB boilers can experience issues such as bed agglomeration and fouling, which can reduce boiler efficiency and require downtime for maintenance.

⇒ Limited Scale: CFB technology is more commonly used in medium to large-scale power plants and industrial applications. It may not be as suitable for smaller-scale applications due to its complex design and higher costs.

Overall, circulating fluidized bed boilers offer several advantages in terms of fuel flexibility, efficiency, emissions control, and heat transfer efficiency. However, they also come with some challenges related to capital costs, operational complexity, maintenance requirements, and potential performance issues that need to be carefully considered when choosing this technology for a specific application.

7.4.2 Alternative Technology

Two alternative biomass boiler technologies are available for consideration. These are Bubbling fluidized bed boilers (BFB) and Grate boilers.

7.4.2.1 Bubbling Fluidized Bed Combustion

Bubbling fluidized bed boilers (BFB) are preferred in small-scale applications, with fuels having low heat value and high moisture content. Bubbling FBC is used for fuels with lower heating values due to its ability to efficiently burn and utilize such biomass materials. The core of the BFB boiler is the combustion chamber or furnace. It features water-cooled walls and bottom. The bottom has a full refractory lining and the lower portion of the water wall is also refractory lined. The bed is fluidised by means of an arrangement of nozzles at the bottom of the furnace which create turbulence that enhances the mixing of the fuel, increasing the boiler's efficiency by converting unburned carbons remaining to usable energy. The bed is usually formed by sand and with a small amount of fuel. Solids fluidization occurs when a gaseous stream (primary air) passes through a bed of solid particles at a high enough velocity (above the minimum fluidization velocity) to overcome the particles gravity force.

Advantages of bubbling fluidized bed technology include:

⇒ Yields a uniform syngas;

⇒ Nearly uniform temperature distribution throughout the reactor;

⇒ Able to accept a wide range of fuel particles sizes;

⇒ Provides high rates of heat transfer between the inert material, fuel and gas;

⇒ High conversion possible with low tar and unconverted carbon.

Disadvantage of bubbling fluidized bed combustion:

⇒ Large bubble size may result in gas bypass through the bed.

⇒ High conversion of solids is not achieved due to back mixing issues.

⇒ Formation of oxidation spots due to the slow oxygen diffusion.

7.4.2.2 Grate Boilers Technology

Grate biomass boilers technology can burn a range of fuels wider than a bubbling fluidized bed boilers, but worse emissions and efficiency as bubbling fluidized bed boilers. Grate boiler provides very good performance burning low moisture and high alkalis content fuels. Grate boilers can burn difficult fuels as straw, chicken litter, high alkaline agro crops that bubbling fluidized bed boilers or circulating fluidized bed combustion boilers can't burn due to high agglomeration tendency. Inside of allowed bubbling fluidized bed boilers fuels range and inside of circulating fluidized bed combustion boilers fuels range, fluidized bed technologies have more fuel flexibility than grate biomass boiler technology. There are different grate technologies available with different characteristics, mainly depending on the fuel to be burned, such as: travelling, rotary, reciprocating or vibrating grates. All grates are mechanically driven and rely mostly on the primary air for cooling, although some grates are additionally water cooled. All grates work on the principle of translating the fuel being burned from one side to the other of the boiler, in order to attain the sufficient residence time to burn as much fuel as possible. Unlike bubbling fluidized bed boilers steady combustion, the nature of fuel distribution over the grate and the form it travels from one side to the other of the furnace creates uneven distribution and consequential uneven burning of the fuel. This uneven combustion promotes higher emissions and increases the unburned content in the ashes and decreases the boiler efficiency. In order to assure as best as possible an even fuel distribution, both fuel feeding and fuel size must be continuously and carefully controlled. Homogeneous fuel size is mandatory.

7.5 Why the Proposed Biomass Boiler's Technology

The proper technology must be selected based on the required cost, available fuel, required steam conditions (cycle/boiler efficiency) and emissions to be reached. Three biomass boiler technology available have been discussed namely grate boilers, bubbling fluidized bed boilers

and circulating fluidized bed combustion boilers. Chronologically and in terms of evolution of the technology, biomass boilers' development started with grate boilers, continuing with bubbling fluidized bed boilers technology and finalizing with the current most advanced technology steam generator, the circulating fluidized bed Combustion boilers.

8. OCCUPATIONAL SAFETY AND HEALTH

Health and safety concerns during operation of captive power plant include non-ionizing radiation, heat, noise, confined spaces electrical hazards, fire and explosion hazards, chemical hazards and dust,

8.1 Non-ionizing radiation

In the power plant workers may be exposed to a higher exposure to electric and magnetic fields (EMF) due to working in proximity to electric power generators, equipment, and connecting high-voltage transmission lines. Occupational electric and magnetic fields exposure should be prevented or minimized through the preparation and implementation of an EMF safety program including the following components:

- ⇒ Identification of potential exposure levels in the workplace.
- ⇒ Training of workers in the identification of occupational EMF levels and hazards.
- ⇒ Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers.
- ⇒ Implementation of action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by Radiation Protection Board.

8.2 Heat

Occupational exposure to heat occurs during operation and maintenance of combustion units, pipes, and related hot equipment. Recommended prevention and control measures to address heat exposure at the captive power plant include:

- ⇒ Regular inspection and maintenance of pressure vessels and piping.
- ⇒ Provision of adequate ventilation in work areas to reduce heat and humidity.
- ⇒ Reducing the time required for work in elevated temperature environments and ensuring access to drinking water.
- ⇒ Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes
- ⇒ Use of warning signs near high temperature surfaces and personal protective equipment (PPE) as appropriate, including insulated gloves and shoes.

8.3 Noise

Noise sources in power plant will include the turbine generators and auxiliaries; boilers and auxiliaries, fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. Recommendations to prevent minimize, and control occupational noise exposures in power plant include:

⇒ Provision of sound-insulated control rooms.

⇒ Design of generators to meet applicable occupational noise levels.

⇒ Identify and mark high noise areas and require that personal noise protecting gear is used all the time when working in such high noise areas.

8.4 Confined Spaces

Specific areas for confined space entry may include turbines, condensers, and cooling water towers (during maintenance activities).

8.5 Electrical Hazards

Energized equipment and power lines can pose electrical hazards for workers at the power plants. Recommended measures to prevent, minimize, and control electrical hazards at the power plants include:

⇒ Consider installation of hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization.

⇒ Use of voltage sensors prior to and during workers' entrance into enclosures containing electrical components.

⇒ Deactivation and proper grounding of live power equipment and distribution lines according to applicable legislation and guidelines whenever possible before work is performed on or proximal to them.

⇒ Provision of specialized electrical safety training to those workers working with or around exposed components of electric circuits. This training should include, but not be limited to, training in basic electrical theory, proper safe work procedures, hazard awareness and identification, proper use of PPE, proper lockout/tagout procedures, first aid, and proper rescue procedures. Provisions should be made for periodic retraining as necessary.

8.6 Fire and Explosion Hazards

The captive power plant besides utilise recovered waste heat to generate 10 MW of electricity, it will also use solid fuels to generator an additional 10MW using Circulating Fluidized Bed Combustion (CFBC) technology. The solid fuels that will be used will be in large quantities; hence will need to be sourced in advance and where possible stored/ held on site. Therefore, careful handling is necessary to mitigate fire and explosion risks. Recommended measures to prevent minimize, and control physical hazards at thermal power plants include:

- ⇒ Use of automated combustion and safety controls.
- ⇒ Proper maintenance of boiler safety controls.
- ⇒ Implementation of start-up and shutdown procedures
- ⇒ Regular cleaning of the facility.
- ⇒ Use of automated systems such as temperature gauges to survey solid fuel storage areas to identify risk points.

9. STAKEHOLDER CONSULTATION AND PUBLIC PARTICIPATION

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

- ⇒ Inform stakeholders especially those drawn from the proposed project site of the proposed development within their locality.
- ⇒ Explain to the stakeholders the nature of the proposed project, its objectives, scope impacts, and measures to address the impacts.
- ⇒ Give stakeholders especially those drawn from the proposed project site an opportunity to present their views, concerns and issues regarding the proposed project.
- ⇒ 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 and participation was two-fold, namely;

- ⇒ Questionnaire survey
- ⇒ Public *Barazas*

9.1 Questionnaire survey

A detailed questionnaire survey was carried out that targeted to reach out to primary stakeholders at the grassroots level. This included local learning institutions, local faith based institutions, among others. Appendix 14 is detailed questionnaire responses.

9.1.1 Questionnaire survey respondents

The following stakeholders' respondent to the questionnaire survey:-

- ⇒ Mishi Said –Shariani Zonal Office
- ⇒ Mkwajuni Vocational Training Centre –Grace Santa Ngombo
- ⇒ Shariani Secondary School
- ⇒ Mkwajuni Secondary School –Jonas Ngala
- ⇒ Takaungu Secondary School
- ⇒ Vuma Primary School –Mwanaisha Bakari Tabwara
- ⇒ Shariani Primary School –Mutuku M.
- ⇒ Takaungu Primary School –Emmanuel Angore Mranja

⇒ Timboni Primary School –Chilumo Kanze Chilumo

⇒ Shauri Moyo Primary School –Swabra M. Rizzik

⇒ Vutakaka Junior School –Wakalo P. Maseghe

⇒ The Zawadi Junior School

⇒ Mtwapa Elite Academy -Shariani

⇒ Mwnagaza Initiative C.B.O –Franklin Mwarome Horome, Director.

