

**ENVIRONMENTAL IMPACT AND SOCIAL ASSESSMENT STUDY FOR THE
PROPOSED MAMBA CEMENT MANUFACTURING PLANT ON PLOT NO:
KISUMU/BORDER/4520, 6276, 5702 & 6277 BORDER II SUB-LOCATION, AWASI
LOCATION, NYANDO SUB COUNTY, KISUMU COUNTY**



Geo. Ref. Coordinates: latitude -0.175294 and longitude 35.116189

**PROPONENT: MAMBA CEMENT LIMITED
P. O. BOX 523 - 40107
MUHORONI**

SEPTEMBER 2025

This Report has been prepared in accordance with the requirements of the Environmental (Impact Assessment and Audit) Amendment Regulations, 2019, pursuant to the Environmental Management and Coordination Amendment) Act (EMCA) 2015

SUBMISSION OF DOCUMENTATION

This Environmental Assessment Report was prepared in accordance with the EMCA 2015 and the Environmental Impact Assessment and Audit Amendment Regulations, 2019 for the proposed development of a cement manufacturing plant with a crushing capacity of 180 tonnes per day in Border II Sub Location, Kisumu County. We, the undersigned confirm that the contents of this report are an accurate and truthful representation of all findings relating to the project.

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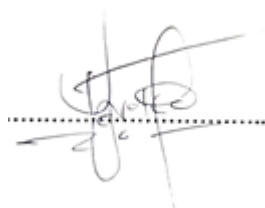


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ACKNOWLEDGEMENT

The EIA/Audit Experts are very grateful to Mamba Cement Limited, Kisumu County for commissioning us to conduct this Environmental and Social Impact Assessment. We further acknowledge the support of the area chief, opinion leaders and anyone either direct or indirect, from the various parties who assisted the EIA/EA experts' team towards the successful completion of this report.

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NON-TECHNICAL SUMMARY

This study covers the preparation of a project-specific Environmental and Social Impact Assessment (ESIA) for the proposed construction of a cement manufacturing plant with a processing capacity of 180 tonnes per day, located along Awasi Quarry Road, off the Kisumu-Nairobi Highway on plot no: Kisumu/Border/4520,6276, 5702, & 6277, Border II Sub-Location, Awasi Location, Nyando Sub County, Kisumu County. This will ensure that the plant provides a long-term supply of high-quality cement to the local, national and regional markets. Mamba Cement Limited is a registered company incorporated under the Companies Act (Cap. 486) to run a Cement Manufacturing Plant at Awasi location, in Nyando Sub-County, Kisumu County.

In today's competitive market, operational efficiency is critical for long-term sustainability. The success of the proposed project is closely tied to the economic wellbeing of the surrounding communities, as it will create employment and stimulate local economic growth. To achieve this, the project will adopt an appropriate scale of operation through careful sizing of the factory and the integration of modern, advanced technology. Given its capital-intensive nature, the development of the proposed Mamba Cement Manufacturing Company will be undertaken in phases to ensure effective implementation and sustainability.

Mamba Cement Limited is committed to supporting Kenya's growing demand for cement by establishing a modern cement manufacturing plant. The project involves the construction and installation of equipment and machinery designed for the production of cement and allied products. During the construction phase, the project is expected to create employment opportunities for over 30 skilled and unskilled workers. The total investment is estimated at Ksh. 59,983,000. Upon completion, the plant will be equipped with advanced machinery and systems to ensure efficient production processes and the manufacture of high-quality cement and related products. These will include;

- Administrative Offices
- Weigh bridge
- Product silo
- Dust collector
- Classifier
- Ball Mill

- Power house
- Chemical room
- Humidity cabinet room
- Sample test room
- Curing Tank
- Store

The operational phase of the proposed project will involve the production of cement, with associated by-products such as kiln dust, clinker dust, and quarry overburden. The main inputs will include limestone, gypsum, pozzolana, clinker, raw water, and electricity. During the decommissioning phase, consideration will be given to restoring the project site to its nearest original condition, where feasible.

This Environmental and Social Impact Assessment (ESIA), together with public participation activities, will provide critical input to the final design of the project. This process is part of an interactive cycle of design refinement and environmental/public assessment as required by the Government of Kenya (GoK), ensuring that the project achieves an environmentally sound and cost-effective design. The final design will incorporate mitigation measures aimed at addressing potential adverse impacts and responding to significant public concerns. These measures will include details on machinery installation, operational protocols, and comprehensive management plans.

This Environmental Assessment study was undertaken pursuant to the requirements stipulated by the National Environmental Management Authority (NEMA) under the Environmental Management and Coordination Act (1999) (amended 2015) that requires all proposed development projects listed under Schedule II of the EMCA, to undergo an Environmental and Social Impact Assessment Study to determine the potential adverse impacts of a project and thereby devising appropriate mitigation measures. The study assesses the impacts of the proposed development and proposes mitigation measures as well as an Environmental Management Plan (EMP). It was carried out through desk research, field visits, and consultations. The team conducted extensive literature review including information sourced from the internet and local communities in relation to the proposed project. During field

investigations, information on physical, ecological and socio-economic aspects of the project area and its environs were determined.

This study analyzed the potential adverse impacts of the project in terms of the possible effect to the environment and on the interested and affected parties. The study looked at the different stages of the development, namely;

- Project design;
- Project construction and equipment installation phase;
- Project operational phase involving use of the premises; and
- Project decommissioning phase.

The study examines the proposed project in terms of its components, the services it will provide to end users, and the potential impacts arising from its implementation and use. Consideration has also been given to the natural aesthetics and scenic value of the project site, with an emphasis on maintaining environmental quality while enhancing investment value.

To identify, predict, and analyze the various impacts that may result from the project, a range of study methods and tools were employed. These included checklists, matrices, expert consultations, and direct field observations. An in-depth analysis of public concerns was undertaken, incorporating the views of interested and affected parties into the development of the Environmental Management Plan (EMP). This process involved discussions and dialogue with neighboring communities and relevant lead agencies linked to the installation and operation of the proposed cement plant.

Baseline data collection was carried out through desktop studies, site visits, photographic documentation, direct interviews, and public meetings with stakeholders. Key environmental concerns identified for further investigation included:

- Incessant noise and dust levels during the construction, machinery installation, and operational phases;
- Potential air, water, soil, and visual pollution during the construction, machinery installation, and operational phases;
- Increased pressure on existing water resources during the construction and operational phases;

- Occupational health and safety hazards during construction, installation, and operational activities.

While these potentially adverse impacts are anticipated during the construction and operational phases, they are expected to be minimized through the implementation of the proposed mitigation measures. On the other hand, the project is expected to yield significant positive impacts, notably the creation of both short-term and long-term employment opportunities across various skill levels.

The impact matrix below highlights the summary of the impacts anticipated.