⇒ Kuruwitu Conservation and Welfare Based Organization (KCW-CBO) –Tracy Mbodze

⇒ Alamin Stores –Fatma Mohammed Hanze

⇒ Vuma GRC CDC

⇒ Pentecostal Evangelistic Fellowship –Rev. Peter Kazungu

⇒ Francis Macharia -Asst. County Commissioner, Shariani Division, Kilifi South Sub-County

⇒ Jackson Yawa Solomon –Asst. Chief, Kuruwitu Sub-Location, Kilifi South Sub-County

⇒ Mohammed Athuman Mbango –Village Elder, Mkwajuni-Kibaoni Village

⇒ Hon. Said Juma Idd –MCA of Junju Ward

⇒ Amina Gambo

⇒ Maurice Karisa

⇒ Dorice Runya Munga

⇒ Chisambo Dume Kadzungu

⇒ Kahaso Charo

⇒ Gona Bombe Kalama

⇒ Msindu Ngowa Alfred

⇒ Joshua Koi Mungumba

9.1.2 Summary of Issues, views and concerns presented by questionnaire respondents

- The proposed project will create job opportunities for people.
- The proposed project is environmentally conscious as it will support climate action on climate change through conversion wastes into proper use.
- The project will modernize the area.
- It will promote business opportunities as various materials and products will required for the project beside increased factory production.

- The project will promote social integration as their will be people from diverse background to implement the project.
- The project will create a new alternative source of energy and thus knowledge and technological transfer.
- The project will increase power generation in the country and thus lessening dependency on the national grid.
- The project will lead to increase in population and thus pressure on existing facilities like schools and health facilities

9.1.3 Measures proposed by stakeholders to address issues and concerns raised

- The proposed project should be implemented by use of right materials and qualified personnel so that it doesn't affect the people negatively.
- Train workers to build their capacity to handle the project.
- Ensure proper waste management and sound production systems.
- Observe health and safety standards in the entire project life.
- The company should work with relevant authorities like NEMA in ensuring that the project is safe and sound to our environment.
- Create more awareness about the proposed project.
- All operation at the plant should be switched to renewable energy.
- Tree planting and marine conservation of which they can incorporate the local community.
- The company should conduct education and awareness on conservation of the environment.
- Support community development initiatives for the wellbeing of the people.

9.2 Public Barazas

9.2.1 First stakeholder consultation and public participation Baraza

The first stakeholder consultation & public participation public baraza was held on the 12th of March 2024 at Assistant County Commissioner's Office Grounds Shariani. The following were the main issues that emanated from the first public meeting:-

- What will be the direct benefits of the project to community?
- Employment especially local members at the company and opportunities for student attachment and internships.
- Is it possible for the community to benefit from the electricity that is to be generated?
- MCL to ensure youth representation in the community development agreement.

- Clarification on source of water being used in the boilers.

Appendix 15 is the attendance list and Minutes of the First Baraza while Plate 2 capture attendees during the first public baraza.

Plate 2 Proceedings during the first public baraza at Sheriani ACC Office Grounds

9.2.2 Second stakeholder consultation and public participation Baraza

The second stakeholder consultation & public participation public baraza was held on the 14th of March 2024 at Vuma Grounds Takaungu. The following were the main issues that emanated from the first public meeting:-

- Job opportunities to the community must be apriority.
- Clarification whether the proposed project is a nuclear plant.
- Clarification whether smoke coming out of the factory is it hazardous.

- Clarification of safety measures taken and to be taken.
- Strategies to keep the coconuts growing now that there will be demand for them.
- Power from the plant to be shared to the community.
- Job opportunities for women.

Appendix 16 is the attendance list and Minutes of the Second Baraza while Plate 3 captures attendees during the second public baraza.

Plate 3 Proceedings during the Second public baraza at Vuma Grounds Takaungu

9.2.3 Third stakeholder consultation and public participation Baraza

The second stakeholder consultation & public participation public baraza was held on the 14th of March 2024 at Chief's Office Grounds Mkwajuni. The following were the main issues that emanated from the first public meeting:-

⇒ Security issue within the community and reported harassment from MCL security officers to the locals.

⇒ Compensation from dust pollution.

⇒ MCL sponsor education for local children.

⇒ Community benefit from the proposed project.

⇒ Employment of local community needs to be addressed as MCL keeps expanding.

⇒ Water scarcity in the community MCL should help community drill boreholes.

Appendix 17 is the attendance list and Minutes of the Third Baraza while Plate 4 captures attendees during the second public baraza.

Plate 4 Proceedings during the Third public baraza at Chief's Office Grounds Mkwajuni

10. POTENTIAL ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION MEASURES

10.1 Construction phase potential positive impacts

Potential positive impacts during the construction phase of the proposed project will include the following:

- ⇒ Employment opportunities for the local community
- ⇒ Support to existing local businesses
- ⇒ On job training opportunities for local people
- ⇒ Revenue to County Government of Kilifi
- ⇒ Revenue to the national government
- ⇒ Technology transfer

10.1.1.1 Employment opportunities for the local community

Construction of the proposed project will likely create direct employment opportunities. Direct labour force will be required in all site construction activities. Other direct employment opportunities will include in the area of equipment operators such employees who will be hired to operate equipment used on site. This and other construction activities will create employment to the local community. The project also will provide indirect employment opportunities, in terms of service providers such as food outlets who will benefit from clientele drawn from workers at the proposed project site, other service providers such as transporters who will be hired to ferry construction equipment and materials into the site.

10.1.1.2 Support to existing local businesses

Once the implementation of the proposed project begins and local people and others get hired at the construction phase, they will be remunerated for their work. This will translate to more money available in the pocket hence improved purchasing power. Local businesses are likely to benefit from improved purchasing power of people in the area as a result of their remuneration. There is likelihood that there will be more money in the pockets of people who will be directly or indirectly employed in the project and that part of the money will be spent in the local economy hence benefits local businesses.

10.1.1.3 On-job training opportunities for local people

Implementation of the proposed project will present an opportunity for non-skilled local people to be involved in the project and acquire skills through on-job training. During the construction phase labour sourced locally will present an opportunity to learn construction and installation of the power plant with associated technologies.

10.1.1.4 Revenue to County Government of Kilifi

The project proponent will have to present design drawings for the proposed project for approval by the County Government of Kilifi. The proponent will have to pay the prescribed fee for application for development permission.

10.1.1.5 Revenue to the national government

Revenue to National Government at the construction stage will be through application fees for the environmental impact assessment license and electricity generation license.

10.1.1.6 Technology transfer

The proposed power plant will be embedded within the existing MCL Vipingo cement factory to be able to tap and utilize waste heat from the plant to generate electricity. Besides the WHR technology, the project will also generate electricity from solid fuels using Circulating Fluidized Bed Combustion (CFBC) technology. Local workers involved in project will directly learn from expatriates how the two technologies are installed. Through this technological transfer will take place.

10.2 Potential negative impacts during construction phase

Potential negative impacts during the construction phase of the proposed project will include the following:

- ⇒ Noise and vibration disturbance
- ⇒ Fugitive dust
- ⇒ Injuries and accidents
- ⇒ Waste generation

10.2.1 Noise and vibration disturbance

The construction phase of the proposed project will involve undertaking various activities that can be a potential source of noise. Noise and vibration is likely to be generated during site preparation, site excavation and construction of the power plant and associated facilities. Heavy equipment activity on site will significantly contribute to noise and vibration on site during construction phase. During construction activities, noise and vibration may be caused by the operation of pile drivers, earth moving and excavation equipment, concrete mixers, cranes and the transportation of equipment, materials and people. Exposure vibration can be through hand-arm vibration from operation of equipment such as hand and power tools, or whole-body vibrations from surfaces on which the worker stands or sits. Potential noise and vibration receptors during the construction phase may include construction workers and staff of Mombasa Cement Vipingo who will be at the vicinity of the proposed project site. Noise

generation during the construction phase however will be limited to the duration of project construction. Noise and vibration can have negative impacts on mental health and well-being. Exposure to excessive noise and vibration can cause fatigue, irritability, anxiety, depression, and insomnia. These can affect the mood, concentration, performance, and relationships of the affected person. Potential negative impacts of exposure to noise and vibration will include:

- **Hearing loss**: One of the most obvious and irreversible effects of noise exposure is hearing loss. Noise-induced hearing loss (NIHL) can occur gradually or suddenly, depending on the intensity and duration of the noise. NIHL can affect one's ability to communicate, understand instructions, and avoid accidents.
- **Vibration syndrome**: Another common effect of vibration exposure is vibration syndrome, also known as hand-arm vibration syndrome (HAVS) or white finger. Vibration syndrome is a condition that affects the blood vessels, nerves, and muscles of the hands and arms. It can cause numbness, tingling, pain, and reduced grip strength. In severe cases, it can lead to tissue damage and gangrene.
- Musculoskeletal disorders: Noise and vibration can also contribute to musculoskeletal disorders (MSDs), which are injuries or disorders of the muscles, tendons, ligaments, joints, or nerves. MSDs can affect any part of the body, but they are more common in the neck, back, shoulders, elbows, wrists, and knees. MSDs can cause pain, stiffness, inflammation, and reduced mobility.
- **Cardiovascular problems**: Noise and vibration can also affect one's cardiovascular system, which is responsible for pumping blood and oxygen throughout your body. Exposure to high levels of noise and vibration can increase blood pressure, heart rate, and stress hormones. This can increase the risk of developing cardiovascular diseases, such as hypertension, angina, or stroke.
- **Mental health issues**: Noise and vibration can also have negative impacts on mental health and well-being of the affected person. Exposure to excessive noise and vibration can cause fatigue, irritability, anxiety, depression, and insomnia. These can affect one's mood, concentration, performance, and relationships.

10.2.2 Proposed mitigation measures of noise and vibration disturbance

Appropriate measures to reduce or control noise should include, but are not limited to:

- ❖ The implementation of preventive measures begins with a thorough noise assessment. This assessment involves measuring noise levels in different areas of the construction

site. The data collected helps identify the primary sources and noise levels, allowing employers to implement appropriate industrial noise control strategies.

- ❖ To prevent industrial noise and protect workers, comprehensive measures must be implemented. Employers should prioritize technical controls to reduce noise at the source. This may involve using quieter machinery and equipment, introducing noise reduction technologies such as acoustic covers, and isolating noisy areas.
- ❖ Implement administrative controls, such as limiting workers' exposure time and rotating them to less noisy tasks. Proper training and education on the risks of noise exposure and the use of Personal Protective Equipment (PPE) such as earplugs or earmuffs are crucial for preserving workers' hearing health.
- ❖ Regular maintenance and inspections of machinery and equipment are essential to ensure they operate at optimal noise levels.

10.2.3 Fugitive dust

Fugitive dust also known as re-entrained or released dust is dust that is not emitted from definable point sources. Construction site is a major source of fugitive dust emissions. Activities at the construction site that emit fugitive dust include earthworks and material handling. Fugitive dust is made up of fine particles. When inhaled; fine particles can accumulate in the respiratory system; causing various respiratory problems including persistent coughs, wheezing, and physical discomfort. Potential negative impacts of fugitive dust may include but not limited to the following:-

- **Respiratory problems:** Fugitive dust can irritate the respiratory system and cause coughing, wheezing, and shortness of breath. Prolonged exposure to fugitive dust can also lead to established respiratory problems such as bronchitis and asthma.
- **Cardiovascular problems:** Fugitive dust can enter the bloodstream through the lungs and cause damage to the cardiovascular system. This can increase the risk of heart attacks, stroke, and other cardiovascular problems.
- **Eye irritation:** Fugitive dust can irritate the eyes and cause redness, itching, and tearing. Prolonged exposure to fugitive dust can also cause conjunctivitis (pink eye).
- **Skin irritation:** Fugitive dust can irritate the skin and cause itching, redness, and rashes. Lengthy exposure to fugitive dust can also cause skin allergies.
- **Neurological problems:** Fugitive dust can contain heavy metals and other toxic substances affecting the nervous system. This can lead to headaches, dizziness, and other neurological problems.

- **Water pollution**: Fugitive dust can contaminate local water sources by depositing pollutants and other contaminants. This can harm aquatic wildlife and make water sources unfit for human consumption.
- **Damage to vegetation**: Dust can damage vegetation by covering plants with a layer of dust, blocking sunlight and reducing the plant's ability to photosynthesise. This can lead to reduced crop yields and lower biodiversity in affected areas.
- **Damage to infrastructure**: Fugitive dust can damage infrastructure like roads, buildings, and bridges by causing corrosion and abrasion. This often leads to increased maintenance costs and shortens the lifespan of infrastructure

10.2.4 Proposed mitigation measures of fugitive dust

⇒ Limit the amount of exposed soil.

⇒ Construct wind barriers or install cover tarps.

⇒ Apply water to suppress dust.

⇒ Apply chemical dust suppressants

⇒ Use vacuum controls on equipment to keep surfaces clean of debris.

⇒ Apply soil stabilizers.

⇒ Establish vegetative cover.

⇒ Control traffic speed through construction site and over unpaved areas.

⇒ Apply gravel surface to cover soil along haul road and in storage areas.

⇒ Pave haul roads and storage areas.

⇒ Regularly clean up track-out.

⇒ Limit work on windy days.

⇒ Never use compressed air or a blower of any sort to clean surfaces.

10.2.5 Injuries and accidents

At the proposed construction site work will be done physical. Workers at the proposed construction will be required to use powerful machinery and climb to great heights. Because of the inherent nature of the work, construction workers at the site will potentially face a risk of injuries on the job. There are many different risks that construction workers face while performing various tasks at a construction site. Top causes of injuries on a construction site include:

- **Falling from heights –** A worker may fall from a building, scaffolding or piece of machinery to the ground below. Workers can also fall into holes or ditches on a construction site.

- **Trench collapse –** When a trench collapses, a worker's air supply can be cut off, and the worker can be buried alive or suffer crushing injuries.
- **Collapsed scaffolding –** A scaffolding can collapse causing a worker to plunge to his death or to fall and sustain serious injury.
- **Electric shock and or arc flash/blast –** Working with generators, power tools, machinery and electrical wiring all put construction workers at risk of suffering electrical burns.
- **Failure to use appropriate protective gear –** A worker can sustain injury due to negligence and of failure to appropriately use the correct protective gera such as hardhats, safety glasses and other personal protective equipment
- **Repetitive motion injuries –** When the body is repeatedly asked to do the same things again and again, the muscles and soft tissues can become worn and damaged, limiting mobility and causing pain.
- In addition to these top injury causes, workers on a construction site could also be hurt as a result of traffic accidents, a ladder's collapse, malfunctioning tools or faulty equipment, errors made by other workers and accidents with tools or machinery.

Workers who experience these or other construction accidents can sustain a variety of serious injuries, including: burns, electrocution, eye injury, including vision impairment or blindness, broken bones, knee and ankle injury, neck, shoulder or back injury, spinal cord injury, including damage that can cause paraplegia or quadriplegia, illnesses caused by toxic chemical exposure and head injury and/or brain injury. In the most tragic of cases, the injuries sustained by the construction worker will be fatal or result in a permanent disability.

10.2.6 Proposed mitigation measures of injuries and accidents at the construction site

⇒ **Always Utilize Safety Gear:** Because construction site accidents occur even though safety measures are in place, it is important to wear safety gear (personal protection equipment). Basic safety gear for most building construction sites includes hard hats, steel-toed boots, hearing protection, eye protection, and harnesses. In some cases, it may also be necessary to wear masks and gloves.

⇒ **Maintain Equipment**: Equipment accidents are common on construction sites. Proper equipment maintenance can reduce the risk of accidents involving equipment.

⇒ **Safety Protocols**: Develop safety protocols and require all employees to follow those protocols when on the construction site. Periodically review safety protocols and revise them as necessary to improve safety.

⇒ **Schedule Regular Safety Meetings**: Safety meetings are an opportunity to review various safety protocols and ensure that new employees are aware of safety measures. Team leaders and supervisors can be kept up-to-date on any changes and can suggest changes based on events on the job site.

⇒ **Take Regular Breaks**: Regular breaks and lunch breaks should be enforced. Some employees may want to work through breaks or lunch to shorten the workday or earn overtime. However, fatigue and failure to hydrate can increase the risk of construction site accidents.

⇒ **Warning Signs**: There should be sufficient signage to warn of dangers and hazards on the construction site. Signs should be clear and accompanied by ropes, cones, and other equipment to cordon off dangerous areas.

⇒ **Worksite Inspections**: Supervisors, safety teams, or other leaders should conduct worksite inspections daily to identify any potential dangers or hazards. Dangers and hazards should be eliminated or addressed immediately.

⇒ **Provide Safety Training**: Employees should be required to complete a safety training course before beginning work. On-going safety training and refresher courses for existing workers can help prevent construction accidents.

⇒ **Proper Material Storage and Handling**: Some materials on a building construction site can pose hazards and dangers. Supplies should be stored and secured according to proper safety measures.

⇒ **Fall Protection**: Falls are one of the most common causes of injury and death on construction sites. Fall protection protocols and fall protection equipment should be mandatory for all employees.

10.2.7 Waste generation

Just like any other construction site, the proposed project site will be a construction site that will likely generate waste. The generated waste will likely have a potential to impact the environmental in different ways. Contributing factors to waste generation during the construction phase of the proposed project will include inadequate planning, over-ordering, damaging or mishandling materials, insufficient storage, or weather damage to materials. Potential negative impacts of construction waste include:

✓ **Environmental degradation**: Poor management of construction leads to excessive material ordering and wastage. Too much timber use leads to deforestation and the

churning up of land to find minerals disrupts ecosystems. And mass excavation also causes damage to soil quality while polluting water sources.