Impact matrix

ENVIRONMENTAL IMPACT	IMPACT TYPE								MITIGATION	
	Positive		Negative							
	Significant	Not Significant	Significant	Not Significant	Short Term	Long Term	Irreversible	Cumulative	No mitigation required	Mitigation required
CONSTRUCTION/MATERIAL INSTALLATION PHASE IMPACTS										
Soil erosion-Land degradation				x	x					x
Accumulation of solid waste storage & disposal – Waste management			x		x					x
Construction works noise – Auditory nuisance			x		x					x
Dusting – Air quality degradation			x		x					x

Equipment/vehicle maintenance – Spillage/noise/visual impacts				x	x					x
Fire outbreak – Environmental disaster			x		x					x
Construction works induced traffic – traffic congestion			X		x					x
Const. works water demand – supply depletion			x		x			x		x
Loss of terrestrial habitat & biodiversity – Degradation of bio-diversity				x	x					x
Solid waste accumulation – Environmental degradation			x		x			x		x
Materials stockpiling & storage –contamination				x	x			x		x
Impervious surfacing & paving – increased run off.			x			x				x
Sewage & litter – public health & contamination			x		x					x
Fuel & chemical spills – Soils & water contamination				x	x					x
Roadside vending – unsightliness & littering				x	x			x		x
Visual amenities - Unsightliness				x	x					x
Emergency situations – Lack of response				x	x					x
Employment	x				x			x	x	
Improved growth of economy	x					x		x	x	
Improved land value	x					x		x	x	

OPERATION PHASE IMPACTS										
	Positive		Negative						Mitigation	
	Significant	Not Significant	Significant	Not Significant	Short Term	Long Term	Irreversible	Cumulative	No mitigation required	Mitigation required
Increased infrastructural pressure – water abstraction			x			x		x		x
Pollution - Accidental Oil Spills				x		x		x		x
Pollution – Environmental degradation				x		x		x		x
Pollution – Alterations of soil property				x		x				x
Pollution – Water contamination(effluent)			x			x				x
Pollution – Air pollution & noise levels			x			x				x
Increased traffic – unnecessary congestion				x		x				x
Drain blockages – Back flooding				x		x				x
Vector and rodents breeding – Increased vulnerability to diseases				x		x		x		x
Electricity consumption – pressure on supply			x			x				x
Social amenities – Cultural interference				x						x
Natural/Manmade disasters – Environmental degradation			x		x					x

Increase in sugar production capacity	x					x			x	
Employment opportunities	x					x		x	x	
Improvement in efficient factory processes	x					x			x	
Optimal use of land	x					x			x	
DECOMMISSIONING PHASE IMPACTS										
	Positive		Negative						Mitigation	
	Significant	Not Significant	Significant	Not Significant	Short Term	Long Term	Irreversible	Cumulative	No mitigation required	Mitigation required
Solid Waste generation			x		x					x
Dust			x		x					x
Noise & vibration			x		x					x
Rehabilitation	x					x			x	
Employment opportunities	x				x				x	

Recommendations to mitigate potential negative impacts have been outlined, with particular focus on the management of air emissions, which represent a significant environmental concern in cement manufacturing. Measures will include the installation of dust suppression systems, bag filters, electrostatic precipitators, and regular monitoring to ensure compliance with national air quality standards. In addition, proper handling of by-products as well as both solid and liquid waste has been emphasized to prevent secondary pollution.

An Environmental Management Plan (EMP) has been developed to identify the areas of potential impact and to propose sustainable measures to address them. Overall, the project is considered environmentally feasible and sound. The anticipated negative impacts, particularly those related to dust and gaseous emissions, can be effectively minimized through corrective action, rehabilitation programs, and the

Acronyms

ACC	Assistant County Commissioner
BDL	Below Detection Limit
BQ	Bills of Quantities
CO	Carbon monoxide
CV	Control Valve
CVP	Continuous Vacuum Pan
DCC	Deputy County Commissioner
EAR	Environmental Assessment Report
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
FCV	Feed Control Valve
GOK	Government of Kenya
GRPF	Grooved Roller Pressure Feeder.
HP	High Pressure
KFS	Kenya Forest Service
kV	Kilo Volts
LVBC	Lake Victoria Basin Commission
LVSWR	Lake Victoria South Water Resources Management
NEMA	National Environmental Management Authority
NET	National Environmental Tribunal
NETF	National Environmental Trust Fund
NO _x	Nitrogen oxides
SO _x	Sulphur oxides

SPM	Suspended Particulate Matter
TMD	Tons Milled per Day
WRA	Water Resources Authority

CHAPTER ONE: INTRODUCTION AND SCOPE OF STUDY

1.0 Introduction

This study covers the preparation of a project-specific Environmental and Social Impact Assessment (ESIA) for the proposed construction of a cement manufacturing plant with a processing capacity of 180 tonnes per day, located along Awasi Quarry Road, off the Kisumu-Nairobi Highway on plot no: Kisumu/Border/4520,6276, 5702, & 6277, Border II Sub-Location, Awasi Location, Nyando Sub County, Kisumu County. This will ensure that the plant provides a long-term supply of high-quality cement to the local, national and regional markets. Mamba Cement Limited is a registered company incorporated under the Companies Act (Cap. 486) to run a Cement Manufacturing Plant at Awasi location, in Nyando Sub-County, Kisumu County.

Mamba Cement Limited is committed to supporting Kenya's growing demand for cement by establishing a modern cement manufacturing plant in Awasi, Kisumu County. The proposed facility will have a production capacity of approximately 180 tonnes per day and will involve the construction and installation of equipment, machinery, and associated infrastructure required for cement production.

Kisumu County is a key hub for economic and industrial development within the Lake Region. The proposed plant in Awasi will not only strengthen the local industrial base but also contribute to job creation, improved livelihoods, and regional infrastructure development. By providing a reliable supply of high-quality cement to local, national, and regional markets, the project will support ongoing construction and infrastructure growth while enhancing economic opportunities in the county.

During the operational phase, the main inputs for cement production will include limestone, pozzolana, gypsum, clinker, water, and electricity. The key by-products will include kiln dust, clinker dust, and quarry overburden, which will be managed in accordance with best environmental practices and national environmental standards.

At the decommissioning stage, measures will be undertaken to restore the site to its nearest original condition, where feasible, to ensure environmental sustainability.

This Environmental and Social Impact Assessment (ESIA), together with public participation activities, will provide essential input into the project's final design. This participatory and consultative process, as required by the Government of Kenya, will ensure that the project attains an environmentally acceptable and cost-effective design outcome.

The final design will incorporate mitigation measures to address potential adverse environmental and social impacts as well as respond to significant public concerns. These will include detailed construction protocols, machinery installation specifications, and comprehensive operations and management plans to ensure sustainability throughout the project's lifecycle.

1.1 Background and Rationale of the EIA

In compliance with the requirements of the Environmental Management and Co-ordination Act (EMCA), 2015, and the Environmental Impact Assessment and Audit (Amendment) Regulations, 2019, the proponent, Mamba Cement Limited, has commissioned the preparation of this Environmental and Social Impact Assessment (ESIA) Project Report. The environmental study was formally commissioned on 21st June 2025.

To initiate the public consultation process, a stakeholder engagement meeting was organized through the area Chief's office, targeting interested and affected parties (I&APs) most likely to be impacted by the proposed project. In addition, consultations were undertaken with relevant lead agencies and stakeholders to capture technical inputs, regulatory guidance, and community concerns for incorporation into the ESIA process.

1.2 Scope

In accordance with the Environmental Management and Coordination Act (EMCA), 1999 (Amended in 2015), every project proponent in Kenya is required to undertake an Environmental and Social Impact Assessment (ESIA) study prior to implementing any project listed under Schedule 2 of the Act. This study has therefore been undertaken to fulfil that legal requirement.

The ESIA is necessary at the planning stage of the proposed undertaking to ensure that potential environmental and social impacts are adequately considered and addressed during the design, construction, operation, and eventual decommissioning of the facility.

As part of the process, screening of the proposed project activities was carried out to identify significant environmental impacts. Key considerations included the sensitivity of the project area, public health and safety, the potential for uncertain or unknown risks, the likelihood of cumulatively significant impacts arising from individually minor activities, and proposals for solid and liquid waste management.

In addition, scoping was undertaken to identify key environmental issues of concern. This focused on assessing the significance of policy, legal, technical, economic, and social factors likely to be influenced by the project. The outcome of this scoping exercise informed the scope and depth of this ESIA study.