- ✓ **Energy consumption**: It takes energy to create and transport construction materials. Poor management of construction leads to excessive material ordering that translates to increased energy consumption to create and transport these materials.
- ✓ **Landfill overload**: Construction activities generate massive amounts of waste, which, when not recycled or disposed of appropriately, contribute to the overloading of landfills.
- ✓ **Resource depletion**: The disposal of construction materials without re-use and or recycling leads to the depletion of valuable resources that could have been reused.

10.2.8 Proposed measures to minimise waste generation during construction phase

- ❖ **Proper Planning**: Proper planning is critical to reducing construction waste. By conducting a waste audit and developing a comprehensive waste management plan before construction begins, you can identify potential waste generation hotspots and plan accordingly. This includes minimizing over-ordering of materials, utilizing prefabricated and modular components, and choosing materials that can be easily recycled or repurposed.
- ❖ **Material Management**: Effective material management is essential to reducing construction waste. This includes proper storage, handling, and transportation of materials to reduce damage and waste. It also means implementing a systematic approach to inventory management and using just-in-time delivery methods to reduce excess inventory and materials that may be subject to damage or spoilage.
- ❖ **Recycling Initiatives**: Recycling is a critical component of construction waste reduction. This includes recycling materials such as concrete, steel, and wood, as well as implementing composting and other waste reduction strategies.
- ❖ **Reduce Packaging**: Purchasing materials in bulk will reduce expenses and waste from individually packaged materials. The packing being recyclable should also be prioritized. Some packaging can even be reused on-site.

10.3 Operational phase potential positive impacts

10.3.1 Economic benefits of the Captive Power Plant

The proposed captive power plant will generate 10MW of electricity from waste heat recovery and an additional 10MW from solid fuels using Fluidized Bed Combustion (FBC) in Boiler Systems. The economic advantages of the proposed captive power plant is significant, encompassing cost savings through reduced electricity charges and fuel consumption

efficiencies. The captive power plant will enable MCL to predict and manage energy costs more effectively, shielding the company from market volatility and high prices associated with power supply from the national grid. Generating electricity through waste heat recovery will provide MCL with a range of benefits that go beyond cost savings. By optimizing energy use, reducing environmental impact, and increasing operational flexibility, MCL will pave the way for a more sustainable and resilient future. Generation of electricity from waste heat recovery is not only a sound business strategy but also a vital step towards achieving global energy efficiency goals and combating climate change.

Potential positive impacts of the proposed captive power plant will include the following:

- ⇒ **Reliability:** The proposed captive power plant will provide a more reliable power supply to MCL Vipingo compared to the grid, which may be prone to outages or fluctuations.
- ⇒ **Cost savings**: The proposed captive power plant will generate power on-site at MCL Vipingo for internal use a move that will be more cost-effective than purchasing electricity from the grid, especially now that MCL will be taking advantage of economies of scale and will be using more efficient technologies.
- ⇒ **Offsetting energy requirements**: Generation of electricity from waste heat recovery will offers substantial cost savings to MCL by reducing the need for additional energy inputs. By reusing waste heat, MCL will offset its energy requirements for heating, cooling, or power generation, resulting in reduced utility bills and operating expenses.
- ⇒ **Energy security**: By having its own power generation capacity, MCL will ensure that it has a secure and stable source of electricity, even in times of grid instability or supply shortages.
- ⇒ **Faster return on investments**: By generating its own electricity, MCL will potentially achieve a faster return on investment, thanks to lower operational costs and the potential for selling excess power back to the grid, further enhancing the company's economic benefits.
- ⇒ **Control and flexibility over energy production**: The proposed captive power plant will offer MCL high control and flexibility over its energy production, allowing the company to tailor its power generation to meet specific operational demands. This

control will enable MCL to optimize its energy consumption, improve efficiency, and adjust production in real time based on the company's current needs.

⇒ **Cost effective energy management strategies**: The proposed captive power plant will make MCL more flexible allowing the company to implement more sustainable and cost-effective energy management strategies, aligning closely with the company's financial and environmental objectives.

⇒ **Quick adoption to changing electricity demand**: The captive power plant will enable MCL to adapt quickly to changes in electricity demand for the company, further securing the company's energy supply and maintaining uninterrupted business processes. This adoption will support not just day-to-day operations, but also long-term planning and growth strategies.

⇒ **Enhanced energy efficiency**: Generation of electricity from waste heat recovery system will enable MCL to capture and utilize heat that would otherwise be wasted. By integrating these systems into its industrial processes, MCL will significantly improve its energy efficiency and reduce overall energy consumption. This will translate into lower operational costs and increased competitiveness in the market.

⇒ **Increased operational flexibility**: Generation of electricity from waste heat recovery will provide MCL with additional operational flexibility. The generated electricity will be used for various purposes, including heating water, or powering additional processes. This versatility will allow MCL to optimize its operations and adapt to changing energy demands effectively.

⇒ **Improved resilience and reliability**: Generation of electricity from waste heat recovery system will enhance the resilience and reliability of energy supply to MCL. By diversifying energy sources and reducing dependence on energy from the national grid, MC will become less vulnerable to energy price fluctuations, supply disruptions, and grid instability.

10.3.2 Environmental benefits of the proposed captive power plant

The proposed captive power plant will generate 10MW of electricity from waste heat recovery and an additional 10MW from solid fuels using fluidized bed combustion in boiler system. The positive environmental impacts of generating electricity from these two systems will include but not limited the following:

⇒ **Environmental impact reduction**: Generation of electricity from waste heat recovery will help MCL to mitigate environmental impact of its cement production by

reducing greenhouse gas emissions. By optimizing energy use and minimizing the need for additional energy generation, MCL will lower its carbon footprint and contribute to climate change mitigation efforts. The proposed electricity generation from waste heat recovery will aligns with sustainability goals and corporate social responsibility initiatives of MCL, enhancing MCL's reputation and stakeholder engagement.

⇒ **Resource conservation**: Generation of electricity from waste heat recovery will contribute to the efficient utilization of energy resources by MCL. By capturing and repurposing waste heat, MCL will reduce its reliance on non-renewable energy sources, such as fossil fuels. This will contribute to the conservation of natural resources and help build a more sustainable energy infrastructure.

⇒ **Avoid landfilling**: Generation of electricity from solid waste using fluidized bed combustion boiler system promotes reuse of waste while at the same time greatly reduces the amount of waste that could otherwise be disposed in landfills. Besides it mitigates environmental impacts associated with landfills such as production of greenhouse gases, the usage of large pieces of land, the potential for pollutants to seep into the ground and groundwater.

⇒ **Energy saving**: Generation of electricity from recovered waste heat from cement production process will enable MCL to create more output, with the same amount of energy resources translating to using resources efficiently.

⇒ **Cleaner and sustainable energy sources**: The proposed captive power plant will enable MCL to utilize cleaner and more sustainable energy sources. This shift will reduce dependence on fossil fuels, thereby decreasing greenhouse gas emissions and contribute to a healthier environment.

⇒ **Efficient use of resources**: The localized production of electricity will minimize transmission losses and promote more efficient use of resources.

10.3.3 Potential negative impacts during operational phase

Potential negative impacts of electricity generation through waste recovery and solid waste using fluidized bed combustion in boiler system will include but not limited to the following:-

⇒ Emission of toxic pollutants

⇒ Increase in demand of process water

⇒ Waste generation impacts

⇒ Risk of bed agglomeration and de-fluidization

⇒ Boiler explosion

⇒ Positive pressure boiler risks

10.3.3.1. Emission of toxic air pollutants

Through thermo-degradation and oxidation reactions, burning biomass in fluidized bed combustion boiler results in emissions of criteria and toxic air pollutants. These pollutants include carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), hydrocarbons/volatile organic compounds (VOCs), and particulate matter (PM). CO emissions are mainly from incomplete combustion of biomass fuels. NOx emissions are predominantly from nitrogen in the fuel, referred to as fuel-bound NOx, but a smaller portion comes from thermal NOx, which produces NOx from nitrogen in the atmosphere reacting within the flame. SO_2 emissions from biomass combustion result from sulfur in the fuel, whereas PM is a result of incomplete combustion, the presence of inert material in the fuel, and an improper air/fuel ratio. PM includes filterable PM (PMf) that can be captured on a filter, and condensable PM (PMc), which is in the gas phase when exiting the stack, but rapidly condenses to form submicron particles once exposed to atmospheric conditions). Air quality impacts are created by the release of particulate matter (flyash), SO2, and NO* into the flue gas stream, with lesser impacts from carbon monoxide (CO) and hydrocarbons (HC). Potential impacts of exposure to toxic air emissions will include but not limited to the following:-

⇒ Air pollution from the presence of pollutants in the air in large quantities for long periods.

⇒ Water pollution through introduction of organic and inorganic charge and biological charge at high levels that affect the water quality.

⇒ Exposure to (coming in contact with) air toxics also may cause health effects, including skin irritation, headaches, nausea, eye, nose and throat irritation, difficulty breathing, coughing, behavioural changes, and fatigue.

⇒ Air pollution can influence the quality of soil and water bodies by polluting precipitation, falling into water and soil environments

10.3.3.2 Increase in water demand

Implementation of the proposed project will require process water that will be used in steam generation and cooling of plant and equipment. The water that will be used will be abstracted from existing boreholes and wells with MCL Vioingo unit. Water to be used for cooling

purpose will be recycled through a cooling tower before circulating back to the plant. To provide the required initial volumes of water for the plant, water abstraction from existing boreholes and wells will have to be increased. Groundwater is in most catchments strongly connected to surface water, and consequently, groundwater abstraction also influences river flow. The principle of groundwater 'capture' stipulates that groundwater abstraction leads to a combination of a lowering of groundwater levels, an increase in groundwater recharge (from surface water or water that would otherwise run off the surface as overland flow or reduced actual evapotranspiration in areas with shallow groundwater tables) and a decrease in groundwater discharge to surface water. Following a change in abstraction, this process continues until a new equilibrium is established in the hydrological system. Thus, in most cases, groundwater abstraction decreases low flow and may cause or aggravate stream-flow drought. Potential negative impacts of increase in process water demand will include but not limited to the following:

- ⇒ Increase in groundwater abstraction will lower groundwater levels and can therefore cause a human-induced or human-modified groundwater drought.
- ⇒ Increase in groundwater abstraction will result in decrease in groundwater discharge to surface water.
- ⇒ Increase in groundwater abstraction will decrease low flow and may cause or aggravate stream-flow drought.
- ⇒ Increase in groundwater abstraction will contribute to localized pressure losses in aquifers that can lead to significant land subsidence issues.
- ⇒ Increase in groundwater abstraction will contribute to localized pressure losses that will result in salt water intrusion as the site is in a coastal area.
- ⇒ Groundwater quality degradation attributed to artificial aquifer recharge by partially treated wastewater.
- ⇒ Diminishing or even disappearing spring discharges and base-flows
- ⇒ Degradation of wetlands

10.3.3.3 Waste generation impacts

Agricultural biomass contains larger amount of ash-forming chemicals than woody biomass since it has a rapid metabolic rate and absorbs more nutrients during its growth stage. Burning solid fuels such as agricultural residues, biomass, municipal waste and industrial waste will generate solid waste such as ash. Rice husk and oil palm wastes, as agricultural biomass, have a higher composition of silica or potassium, and have higher ash content than

woodchip biomass which has a higher composition of calcium. Solid waste generation impacts result from disposal of bottom and fly ash and flue gas desulfurization products.

Potential negative impacts of solid waste will include but not limited to the following:-

- ⇒ Soil pollution through the release of chemicals or the disposal of wastes, such as heavy metals, hydrocarbons, and pesticides.
- ⇒ Water pollution when the waste end up in a water body
- ⇒ Air pollution when the waste is disposed by burning
- ⇒ Incubation for disease vectors.

10.3.3.4 Bed agglomeration and de-fluidization

Whereas fluidized beds are characterized by good controllability, excellent solids mixing, long residence times, and homogenous heat release, when using agricultural residues as fuel, the challenges of bed agglomeration and de-fluidization can arise. Combustion of biogenic solid fuels in fluidized bed furnaces show that high-temperature chlorine corrosion and slag deposition can occur. Furthermore, agglomerations in the bed material and the subsequent de-fluidization of the fluidized bed are other major problems. The use of agricultural residues aggravates these challenges because of ash composition. Alkali metals (e.g., sodium and potassium) are present in the biomass form low-melting eutectics with silica sand (used for the fluidized bed). They subsequently form a sticky superficial layer around the particles that ultimately leads to the formation of agglomerates. The agglomerations alter the flow regime in the fluidized bed by degrading the mixing quality and the temperature homogeneity. Subsequently, temperature peaks can lead to further agglomerations and finally to the de-fluidization of the bed, which causes undesirable plant shutdowns. Bed agglomeration and de-fluidization is thus an operational challenge associated with the combustion of biomass in fluidised bed boilers. Ash agglomeration can lead to bed de-fluidisation and consequently the shutdown of the fluidised bed combustion plant. Firing biomass fuels in fluidized-bed combustors may increase the risk of bed agglomeration and de-fluidization, because biomass fuels often have lower ash melting temperatures. Potential negative impacts of bed agglomeration and de-fluidization include but not limited to the following:

- ⇒ It can lead to sand particles sticking together to form a clinker, which is too heavy to fluidize.
- ⇒ Destroys the fluidization of the bed, which can lead to a hot spot forming in the bed that can in turn lead to further melting and fusion of the ash.

⇒ It can shut down the fluidised bed combustion plant.

10.3.3.5 Boiler explosion

Explosions in fluidized bed combustion boilers can be caused by various conditions including the following:

⇒ An interruption of the fuel or air supply or ignition energy to auxiliary burners, sufficient to result in causing momentary loss of flames, followed by restoration and delayed re-ignition of accumulated combustibles.

⇒ The accumulation of an explosive mixture of fuel and air as a result of fuels entering a bed whose temperature is below its ignition temperature and the subsequent ignition of the accumulation by a spark or other source of ignition.

⇒ Insufficient air to all or some bed compartments, causing incomplete combustion and accumulation of combustible material.

⇒ An accumulation of fuel in an idle fluidized bed that is still hot, leading to the distillation of combustible vapours followed by delayed ignition when the bed is fluidized as in a purge sequence.

Impacts of explosion of a circulating fluidized Bed furnace boiler may include the following:-

⇒ There is a significant risk to human life; the force unleashed during an explosion of the boiler can cause severe injuries or even fatalities to those in close proximity to the boiler.

⇒ Cause catastrophic damage on the building's external and internal structural frames and collapsing of walls.

⇒ Extensive destruction not only to the boiler itself but also to surrounding structures and equipment.

⇒ Fires may also break out as a result of the explosion, further compounding the damage.

10.3.3.6 Positive pressure boiler risks

Positive pressure in the boiler is the phenomenon where the amount of air pushed into the combustion chamber exceeds the amount of air drawn out of the chamber, causing the fire to leak outside the boiler through the operation doors. This poses safety hazards to operators and compromises the cleanliness of the operational area. Potential negative impacts of positive pressure in boilers include but not limited to the following:-

- Drastically reduces boiler efficiency.

- Can result in leaks that release hot steam or gases into the surrounding environment, which can be dangerous for personnel and equipment.
- Contribute to boiler explosion.

10.3.4 Proposed mitigation measures of operational phase negative impacts

10.3.4.1 Proposed mitigation measures of emission of toxic air pollutants

⇒ Beneficial use of the heat of exhaust-gases. Capture and recover all the flue gases and waste heat generated from burning of solid waste in the fluidized bed combustion in boiler and use it in generation of electricity in the waste heat recovery wing of the proposed project.

⇒ Install emission control technologies such as electrostatic precipitators, scrubbers, and bag-house filters to control particulate matter (PM_{10} and $PM_{2.5}$) emissions.

⇒ Operate at optimal temperature to achieve complete combustion to release all of the energy present in the fuel avoid emission of carbon monoxide.

⇒ Practice good start-up and shutdown procedures.

⇒ Minimise NOx emission by appropriate fuel selection, burner modifications, low excess air firing, flue gas recirculation and constant water stream injection.

⇒ Eliminate NOx formation through low combustion temperature.

⇒ Minimise flue gasses emission by appropriate fuel selection

⇒ Sulphur present in the fuel is retained in the circulating solids in the form of calcium sulphate and removed in solid form. Achieve higher sulphur retention rate by using limestone or dolomite sorbents.

⇒ Mitigate Volatile organic compounds by proper burner set-up and adjustment, and maintenance of the burner boiler with proper air/fuel ratio.

10.3.4.2 Proposed mitigation measures of increased water demand

- ✓ Increase in intercepted natural groundwater recharge through increase in vegetation cover.
- ✓ Increase in induced groundwater recharge using treated wastewater
- ✓ Increase artificial aquifer recharge.
- ✓ Reduce water abstraction by reuse process by circulating it through a cooling tower.
- ✓ Fix any leakages in the system
- ✓ Use polycarboxylate superplasticizer to reduce water consumption.
- ✓ Recirculate back to the system condensate extracted .

10.3.4.3 Proposed measures to mitigate waste generation

- Increase combustion temperature (from 400^0C-800^0C) to significantly decrease ash residue formation when using agricultural crop residual biomass fuels.
- Reduce the slag content in residual ash buy combusting in low temperature.
- Reuse all generated ash of low slag content in farms as fertilizer after simple treatment.
- Use high grade solid fuels to minimise the quantity of waste generated in the form of ash.
- Reusing generated ash as alternative raw material for the production of building materials.
- Reusing the generated ash in wastewater treatment.

10.3.4.4 Proposed mitigation measure of bed agglomeration and de-fluidization

- ❖ Decrease the operating temperature of the reactor.
- ❖ Increase the gas velocity.
- ❖ Replace the bed material.
- ❖ Remove alkali metals by the pre-treatment of the solid fuels
- ❖ Use bed additives such as kaolin, dolomite and olivine.
- ❖ Replace bed material.