1.3. Terms of Reference (NEMA/ENVIS/EIA/TOR/00177)

The Terms of Reference (ToR) for this Environmental and Social Impact Assessment (ESIA) have been developed in line with the Environmental Impact Assessment and Audit Regulations of June 2003 (as amended in 2019). The ToR were duly submitted to the National Environment Management Authority (NEMA) and subsequently approved, thereby providing the framework for the conduct of this study.

1.4 Methodology

After preliminary visits to the proposed site, the following were carried out in the preparation of this document:

- i) Observations, discussions with stakeholders and lead agencies
- ii) Documentary review of the nature of the proposed project;
- iii) Policy and legal frameworks, social and environmental setting of the area;
- iv) Checklists were prepared to identify possible environmental and human safety issues, photography, etc;
- v) Review of the project designs and implementation plans and comprehensive discussions with the project proponent;
- vi) Report writing

CHAPTER TWO: PROJECT DESCRIPTION

2.0 Project Location

This report covers the preparation of a project-specific Environmental and Social Impact Assessment (EIA) for the proposed construction of a cement manufacturing plant on plot no: Kisumu/Border/4520,6276,5702 & 6277 Border II Sub-Location, Awasi Location, Nyando Sub County, Kisumu County. Specifically, on GPS coordinates latitude -0.175294 and longitude 35.116189.

The proposed project site is close to other industrial establishments noticeably, Prime Steel Mills, Rai Cement factory, Stone Field quarry. It sits on a total area of about 5 acres.

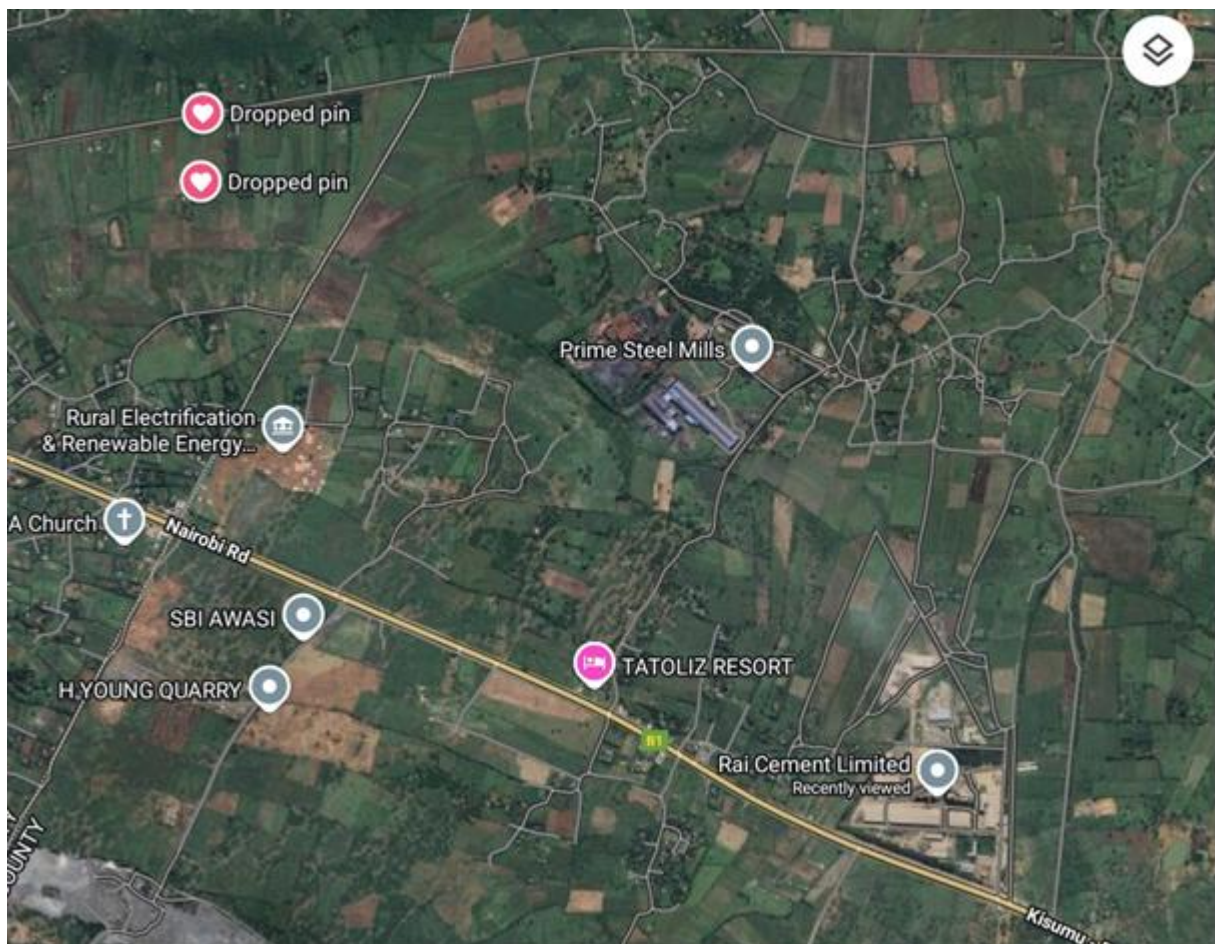


Plate 1: Google earth maps, 2025

2.1 Project Objectives

Mamba Cement Limited is a registered company incorporated under the Companies Act (Cap. 486) of Kenya to establish and operate a cement manufacturing plant at Border II Sub-Location, Awasi Location, Nyando Sub-County, Kisumu County. The proposed plant will provide a sustainable, long-term supply of high-quality cement to local, national, and regional markets.

The company's core operation will focus on the production of cement, with a vision of becoming a premier producer in the sector. Mamba Cement Limited is committed to achieving this while continually pursuing sustainable growth, environmental stewardship, and profitability.

2.2. Project Implementation

The project will be implemented in four phases: design, construction & equipment installation, operation and decommissioning.

2.2.1. Design Phase

This phase represents the conceptualization of the planned development and the design of a cement manufacturing facility that is both functional and environmentally sustainable. The proposed plant has been designed to address key environmental considerations, including the management of liquid and solid waste, air emissions, occupational health and safety, and site security.

The production process has been carefully planned to ensure high efficiency, reduced energy consumption, and continuous, reliable operation. The plant design philosophy is based on modern technology and best practices, with particular attention given to minimizing air pollution, conserving water resources, and maximizing energy efficiency.

The main parameters forming the basis of the design philosophy include:

Normal Production Capacity	180 tonnes of cement per day (TPD), operating on a 24-hour basis.
Raw Material Inputs	Limestone, pozzolana, gypsum, and clinker of consistent quality and supply.

Energy Requirements	Electricity supply (3-phase, 50 Hz AC) and standby diesel generators for reliability.
Process Instrumentation	Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) systems powered at 24V DC for process automation and efficiency.
Cooling and Process Water Quality	Water sourced and treated to meet process specifications, maintained at ambient temperature to avoid scaling and corrosion in machinery.
Pollution Control Systems	Installation of bag filters, dust collectors, and electrostatic precipitators to ensure emissions comply with NEMA and international air quality standards.

Tables providing technical data on the proposed kiln system, fuel requirements, and utility specifications has been included to guide the final plant design and operations.