10.3.4.5 Proposed mitigation measures of boiler explosion

- ✓ Regular maintenance is essential to ensure that boilers are operating safely and efficiently. This includes checking for any signs of wear or damage, inspecting safety valves, and cleaning or replacing filters as needed. By conducting routine inspections and addressing any issues promptly, potential problems can be identified early on and prevented from escalating into dangerous situations.
- ✓ Have robust safety protocols in place. One key aspect is ensuring that safety valves are installed correctly and functioning properly. Safety valves are designed to release excess pressure within the boiler, preventing it from reaching dangerous levels. Regular testing and maintenance of these valves should be carried out by qualified professionals.
- ✓ Inspection of pump inlets and fixing loose connections
- ✓ Installation of ash removal system to avoid ash accumulation in the furnace or other equipment
- ✓ Pump priming
- ✓ Regular checking of safety valves

- ✓ The boiler should be operated as per its design pressure
- ✓ Treatment of water before feeding it to boiler
- ✓ Ensure that the boiler vents function properly
- ✓ Regular inspection for leakages of water, gases, steam, and air
- ✓ Ensure proper insulation of heated parts of boilers
- ✓ Maintenance of Forced Draft Fan and Induced Draft Fan
- ✓ Regular checking of Pressure Gauge
- ✓ Regular cleaning of accessible boiler parts
- ✓ Cleaning of boiler tubes to prevent ash accumulation or scale formation
- ✓ Maintaining the primary and secondary air ratio as per fuel feeding
- ✓ Scheduled checking of burner operation, back pressure, and line pressure to avoid thermal stress
- ✓ Proper training of operating personnel on appropriate methods of operation

10.3.4.6 Proposed mitigation measures of positive pressure safety hazard

⇒ Ensure no blockage of fuel due to ash accumulation.

⇒ Ensure no air leakage from boiler.

⇒ Ensure sufficient air volume & pressure of induced draft fan.

11. ENVIRONMENTAL MANAGEMENT PLAN

11.1 Working policies to be developed by the project proponent

Implementation of the proposed project will require careful and sound environmental planning to ensure that all issues and concerns raised by all stakeholders are fully addressed and that all potential negative impacts are appropriately mitigated to ensure environmental sustainability. To achieve this; Mombasa Cement Limited who is the project proponent will upgrade existing policies and develop new ones where there is no existing policy to guide the implementation of the proposed project. The policies once upgraded and or developed will be vital in the following ways among others:

- ✓ The policies will enable management to develop and maintain sound relations with project staff and the neighboring community.
- ✓ The policies will enable management put in place measures and structures that will care for the safety, health and welfare of all project staff on site and the neighbouring community residents.
- ✓ 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, and sustainable waste management.
- ✓ The policies will provide a framework for Mombasa Cement Limited to scale-up its corporate social responsibility, conservation of the environment as well as for the well-being of the local community.

The following policies will need to be either developed and documented or if they are in place upgraded by the project proponent to include the proposed project:-

- ⇒ Environmental and sustainability policy
- ⇒ Occupational Health and safety policy
- ⇒ Stakeholder engagement and involvement policy
- ⇒ Training and development policy
- ⇒ Risk Management policy

11.1.1 Environmental and sustainability policy

Mombasa Cement Limited has an existing environmental policy. Management will be required to updated and enhance this policy to an environmental and sustainability policy. The enhanced policy will guide the project proponent to carry out the proposed project activities with the highest regard to the natural environment, social environment and sustainable utilization of natural resources. The policy will be in line with applicable national

legislations, international guidelines, standards and best practices. The environmental and sustainability policy will therefore cover the following, among other issues: -

- ✓ All Kilifi County relevant legislations that the proponent will have to comply with before commencement of project implementation.
- ✓ All national statutory requirements that the project proponent will have to comply with before commencement of project implementation.
- ✓ Systems to be put in place to ensure continuous environmental improvement and performance throughout the project lifecycle.
- ✓ Comprehensive measures to be adopted by the proponent to ensure that utilization of natural resources are optimal with sustainability measures in place to ensure resource availability for future generation.
- ✓ Awareness creation to the surrounding community regarding sustainable utilization of natural resources, protection of sensitive ecosystems and bio-diversity maintenance for communal livelihood.
- ✓ Measures that provide for and ensure balancing between natural resource use, environmental conservation and economic development.

11.1.2 Occupational Health and safety policy

The project proponent has an existing Occupational Health and Safety Policy in place. However, management will be required to update this policy to meet the expanded requirement of the proposed project. This will ensure that the project proponent put in place appropriate measures that will ensure that the health, safety and welfare of all employees are cared for. Further the policy will also ensure and safeguard the health and safety of the local community within the project catchment. In addition to this the policy will safeguards the health and safety of visitors to the project site and all other stakeholders. The policy will highlight the following, among others: -

- ✓ Identity health and safety requirements of employees that need to be safeguarded in line with requirements and provisions of national legislations, international guidelines of best practices.
- ✓ Identity health and safety requirements of local community within the project catchment area that need to be safeguarded in line with constitutional requirements and provisions, national legislations and international guidelines of best practices.

- ✓ Identity health and safety requirements of visitors to the project site that need to be safeguarded in line with constitutional requirements and provisions, national legislations and international guidelines of best practices.
- ✓ Identity health and safety requirements of all other stakeholders that need to be safeguarded in line with constitutional requirements and provisions, national legislations and international guidelines of best practices.
- ✓ Identify ways and means of safeguarding health and safety of employees, local community, visitors to the project site and all other stakeholders.
- ✓ Identify safety measures that need to be put in place for all machines and equipment to be used.
- ✓ Identify required appropriate safety and rescue equipment to be availed in all work places within the project site.
- ✓ Document an elaborate emergency procedures and actions.
- ✓ Identify ways to ensure risk is eliminated and or minimized within the project site
- ✓ Document required training needs in safety.

11.1.3 Stakeholder engagement and involvement policy

The project proponent will develop and document a comprehensive stakeholder engagement and involvement policy that will ensure that the project proponent develops and maintains sound relations with all stakeholders. The policy will identify all the project stakeholders including those who have an interest in the project and those that are affected by the project. In additions the policy will provide a broad framework on how each of the stakeholders will be engaged and involved in the project. The policy will highlight the following, among others:-

- ✓ Identify all project stakeholders and potential stakeholders.
- ✓ Identify the stake/interest/role of each of the identified stakeholder
- ✓ Outline how management will address each stakeholder needs/requirements/interests
- ✓ Document how project management will engage and involve each of the stakeholders
- ✓ Document how the stakeholders will interact among themselves and with the project

11.1.4 Training and development policy

The project proponent will develop and document a comprehensive training and development policy to meet project environmental protection and sustainability needs, project occupational safety and health needs, community health and safety safeguards, and other training and

development needs that will be necessitated by project activities. The training and development policy will be aligned to applicable national legislations, international guidelines and best practices. The policy will highlight the following among other issues: -

- ✓ In-house training and capacity development for project workforce to address and meet required project environmental protection and sustainability threshold.
- ✓ In-house training and capacity development for project workforce to address and meet required project occupational safety and health threshold.
- ✓ In-house training and capacity development for project workforce to address and meet required community health and safety safeguard threshold.

11.1.5 Risk Management policy

The project proponent will develop and document a comprehensive risk management policy to address all potential risks that are likely to be associated with the project. The policy will document guidelines of addressing each potential risk with the aim of preventing the risk from occurring while spelling out measures to be taken to address the risk should it occur. The risk management policy will cover project related environmental risks, project related social risks, and project related occupational risks among other risks. The risk management policy will highlight the following among others:-

- ✓ Identify all project related risks to the natural environmental and social environment.
- ✓ Spell out measures to be taken to prevent identified project risks.
- ✓ Spell out remedial measures that will be taken should the risk occur.

11.2 Environmental management action plan

The Environmental Management Plan prepared covers identified issues of concern of construction phase namely noise and vibration disturbance, fugitive dust, injuries and accidents and waste generation. Identified issues and concern of operational phase namely; mission of toxic pollutants, increase in demand of process water, waste generation impacts, risk of bed agglomeration and de-fluidization, boiler explosion and positive pressure boiler risks. Identified issues and concern of decommissioning phase namely noise and vibration, injuries and accidents, dust pollution and waste generation. The EMP also covers environmental monitoring and auditing requirements, training and capacity building, institutional arrangements for safeguards implementation and reporting obligations.

Table 9 Environmental management action plans

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
CONSTRUCTION PHASE						
Noise & vibration	• Hearing loss • Vibration syndrome • Musculoskeletal disorders • Cardiovascular problems • Mental health	○ Use noise reduction technologies e.g. acoustic covers & isolating noisy areas ○ Administrative controls e.g. PPE use, training, limiting exposure ○ Thorough noise assessment ○ Maintenance & inspections of machinery & equipment	• Periodic measurement of noise & vibration levels	• MCL GM • MCL EHS Officer • Section Heads • Individual workers	During the construction phase and to be sustained throughout the lifecycle of the proposed project	1,000,000
Fugitive dust	○ Respiratory problems ○ Cardiovascular problems	• Limit areas of exposed bare ground • Wind barriers / install cover tarps	• Physical observations of fugitive	• MCL GM • MCL EHS	During the construction phase and to be	1,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
	○ Eye irritation ○ Skin irritation ○ Neurological problems ○ Water pollution ○ Damage to vegetation ○ Damage to infrastructure	• Use suppressants e.g. water • vacuum controls • soil stabilizers • soil vegetation establishment • Control traffic speed through construction site & over unpaved areas • Pave haul roads & storage areas • Regularly clean up track-out • Limit work on windy days	dust • Monitoring of fugitive dust	Officer • Section Heads • Individual workers	sustained throughout the lifecycle of the proposed project	
Injuries & accidents	▪ Loss of life ▪ Loss of livelihoods ▪ Loss of productive time	○ Always Utilize Safety Gear ○ Maintain Equipment ○ Safety Protocols	• Log of accidents • Log of injuries	• MCL GM • MCL EHS Officer	During the construction phase and to be sustained	500,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
	▪ Loss of manpower ▪ Litigations ▪ Corporate image damage	○ Schedule Regular Safety Meetings ○ Take Regular Breaks ○ Warning Signs ○ Worksite Inspections ○ Provide Safety Training ○ Proper Material Storage and Handling ○ Fall Protection		• Section Heads • Individual workers	throughout the lifecycle of the proposed project	
Waste generation	○ Environmental degradation ○ Energy consumption ○ Landfill overload ○ Resource depletion	▪ Proper Planning to identify potential waste generation hotspots ▪ Material Management to reduce construction waste ▪ Recycling initiatives to achieve waste reduction	○ Log of reuse & recycling initiatives ○ Duly completed waste tracking documents	• MCL GM • MCL EHS Officer • Section Heads • Individual workers	During the construction phase and to be sustained throughout the lifecycle of the proposed project	5,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
		▪ Reduce packaging to reduce waste from individually packaged materials				
PRODUCTION PHASE						
Gaseous emissions	○ Air pollution ○ Water pollution ○ Health effects e.g. skin irritation, headaches, nausea, eye, nose and throat irritation, difficulty breathing, coughing, behavioural changes, and fatigue	• Beneficial use of the heat of exhaust-gases through waste heat recovery • Emission control technologies such as electrostatic precipitators, scrubbers, and bag-house filters to control particulate matter (PM_{10} and $PM_{2.5}$) emissions • Complete combustion	○ Air quality monitoring report every three months ○ Feedback from neighbours & other stakeholders	○ MCL GM ○ MCL EHS Officer ○ Section Heads ○ Individual workers	During production phase and to be sustained throughout the lifecycle of the proposed project	2,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
		avoid emission of carbon monoxide complete combustion • Practice good start-up and shutdown procedures				
Increase in water demand	○ Human-induced or human-modified groundwater drought ○ Decrease in groundwater discharge to surface water ○ Decrease in low flow ○ Aggravate stream-flow drought ○ Localized pressure losses in aquifers leading to land subsidence	❖ Artificial aquifer recharge ❖ Induced aquifer recharge ❖ Water recycling to minimise abstraction ❖ Collect & recirculate condensate formed in heat recovery system ❖ Use polycarboxylate superplasticizer to reduce water consumption ❖ Minimise/eliminate	▪ Meter waster abstraction from each well and borehole	○ MCL GM ○ MCL EHS Officer ○ Section Heads ○ Individual workers	During production phase and to be sustained throughout the lifecycle of the proposed project	1,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
	○ Localized pressure losses resulting in salt water intrusion ○ Groundwater quality degradation ○ Degradation of wetlands ○ Diminishing / disappearing spring discharges and base-flows	water loss through leakages by fixing all leaks ❖ Proper insulation to minimise/eliminate steam losses.				
Waste generation	➢ Soil pollution ➢ Water pollution ➢ Air pollution	○ Increase combustion temperature to significantly decrease ash residue formation ○ Reduce the slag content in residual ash buy combusting in low temperature ash residue formation	▪ Records on the type of waste generated ▪ Records on quantity of waste generated ▪ Dually filled	▪ MCL GM ▪ MCL EHS Officer ▪ Section Heads ▪ Individual workers	During production phase and to be sustained throughout the lifecycle of the proposed project	5,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
		○ Reuse all generated ash of low slag content in farms as fertilizer ○ Use high grade solid fuels to minimise the quantity of waste generated ○ Reuse generated ash as raw material for the production of building materials	waste disposal tracking documents			
Bed agglomeration and de-fluidization	⇒ It can lead to sand particles sticking together to form a clinker, which is too heavy to fluidize ⇒ Destroys the fluidization of the bed	• Decrease the operating temperature of the reactor. • Increase the gas velocity. • Replace the bed material. • Remove alkali metals	Frequency analysis of pressure fluctuations	▪ Plant Head ▪ Production Manager ▪ Quality Manager ▪ Section Heads	During production phase and to be sustained throughout the lifecycle of the proposed project	10,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
	⇒ Hot spot forming in the bed leading to further melting and fusion of the ash	by the pre-treatment of the solid fuels. • Use bed additives such as kaolin, dolomite and olivine. • Replace bed material.				
Boiler explosion	• Significant risk to human life • Damage on the buildings • Damage to surrounding structures and equipment • Outbreak of fires	➢ Regular maintenance ➢ Have robust safety protocols in place ➢ Inspection of pump inlets ➢ Check for loose connections ➢ Efficient ash removal system to avoid ash accumulation ➢ Regular checking of Pressure Gauge	○ Monitor boiler pressure ○ Monitor boiler temperature	▪ MCL GM ▪ MCL EHS Officer ▪ Section Heads ▪ Individual workers	During production phase and to be sustained throughout the lifecycle of the proposed project	5,000,000
Positive pressure	○ Reduces boiler efficiency	⇒ Ensure no blockage of fuel due to ash	Monitor pressure in the combustion	▪ Plant Head ▪ Production	During production	5,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
	○ Leaks & release hot steam or gases. ○ Boiler explosion	accumulation ⇒ Ensure no air leakage from boiler ⇒ Ensure sufficient air volume & pressure of induced draft fan.	chamber which must always be lower than atmospheric pressure	Manager ▪ Quality Manager ▪ Section Heads	phase and to be sustained throughout the lifecycle of the proposed project	
DECOMMISSIONING PHASE						
Noise & vibration	• Hearing loss • Vibration syndrome • Musculoskeletal disorders • Cardiovascular problems • Mental health	➢ Use noise reduction technologies e.g. acoustic covers & isolating noisy areas ➢ Administrative controls e.g. PPE use, training, limiting exposure ➢ Thorough noise assessment ➢ Maintenance & inspections of machinery &	❖ Periodic measurement of noise & vibration levels	MCL GM MCL EHS Officer Section Heads Individual workers	To be implemented throughout decommissioning phase	2,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
		equipment				
Fugitive dust	⇒ Respiratory problems ⇒ Cardiovascular problems ⇒ Eye irritation ⇒ Skin irritation ⇒ Neurological problems	❖ Secure site with dust screens ❖ Sprinkle water ❖ Use PPEs	○ Physical observations of fugitive dust ○ Monitoring of fugitive dust	• MCL GM • MCL EHS Officer • Section Heads • Individual workers	To be implemented throughout decommissioning phase	5,000,000
Injuries & accidents	• Loss of life • Loss of livelihoods • Loss of productive time • Loss of manpower • Litigations • Corporate image damage	➢ Always Utilize Safety Gear ➢ Maintain Equipment ➢ Safety Protocols ➢ Schedule Regular Safety Meetings ➢ Take Regular Breaks ➢ Warning Signs	✓ Log of accidents ✓ Log of injuries	MCL GM MCL EHS Officer Section Heads Individual workers	To be implemented throughout decommissioning phase	4,000,000
Waste generation	⇒ Environmental degradation ⇒ Energy consumption	○ Reuse and recycling of all recovered scrap and concrete waste	○ Log of reuse & recycling initiatives	• MCL GM • MCL EHS Officer	To be implemented throughout	5,000,000

Issue/concern	Potential impact	Mitigation	Monitoring	Actor	Timeframe	Budget
	⇒ Landfill overload ⇒ Resource depletion		○ Duly completed waste tracking documents	• Section Heads • Individual workers	decommissioning phase	

11.3 Environmental Monitoring

11.3.1 Greenhouse gasses monitoring

Monitoring of greenhouse gasses concentration will be quarterly i.e. every three months. The following greenhouse gases will be monitored sulphur dioxide (SO_2); oxides of nitrogen (NO_x) (which includes nitric oxide (NO) and nitrogen dioxide (NO_2)); carbon monoxide (CO); carbon dioxide (CO_2); Total Volatile organic compounds, (TVOCs) and Ammonia (NH_3). The results of the monitoring will be compared against the baseline monitoring values that were established before the construction and operation of the proposed project which are annexed in this report and the provisions of the fourth schedule of the Environmental Management and Coordination (Air Quality) Regulations 2014 that stipulates limit values of greenhouse gases as shown in Table 10.

Table 10Ambient Air Quality Tolerance Limits greenhouse gases to guide monitoring

Greenhouse gas pollutant	Time weighted Average	Industrial area	Residential, Rural & Other area	Controlled areas***
Sulphur dioxide	Instant Peak		500 μg/m^3	-
	Instant peak (10min)		0.191 ppm	-
Non-methane hydrocarbons	instant Peak	700ppb	-	-
Total VOC	24 hours**	600 μg/m^3	-	-
Oxides of Nitrogen	24 hours	100 μg/m^3	0.1 PPM	-
	Instant peak		0.5 PPM	-
Nitrogen dioxide	One hour		0.2 ppm	-
	Instant peak		0.5 ppm	-
Carbon monoxide / carbon dioxide	One Hour	10 mg/m^3	4.0 mg/m^3	10 mg/m^3
Ozone	1-Hour	200 μg/m3	0.12 PPM	-

Extract from the Ambient EMC Air Quality regulations, 2014 (Tolerance Limits)

11.3.2 Noise and excessive vibrations monitoring

The noise levels will be monitored quarterly to ensure they are in line with the provisions of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 as shown in the table 11.