Table 2.1: Grinding / Milling Process Specifications

Parameter	Specification (Indicative)	Notes
Ball mill Type	Closed Circuit Ball mill	Most common for modern plants
Capacity	150–180 t/day Cement produced	Adjust based on project design
Ball mill Dimensions	2.5 m dia × 12 m	Varies with supplier
Classifier system	Dynamic Classifier Capacity 10–13 TPH	Energy efficient
Bucket Elevator	Height 12 m, 7.5 hp motor	
Conveyor system	U-troughed Screw feeder for ball-mill out	dia 1.2 × 1.2 m
Dust Collection	Bag filters/ESP 24.5 m ²	For PM control – Pneumatic Cleaning

Table 2.2: Fuel and Power Analysis

Parameter	Requirement/Consumption	Notes
— (removed)	—	—
Power Requirement	~90–110 kWh/ton cement	Depending on grinding efficiency
Power Source	National Grid + Captive Generator + Solar (optional)	Hybrid power security
— (removed)	—	—

Table 2.3: Utility Requirements

Utility	Estimated Requirement	Notes
Water (Process & Cooling)	0.2–0.3 m ³ /ton cement	Recycled & treated
Water (Domestic)	~50–100 m ³ /day	For staff facilities
Compressed Air	6–8 bar	For kiln and plant instruments
Cooling System	Closed loop cooling tower	To minimize water use
Raw Materials	Limestone, Clay, Gypsum, Pozzolana, Additives	Locally sourced
Storage Facilities	Silos for clinker & cement (50–100 tons capacity)	Dust-proof silos with Dust Collection

2.2.2. Construction and equipment installation Phase

This phase will be based on the building standards, code and all other relevant regulations applicable in Kenya. All the proposed works will follow standard environmental guidelines, health and safety measures.

2.2.2.1. Construction & Equipment installation Activities

i. Construction activities

This will involve construction of building walls, foundation, floor pavement, and drainage system to provide support and shelter for the equipment to be installed. The masonry works will include concrete mixing, plastering, slab construction, construction of foundations, and curing of fresh concrete surfaces. These activities are labour - intensive but will be supplemented by machinery such as concrete mixers and compactors.

Roofing activities will include laying of iron sheets, and structural steel to the roof and fastening the roofing materials to the roof. While electrical work during both construction and operation will involve installation of electrical gadgets and appliances including electrical cables, lighting apparatus, sockets etc.

The administrative offices will be the nerve center of the cement manufacturing facility, responsible for strategic planning, documentation, compliance management, procurement coordination, and personnel supervision. These offices will host key personnel such as the plant manager, safety officers, human resources, finance, and environmental officers. All records related to production schedules, safety audits, environmental monitoring, and maintenance are maintained here. The offices will be typically constructed to standard commercial building specifications, with necessary utility connections such as power, water, internet, and sanitation. From an ESIA perspective, this section will contribute to employment and administrative order but also present minor environmental concerns such as waste paper generation, water usage, and electricity consumption.

The project proposes to construct and install the following equipment and machinery:

- | | | |
|----|-------------------------------|---|
| 1. | Primary Crusher Plant | Jaw and impact crushers for limestone and other raw material size reduction. |
| 2. | Raw Material Handling System | Conveyors, feeders, and storage bins for limestone, clay, and additives. |
| 3. | Cement Mill & Preheater Plant | Ball Mill for grinding raw materials and multi-stage cyclone preheater with a Classifier. |

4. Cement Grinding Plant Ball mill with Classifier for cement grinding and blending.
5. Clinker and Cement Enclosed silos with dust extraction systems.
Storage Silos
6. Dust Collection and Air Bag filters, electrostatic precipitators, and stack
Pollution Control Units monitoring systems.
7. Water Supply and Storage tanks, pumps, and treatment facilities for
Treatment Plant process and domestic use.
8. Effluent Management Sedimentation tanks, oil-water separators, and
System wastewater recycling units.
9. Power Supply and Substations, transformers, switchgear, and backup
Distribution System generators.
10. Workshops and For servicing of plant and equipment.
Maintenance Facilities
11. Administration Block, For management, security, and operational staff.
Offices & Laboratory
12. Weighbridge and Access For raw material and product transport logistics.
Roads
13. Safety and Firefighting Fire hydrants, extinguishers, alarms, and emergency
Infrastructure assembly areas.

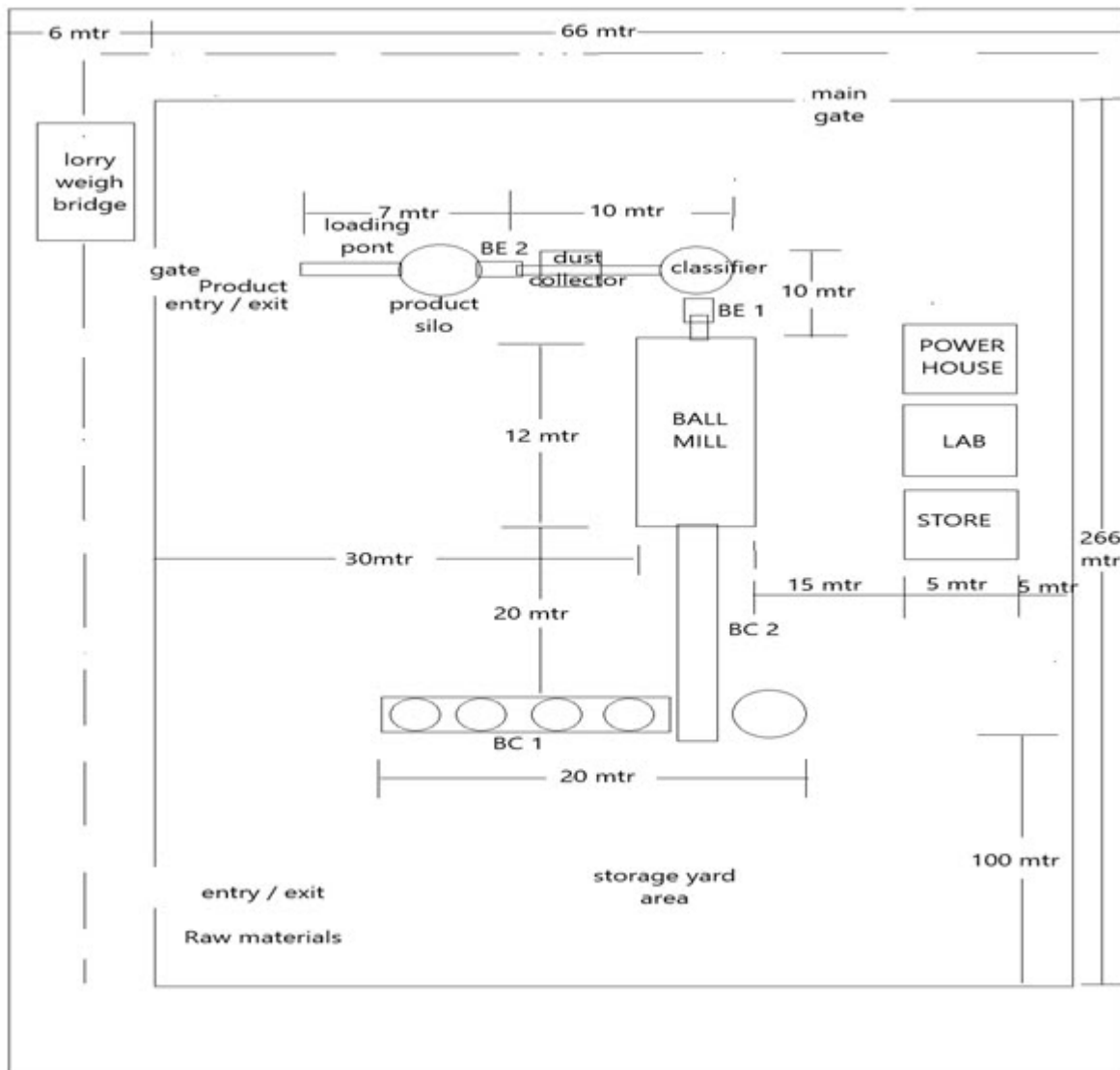


Plate 2: Proposed project layout

2.2.2.2. Equipment and specifications

2.2.2.2.1. Weighbridge

The weighbridge will be a critical infrastructure for logistical and inventory control. It shall be installed at the plant entrance or near the raw material intake point, it will facilitate the accurate weighing of inbound raw materials like pozzolana, gypsum, and limestone, as well as outbound finished cement. This system will be computerized and will help maintain transparency in material accountability and taxation. Environmental considerations around the weighbridge include possible dust from open trucks and minor noise from vehicle operations. Dust suppression mechanisms and designated parking zones will help minimize such impacts.

2.2.2.2.2. Product Silo

The product silo serves as a vertical storage unit for the final cement product before it is bagged or loaded in bulk. These silos will be made of reinforced concrete or steel and equipped with aeration systems, pressure relief valves, and filters to control dust. The silo ensures a steady supply of cement for packaging and dispatch operations, minimizing production downtime. From an environmental perspective, potential risks include fugitive dust emissions during filling and emptying operations, which will be mitigated by enclosed systems and high-efficiency filters.

2.2.2.2.3. Dust Collector

Dust collectors will be installed at various dust-emitting points throughout the plant, especially near grinding units, conveyors, classifiers, and silos. These systems will play a vital role in ensuring compliance with air quality standards by capturing particulate matter generated during the cement manufacturing process. The dust collector will use bag filters, cyclones, or electrostatic precipitators. Proper handling and disposal of collected dust and regular maintenance of the filtration units will be key to avoiding secondary pollution and occupational health hazards.

2.2.2.2.4. Classifier

The classifier will be integrated with the milling section and is responsible for separating fine cement particles from coarser ones. It will ensure that only appropriately sized particles proceed to packaging, while oversized materials are returned to the mill for reprocessing. This improves product quality and efficiency. Environmental concerns linked to the classifier include noise and dust emissions, which will be addressed through acoustic enclosures and dust extraction systems. Operational control measures are necessary to prevent overloading and ensure optimal separation efficiency.

2.2.2.2.5. Ball Mill

The ball mill is the primary grinding unit in the cement production process. It is a large cylindrical rotating device loaded with steel balls that crush and grind the raw materials; limestone, gypsum, pozzolana, and additives into fine powder. The grinding process is energy-intensive and will operate continuously. The ball mill is typically enclosed in a soundproof and dust-controlled structure. Noise pollution, heat generation, and dust are key concerns that will

require engineering controls like insulation, lubrication, and environmental management systems.

2.2.2.2.6. Power House

The powerhouse will supply electrical energy to the entire cement manufacturing plant. It will be connected to the national grid and also to operate a dedicated generator system, especially in times of power blackouts. It will power critical components such as the ball mill, classifier, dust collectors, lighting, and laboratory equipment. The powerhouse will be equipped with transformers, switchgear, and backup power systems. Environmental considerations include fuel storage and handling, emission controls for generators, noise insulation, and energy efficiency strategies to reduce the carbon footprint.

2.2.2.2.7. Chemical Room

The chemical room will store reagents and solutions used in the testing and quality assurance processes. It will house acids, bases, solvents, and calibration standards, which are used for chemical analysis of cement composition and quality. The room will be designed with ventilation systems, fire safety equipment, spill containment mechanisms, and secure shelving. Proper handling, labeling, and disposal protocols will be followed to mitigate chemical exposure risks, environmental contamination, and fire hazards.

2.2.2.2.8. Humidity Cabinet Room

The humidity cabinet room is a controlled environment used to store and condition cement samples for performance testing under specified humidity and temperature conditions. It will ensure that samples are preserved in a consistent state, which is essential for reliable compressive strength and durability tests. The room will be air-conditioned with humidity control devices and is part of the broader quality assurance infrastructure. The environmental footprint is low, with electricity consumption being the primary concern.

2.2.2.2.9. Sample test room

The sample test room will be a specialized laboratory where physical and chemical analyses of cement samples are conducted. Standard tests include fineness, setting time, soundness, and compressive strength. The room will be fitted with precision equipment such as vicat apparatus, compression testing machines, blaine air permeability devices, and balances. Trained personnel

will operate under standardized procedures to ensure quality control. Proper lab waste disposal and PPE use will be essential to minimize occupational and environmental risks.

2.2.2.2.10 Curing tank

The curing tank will be used for storing cement specimen molds in water at a controlled temperature to simulate curing conditions. This setup is essential for compressive strength testing at various intervals (e.g., 3, 7, and 28 days). The tank will typically be made of reinforced plastic or steel and equipped with heating elements and thermostats to maintain desired temperatures. From an ESIA perspective, the curing tank has minimal environmental impact, but regular monitoring of water quality and proper drainage systems is advised to prevent stagnation and bacterial growth.

2.2.2.2.11. Store

The store will be a secure facility used to hold spare parts, maintenance tools, personal protective equipment, and consumables necessary for plant operations. It will hold packaging materials like cement bags, pallets, and sealing units. The store will be organized to ensure easy access, inventory tracking, and fire safety. Environmental issues such as packaging waste, pest control, and proper lighting will be managed through housekeeping protocols and inventory control measures.

2.2.2.2.12. Effluent Management

Sedimentation tanks at the Mamba Cement Manufacturing Plant in Awasi will be used as the primary stage of effluent treatment. Wastewater generated from raw material handling areas, surface runoff, equipment washing bays, and cement transfer zones will be directed into these tanks. Here, suspended solids such as cement particles, dust, and other fine materials will be allowed to settle naturally through gravity. This process reduces turbidity and prevents excessive solid loads from entering downstream systems. The accumulated sludge will be periodically removed and handled appropriately, while the clarified water will be channelled to the next treatment step.

Oil–water separators will be installed to manage effluent originating from workshops, fuel and lubricant storage areas, heavy machinery parking bays, and maintenance zones. These units will capture petroleum-based contaminants, including oils, greases, and hydrocarbons that may

accidentally mix with stormwater or wash-water. Through gravity separation and coalescing mechanisms, the separators ensure that oils rise to the surface for skimming and collection. The recovered oil will be stored in designated containers and disposed of through licensed waste handlers. This prevents the release of harmful hydrocarbons into the surrounding environment and protects watercourses from contamination.

After removal of solids and oils, the partially treated wastewater will be channelled into wastewater recycling units to promote water conservation within the plant. These units will incorporate filtration and conditioning processes that further purify the water, making it suitable for reuse in various non-potable applications. Recycled water will be utilized for dust suppression on internal roads, equipment cleaning, cooling operations, and landscaping, thus reducing reliance on freshwater sources. Any excess water that meets the required discharge standards will be safely released through a designated outlet, ensuring adherence to NEMA guidelines. Through this integrated system, the plant will effectively manage effluent while minimizing environmental impact and enhancing operational efficiency.