Table 11 Maximum permissible noise levels for constructions sites (Measurement taken within the facility).

Facility		Maximum Noise Level Permitted (Leq) in dB(A)	
		Day	Night
i.	Health facilities, educational institutions, homes for disabled etc.	60	35
ii.	Residential	60	35
iii.	Areas other than those prescribed in (i) and (ii)	75	65

Timeframe: Day; 6:01am-6:00pm & Night; 6:01pm-6:00am
Source: Second schedule of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.

11.3.3 Air Quality Monitoring

Monitoring of particulate matter to ensure that the project activities adhere to the Ambient Air Quality requirements at Property Boundary for General Pollutants. Part (b) of the First Schedule of the Environmental Management and Coordination (Air Quality) Regulations, 2014 require that the particulate matter for at a property boundary should not exceed 70µg/m^3. The proponent will be monitoring particulate matter from the project site during construction phase to ensure they are within the legal limits.

11.3.4 Solid waste disposal monitoring

Waste generated and disposed from the proposed project will be managed and disposed as provided for in the Sustainable Waste Management Act, 2022 and the Environmental Management and Coordination (Waste Management) Regulations, 2006. To ensure that the provisions of the regulation and Act are adhered to, the proponent will prioritize was segregation at source, reuse and or recycling of recovered materials. Further for any waste that must be disposed, then the proponent will monitor the type of solid waste generated, quantity of solid waste generated, frequency of collection and disposal, where the waste is disposed and proof of waste tracking documents in the format provided in FORM III schedule one of the Environmental Management and Co-ordination (Waste Management) Regulations 2006. This monitoring is to be done monthly.

11.4 Training and capacity building

The following training and capacity building is proposed: -

- ⇒ Sensitization of the Proponent, and Contractor who will undertake the implementation of the proposed project on the importance of the EMP, its contents, how it is applied and who is responsible for the implementation of each part of the EMP.
- ⇒ Training and capacity building for contractor and the construction labour on the importance and proper use of PPEs.
- ⇒ Training and capacity building for Contractor and construction labour on sustainable waste management practices.
- ⇒ Training and capacity building of the construction site occupational safety and health committee on construction site occupational safety and health requirements and individual safety obligations.
- ⇒ Training and capacity building of construction site first aiders.
- ⇒ Training and capacity building on construction site fire safety team.
- ⇒ Sensitization on HIV and AIDS and other communicable diseases to site construction workforce.

11.5 Institutional arrangements for safeguard implementation and reporting

11.5.1 Institutional arrangement

The responsibility of implementation of the safeguards proposed in this EMP is vested on the project proponent who is Mombasa Cement Limited. The National Environment Management Authority (NEMA) and other relevant lead agencies will enforce compliance. There will be periodic site visits by NEMA and relevant lead agencies to assess and enforce compliance. During the construction phase, the contractor will be required to prepare monthly progress reports and submit the progress reports to the proponent on the contractor's contractual obligations on safeguards implementation responsibilities specified in the EMP. The contractor will be supervised on the ground directly by the proponent or proponent representative as will be determined by the proponent. The proponent will be required to promptly respond to improvement orders issued by NEMA and other lead agencies by compiling a report on the issues raised in the orders. The proponent will be required to prepare periodic monitoring reports and annual environmental audit reports and submit these reports to NEMA and other relevant lead agencies.

11.5.2 Reporting obligations

The following reports will be prepared:

⇒ Monthly progress reports by the contractor on the implementation status of every obligation of the contractor on safeguards implementation specified in the EMP. These monthly reports will be submitted by the contractor to the Proponent.

⇒ Periodic monitoring reports to be prepared by the proponent and submitted to NEMA on the status of:-

- ✓ Mitigation of Greenhouse gas emission as prescribed in the Environmental Management and Coordination (Air Quality) Regulations, 2014
- ✓ Mitigation of Particulate matter (dust) emission as prescribed in the Environmental Management and Coordination (Air Quality) Regulations, 2014.
- ✓ Mitigation of emitting of Noise and excessive vibration as prescribed in the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.
- ✓ Sustainable Waste management practices as prescribed in the Sustainable Waste Management Act 2022 and the Environmental Management and Coordination (Waste Management) Regulation, 2006.
- ✓ Reporting on monitoring and report in terms of Initial Environmental Audit report to be prepared by the proponent and submitted to NEMA in the first year of operation of the project to check the efficacy and adequacy of the EMP.
- ✓ Monitoring and reporting in terms of Self-environmental audit report to be prepared annually by the proponent and submitted to NEMA to report on the progress of implementation of the EMP.
- ✓ Monitoring and reporting in terms of Reports responding to NEMA improvement orders to be prepared by the proponent and submitted to NEMA as and when such improvement orders are issued.

11.6 Environmental auditing

The project proponent will carry out an initial environmental audit and Annual Environmental Audit for the project activities as provided for in the Environmental (Impact Assessment and Audit) Regulations 2003. The Audits will serve to confirm the efficacy and adequacy of the proposed Environmental Management Plan.

11.7 Decommissioning

Decommissioning of the project will involve terminating project operations, dismantling of the

power plant, all project equipment and allied infrastructure and rehabilitating the site to the original status. Before decommissioning will be done, the Project Management will communicate in writing to the National Environment Management Authority stating their intension to decommission and provide a detailed decommissioning plan for approval.

12. FINDINGS, CONCLUSION AND RECOMMENDATIONS

12.1 Key findings

The following are the main findings:

- ✓ The proposed project is a captive power plant that is to generate 20 MW of electricity.
- ✓ The proposed project is to generate electricity from waste heat recovery system and solid fuels using circulating fluidized bed combustion technology.
- ✓ The waste heat to be used in power generation will be recovered from waste flue gasses that are emitted during clinkerization and cement production at Mombasa Cement Limited (MCL) Vipingo Unit.
- ✓ The solid waste that will be used will be solid fuels of good calorific value varying between 3400kcal/Kg to 5200kcal/kg,
- ✓ The solid waste fuels will mainly be industrial, agricultural, and municipal waste.
- ✓ Fluidized bed combustion technology that will be used is a versatile technology that can be used to burn a variety of fuels, including biomass, and waste. It is a more efficient and environmentally friendly way to produce heat and power than traditional combustion methods.
- ✓ The proposed project will environmental friendly and green as it will be in line with the provisions and requirements of the Sustainable Waste Management Act, 2022 as it will be using both gaseous and liquid waste to generate electricity.
- ✓ Waste heat recovery not only conserves energy but also contributes to reducing greenhouse gas emissions.
- ✓ The captive power plant will be embedded within the existing MCL Vipingo cement factory in Kilifi County.
- ✓ The proponent of the proposed project is Mombasa Cement Limited, private company incorporated in Kenya with Limited liability.
- ✓ The proposed power plant will be constructed on sections of land parcel MN/III/291/2 and MN/III/4391.
- ✓ Most stakeholders consulted supported implementation of the proposed project as it contribute to reduction of greenhouse gasses emission from MCL plant and hence a cleaner local environment.

12.2 Conclusions

Waste heat recovery and use of solid wastes in electricity generation is a sustainable practice that will contribute to achieving energy efficiency, reducing emissions and enhancing

sustainability. By recovering and recycling waste heat and reusing solid waste MCL will be environmentally responsible and sustainable. Capturing and reusing waste heat to generate electricity will significantly reduce MCL's energy consumption and associated costs. This will result in a more efficient use of resources and a reduced environmental footprint for the company.

12.3 Recommendations

To enhance sustainability of the proposed project, maintain sound environmental stewardship and further minimise environmental footprint of the company all waste heat that will be generated from combustion of solid waste in the circulating fluidized bed combustion boiler to be collected and used in generating electricity.

APPENDICES

Appendix 1 Land documents of the proposed project site

Appendix 2 Certificate of incorporation & KRA PIN Certificate

Appendix 3 ToR approval from NEMA

Appendix 4 Practicing licenses of the firm of experts and Lead Expert

Appendix 5 Environmental baseline study report for ambient acoustic emissions levels

Appendix 6 Baseline Carbon Emission Footprint Report

Appendix 7 Detailed Air Quality Dispersal Modeling Report

Appendix 8 Detailed geotechnical investigation report

Appendix 9 Detailed well water analysis report

Appendix 10 Ambient greenhouse gasses baseline

Appendix 11 Process flow diagram for WHR and CPP

Appendix 12 Borehole water analysis report after treatment in the RO plant

Appendix 13 Detailed Bills of Quantities

Appendix 14 Detailed Questionnaire survey responses

Appendix 15 Attendance list and minutes of the first baraza

Appendix 16 Attendance list and minutes of the second baraza

Appendix 17 Attendance list and minutes of the third baraza