Key numbers

1. Estimated average raw wastewater: 20 m³/day (process + dust + cooling + workshops + domestic + stormwater)
2. Design flow (20% contingency): 24 m³/day
3. Equalization tank: $\approx 24 \text{ m}^3$ (≈ 1 day storage)
4. Sedimentation: 2 tanks $\times 18 \text{ m}^3$ each (total 36 m³) — ~ 4 hours retention at peak design flow
5. Oil–water separator: $\approx 0.08 \text{ m}^3$ (designed for short peak retention for workshop/runoff)
6. Polishing / filtration & recycle storage: $\approx 12 \text{ m}^3$ (buffer and recycle storage; supplies dust suppression, cleaning, cooling)
7. Sludge generation: $\approx 0.20 \text{ m}^3$ /day, 30-day sludge storage $\approx 6 \text{ m}^3$

2.2.3. Operation Phase. (The Cement Making Process Description)

The proposed cement manufacturing plant will adopt a dry, non-kiln grinding and blending process, centered around the efficient utilization of outsourced raw materials to produce environmentally friendly green cement. The core of the process involves the mechanical grinding of pozzolana, which is delivered to the site in sizes ranging between 0 – 50 mm.

Pozzolana is a siliceous or siliceous-aluminous material, typically sourced from natural volcanic ash deposits or industrial by-products like calcined clay or fly ash. It has cementitious properties when combined with calcium hydroxide and water, making it an ideal material for reducing the reliance on energy-intensive clinker in cement production. Upon arrival, the pozzolana is stored in covered stockpiles to prevent contamination and moisture absorption before being fed into the grinding system.

Limestone and gypsum are the other key raw materials, both of which will be sourced from certified suppliers and transported to the plant. Limestone once heated converts to clinker. Clinker is a hard, nodular material produced in rotary kilns at high temperatures in conventional cement plants. It contains primary compounds such as tricalcium silicate and dicalcium silicate, which are responsible for the strength characteristics of cement. Gypsum, on the other hand, is added in small quantities; typically, around 3-5% to regulate the setting time of cement and prevent flash setting. All materials are conveyed in controlled proportions to the grinding mill, where they undergo fine grinding to achieve a homogeneous blend.

In line with global best practices for sustainable cement production, the project will incorporate the use of specialized cement additives. These additives ranging from performance-enhancing chemicals to supplementary cementitious materials such as slag or limestone serve to optimize the performance of the final product while significantly reducing the clinker factor. This results in the production of green cement, characterized by lower embodied carbon, reduced energy input, and improved durability. The blending of additives is carefully calibrated to maintain high performance standards while promoting environmental sustainability and resource conservation.

Dust emissions, a common challenge in dry cement production processes, will be comprehensively managed through the installation of high-efficiency dust collection systems.

These systems, which include bag filters and enclosed conveyors, are strategically placed at critical points such as material unloading areas, grinding mills, and transfer points. Captured dust is collected and reintegrated into the production cycle, ensuring zero waste generation. Notably, the process is designed to operate without producing any solid or liquid by-products, making it a clean and resource-efficient solution aligned with modern environmental management standards.

2.3. Raw Material Sourcing

Pozzolana, limestone, and gypsum constitute the key raw materials required for the proposed cement production activities. Mamba Cement Limited intends to outsource these materials exclusively from quarries and suppliers that are duly licensed and approved by the National Environment Management Authority (NEMA) and the relevant mining authorities. By procuring only from certified suppliers, the company will ensure that the entire supply chain remains compliant with Kenyan environmental laws and regulations, while also safeguarding against the risks associated with illegal or unregulated quarrying. Each supplier will be required to provide valid quarry licences, NEMA approvals, and evidence of approved rehabilitation and closure plans before any procurement contracts are signed. This approach strengthens accountability and traceability from source to plant.

In line with the Environmental Management and Coordination Act (EMCA) and the Environmental Impact Assessment and Audit Regulations, Mamba Cement Limited will ensure that its operations and supply chain conform to legal requirements governing quarrying, mineral transportation, and processing. The Air Quality Regulations further require strict management of dust and emissions, both during transport and at the processing facility. Licensed transporters with valid commercial vehicle licences will be engaged to deliver the raw materials to the site. All trucks will be required to secure and cover loads with tarpaulins to prevent spillage, operate along designated haul routes to minimize disruption to local communities, and observe strict road safety protocols.

Environmental and social impacts are anticipated at both the quarry sites and along the transportation routes. Potential impacts include land degradation, dust emissions, noise and vibration from quarry operations, increased traffic along local roads, and associated safety concerns. By sourcing from NEMA-approved quarries, these risks are significantly reduced, as

such sites are expected to implement dust suppression, water management, and progressive rehabilitation measures. Transportation-related risks will be mitigated by enforcing covered loads, route management, wheel-wash facilities at plant entry points, and spill-response protocols. Within the plant, material handling and storage will be managed through enclosed transfer points, fabric filters, and water-spray systems to control fugitive dust emissions, while noise will be minimized through the use of silencers and enclosed machinery.

From a social perspective, Mamba Cement Limited will put in place a stakeholder engagement plan to maintain continuous communication with communities along haul routes and within the project's area of influence. A grievance redress mechanism will also be established to provide timely responses to any complaints raised by local residents. Additionally, the company will maximize opportunities for local employment and procurement to offset potential negative impacts associated with increased truck traffic and industrial activity.

Overall, by outsourcing pozzolana, limestone, and gypsum from NEMA-approved quarries and transporting them in line with national regulations, Mamba Cement Limited will not only comply with the law but also proactively mitigate environmental and social risks. This strategy significantly reduces the likelihood of non-compliance, community grievances, and reputational damage, while demonstrating the company's commitment to sustainable and responsible cement production.

2.4. Transport plan

The proposed cement plant will rely on an efficient and well-managed transportation system for both raw materials (pozzolana, limestone, gypsum, and additives) and finished products (green cement). The plant is accessible from the Kisumu–Nairobi highway, branching off at CEABUD Quarry (locally known as Gogni Quarry) and proceeding past Stonefield Quarry along an earth-graded access road. This route will serve as the main entry and exit corridor for heavy commercial vehicles (HCVs) delivering raw materials to the plant and for trucks transporting finished cement products to markets.

Raw Material Transport:

Raw materials will be sourced from NEMA-approved and licensed quarries and transported to the site using covered tipper trucks and flatbed lorries operated by licensed transporters. The

trucks will travel primarily along the Kisumu–Nairobi highway and then use the designated branch road to the project site. Loads will be securely covered with tarpaulins to prevent dust emissions and spillage during transit. The vehicles will be subject to routine inspection for roadworthiness, and drivers will undergo safety training to ensure compliance with traffic regulations and occupational health and safety standards.

Finished Product Transport:

The finished cement will be packaged at the plant and dispatched in bulk tankers or palletized bags for distribution to local and regional markets. Transportation will mainly be via the Kisumu–Nairobi highway, which connects to major distribution centers and regional markets. To ensure safe handling, cement bags will be shrink-wrapped and secured to prevent tearing and product loss during loading, transit, and unloading. Bulk tankers will be sealed to eliminate spillage and moisture ingress.

Potential Risks and Impacts:

- i. **Dust and Air Quality:** Uncovered or poorly secured loads of pozzolana and limestone may generate fugitive dust along haul routes, contributing to air pollution and nuisance to roadside communities.
- ii. **Traffic Congestion and Road Safety:** Increased movement of heavy trucks along the Kisumu–Nairobi road and the earth access road may lead to congestion, increased accident risks, and conflicts with other road users, including pedestrians, boda-boda operators, and livestock.
- iii. **Noise and Vibration:** Heavy vehicles may generate noise and vibration, particularly when passing through settlements or operating at night.
- iv. **Soil Erosion and Road Damage:** The use of the earth-graded road, particularly during rainy seasons, may accelerate road degradation, cause rutting, and contribute to erosion.
- v. **Spillage and Littering:** Poorly loaded or unsecured raw materials and cement bags may spill along the route, leading to environmental degradation and increased operational costs.
- vi. **Community Health and Safety:** Increased truck traffic exposes roadside communities to risks of accidents, respiratory challenges due to dust, and potential disruption of daily activities.

Mitigation Measures:

- i. **Dust Suppression:** Ensure all trucks carrying raw materials are fully covered with tarpaulins. Enforce strict prohibition of overloading. Water spraying along the earth access road during dry and windy conditions will reduce dust generation.
- ii. **Traffic and Road Safety Management:** Implement a traffic management plan, including route scheduling to avoid peak hours, speed limits (particularly near settlements), and road signage at critical points. Drivers will undergo periodic safety training, and defensive driving will be emphasized. Coordination with local authorities and communities will help ensure safety awareness along haul routes.
- iii. **Noise Control:** Restrict night-time haulage to minimize disturbance to nearby communities. Regular vehicle maintenance will also reduce noise and vibration levels.
- iv. **Road Maintenance and Erosion Control:** Collaborate with the county government and quarry operators to maintain and grade the access road periodically, especially after rainy seasons. Install proper drainage structures such as culverts and side drains to reduce erosion.
- v. **Spillage Prevention:** Standard operating procedures (SOPs) will be developed for material loading, securing, and unloading to minimize loss in transit. Regular inspections will be carried out at loading points before departure.
- vi. **Community Engagement:** Establish a grievance redress mechanism for local residents to report transport-related disturbances or accidents. Conduct regular awareness campaigns in collaboration with local leaders on traffic safety and environmental stewardship.
- vii. **Monitoring:** The transport system will be incorporated into the Environmental and Social Management Plan (ESMP), with monitoring indicators covering air quality, traffic incidents, road condition, and community feedback.

2.5. Decommissioning Phase

At the end of the construction phase, all the equipment and waste materials from the construction/equipment installation will be removed from the site. The materials that can be reused will be separated and used for other construction work and others disposed of appropriately. The areas not intended for parking of vehicles will be landscaped and planted with beautiful vegetation to improve the aesthetics of the surrounding.

CHAPTER THREE: BASELINE INFORMATION

3.0 Project Location

Herein, the location of the area and characteristics of the proposed site and its neighborhood in terms of; Climate: hydrology and meteorology, Soils, Geology, Vegetation Type(s) within the project area, Current land use of the project site and adjacent properties; have been discussed.

3.1 Position and Size

Awasi is a small but growing market and administrative town in Nyando Sub-County, Kisumu County, located inland from the southern shore of Lake Victoria along the Kisumu–Nairobi transport corridor. The town centre is commonly mapped at approximately 0°10' South, 35°05' East (decimal: -0.1677, 35.0824 WGS84), with elevation ranging between 1,200–1,300 m above sea level.

The proposed cement manufacturing plant by Mamba Cement Limited is located on Plot Nos: Kisumu/Border/4520, 6276, 5702 & 6277 (Border II Sub-Location, Awasi Location, Nyando Sub-County, Kisumu County). The precise georeferenced coordinate for the site is Latitude – 0.175294, Longitude 35.116189 (WGS84). This point lies approximately 3.9 km east-southeast (bearing $\approx 103^\circ$) of the mapped Awasi town centre.



Plates 3 & 4: Neighbouring quarries and access road

The site is accessed via the Kisumu–Nairobi highway, branching at CEABUD (Gogni) Quarry, and proceeding past Stonefield Quarry along an earth-graded road before reaching the project

plots. Its placement within the Nyando River catchment and on the eastern edge of the Lake Victoria lowland makes it geographically significant for both transport and ecological considerations.

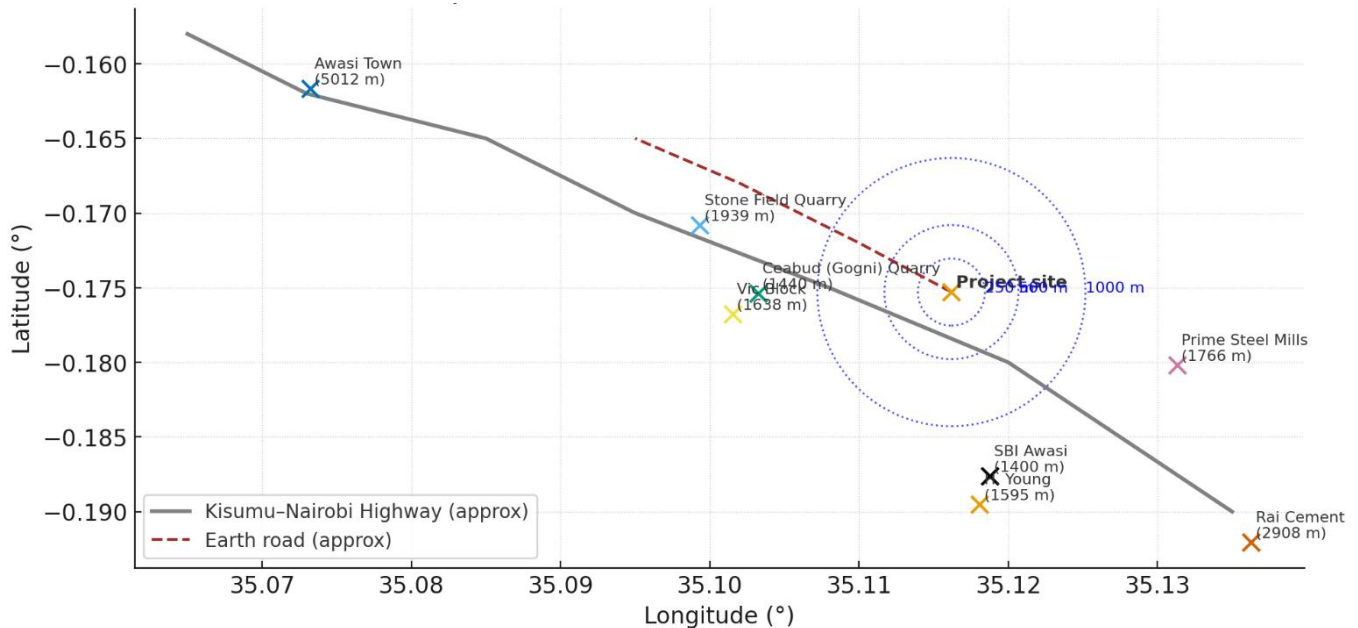


Plate 5: Schematic map of project site

3.2. Ecological Conditions

Awasi is situated on the eastern edge of the lower Nyando River floodplain within the Lake Victoria basin and lies along the Kisumu–Nairobi corridor. The locality forms part of the broader Kano–Nyando lowland system: a gently sloping landscape that drains to the Nyando River and ultimately into Lake Victoria. The area includes a mosaic of agricultural fields, emerging urban and peri-urban settlements (Awasi town), quarry sites and strips of seasonally inundated wetlands and riparian habitats close to the river and lakeshore wetlands. This landscape configuration makes Awasi an ecotone between upland agricultural/settlement land uses and the extensive lacustrine wetland system downstream.

The climate in Awasi is characteristic of the Lake Victoria basin — warm and humid with a bimodal rainfall regime. Long rains typically occur March–May and short rains October–December, although inter-annual variability and extreme events (floods and droughts) have increased in recent decades. These climatic patterns control river flow, wetland inundation cycles and agricultural calendars, and they are central to hydrological risk in the Nyando

floodplain (flooding during peak rains and low baseflows during dry seasons). Climate variability is a key contextual factor for ecosystem functioning and project risk assessment.

Hydrologically, Awasi forms part of the Nyando River catchment which drains a large upland area into the Lake Victoria floodplain. The Nyando wetland complex downstream has dynamically changed in extent and form over the past decades, with documented enlargement and contraction linked to sedimentation, river migration and human conversion. The wetland network near the river mouth comprises papyrus-dominated marshes, floating and emergent vegetation mats, and shallow open-water channels that are critical for attenuating floods, trapping sediments and maintaining baseflows into Lake Victoria. Groundwater–surface water interactions are important locally and influence the availability of water in shallow wells and springs used by communities.

Soils and geomorphology across the Awasi–Nyando corridor range from alluvial clay and silty deposits in the floodplain to more drained loamy soils on slightly elevated surfaces. The alluvial soils of the wetlands are nutrient-rich and have historically supported wetland agriculture and papyrus harvesting, while upland fields and smallholder farms cultivate rice, maize, vegetables and small-scale cash crops. The basin is also a major source of sediments; erosion in the uplands and along river channels contributes to siltation downstream, altering wetland form and function. Geological features associated with local quarrying (limestone/volcanic deposits) are present in the area and have influenced local land use.

Ecosystem services supplied by the Awasi–Nyando system are substantial: flood regulation and water retention during peak rains; sediment trapping and water quality filtration before water reaches Lake Victoria; provisioning services such as papyrus reeds, fish, natural materials and water for domestic/irrigation needs; and cultural and livelihood benefits linked to artisanal fishing, reed crafts and small-scale agriculture. These services are critical to local livelihoods and regional ecological integrity.

3.3.Climate

Awasi lies in the Lake Victoria basin in Nyando Sub-County (Kisumu County) at roughly ~1,200–1,300 m asl, and experiences a warm, humid, tropical climate typical of the Lake Victoria lowlands. Mean annual temperatures are moderate (generally about 21–23°C) with

daily/seasonal ranges roughly from the high teens to the low-30s °C depending on the month. Rainfall is abundant and distributed throughout the year with a bimodal pattern: the long rains occur March–May (peak rainfall typically in April/May) and a shorter rainy season falls October–December; the June–August period is comparatively drier but not arid. Annual precipitation in the Kisumu/Awasi area is substantial (order of magnitude ~1,200–1,400 mm per year in most climatologies), and monthly rainfall can be heavy during peaks (intense convective storms are common in the wet seasons). Lake Victoria strongly moderates temperatures and contributes to humidity, local lake-breeze circulations and convective rainfall formation, so conditions are generally humid and cloudy much of the year.

Climate variability and change are important considerations for the Awasi area. Kisumu County climate assessments indicate a trend of rising average temperatures and increasingly unpredictable rainfall patterns, with the risk of intense storm events and localized flooding in low-lying areas. These conditions necessitate that the proposed cement factory be designed and operated in a climate-resilient manner.

Potential Climate-Related Impacts of the Project

The warm and wet conditions present both opportunities and risks for the project. On one hand, reliable rainfall supports local water recharge and availability for industrial use, while the relatively moderate temperatures reduce the risk of overheating in plant operations. On the other hand, heavy rainfall events pose risks of soil erosion, flooding of earth access roads, and sediment-laden runoff, particularly during the construction phase. Prolonged wet seasons could slow down earthworks and masonry, while drier months may result in increased dust generation from quarrying and transportation activities. Climate change may exacerbate these risks by increasing the frequency and severity of extreme weather events.

Proposed Climate-Sensitive Mitigation Measures

To minimize these risks, the following measures will be integrated into project design and implementation:

- **Storm water and Drainage Management:** Installation of lined drainage channels, sediment traps, and retention basins to handle peak storm water flows and reduce flooding risks on-site.

- **Soil Erosion Control:** Scheduling of heavy earthworks outside peak rainfall months, use of gabions, grassing, and mulching to stabilize exposed soil surfaces.
- **Dust and Air Quality Management:** Water spraying on haul roads during dry months, use of covered conveyors and enclosed crushers to limit dust emissions.
- **Flood Risk Management:** Site planning to avoid construction in low-lying or flood-prone areas and reinforcement of access roads with proper camber and culverts to remain passable during rains.
- **Water Efficiency:** Adoption of water recycling systems within the factory to safeguard against variability in water supply during prolonged dry spells.
- **Climate-Proofing Infrastructure:** Designing factory buildings, warehouses, and utilities with durable materials and adequate roof drainage to withstand intense rainfall events.

3.3.1. Rainfall Profile

Awasi, located in Nyando Sub-County of Kisumu County, experiences high and frequent rainfall typical of the Lake Victoria Basin. The area records an annual average of about 1,768 mm spread across nearly 301 days of the year, meaning rainfall is experienced almost daily. The rainfall regime follows a bimodal pattern, with the long rains from March to May and the short rains from October to December. Even in the so-called dry months, measurable precipitation still occurs, ensuring no completely dry season.

The peak rainfall months are April and May, averaging 246 mm and 233 mm respectively, with more than 28 rainfall days each month. These periods are marked by intense convective storms, high soil saturation, and potential flooding risks, especially in low-lying plains around Awasi and downstream areas. The short rains in October and November also bring significant rainfall, averaging 170 mm and 166 mm respectively, with over 28 rainy days each month. In contrast, January and February are relatively drier, recording 66 mm and 48 mm on average, making them suitable windows for construction activities. July is moderately wet, but rainfall increases again in August and September before the onset of the short rains.

The frequency of rainy days is remarkably high, with most months experiencing rainfall on 25–30 days. This implies that the ground remains persistently wet, limiting continuous dry spells and presenting challenges for construction, quarrying, and transportation. The high

number of rainy days increases the likelihood of soil erosion, surface runoff, and sediment transport into nearby watercourses. These climatic conditions underscore the need for well-designed stormwater management systems and erosion control measures for industrial projects such as the proposed cement factory.

Table 3.1: Rainfall in Awasi / Kisumu Area: Detailed Overview

Month	Average Rainfall (mm)	Rainfall Days
January	~ 66 mm	~ 14.3 days (Weather Atlas)
February	~ 48 mm	~ 13.6 days (Weather Atlas)
March	~ 138 mm	~ 21.2 days (Weather Atlas)
April	~ 246 mm	~ 28.2 days (Weather Atlas)
May	~ 233 mm	~ 30.1 days (Weather Atlas)
June	~ 144 mm	~ 27.3 days (Weather Atlas)
July	~ 108 mm	~ 28.2 days (Weather Atlas)
August	~ 166 mm	~ 28.7 days (Weather Atlas)
September	~ 140 mm	~ 27.5 days (Weather Atlas)
October	~ 170 mm	~ 29.2 days (Weather Atlas)
November	~ 166 mm	~ 28.1 days (Weather Atlas)
December	~ 143 mm	~ 24.5 days (Weather Atlas)

From an environmental and operational standpoint, the heavy and frequent rainfall has both opportunities and challenges. On one hand, abundant rainfall can be harnessed for water harvesting and supply, reducing dependence on groundwater or external water sources. On the other hand, intense rainfall events demand robust drainage systems, flood-risk management strategies, and road maintenance interventions to safeguard project infrastructure and ensure continuity of operations. Construction activities such as earthworks, excavation, and masonry are best scheduled during the relatively drier months of January–February or mid-year windows when rainfall is less intense.

Incorporating climate-sensitive planning is therefore essential. Drainage channels, sediment traps, and retention basins must be sized to handle peak stormwater flows. Erosion control strategies such as grassing, mulching, and use of gabions should be employed on exposed surfaces. Access roads, especially earth roads, require reinforcement with culverts and camber to remain passable during the rains. Furthermore, adaptive monitoring of rainfall trends on-site will allow timely adjustments to project operations in response to shifting rainfall patterns, which are expected to intensify under climate change.

3.3.2. Temperature Profile

Awasi experiences a warm tropical climate moderated by its location within the Lake Victoria Basin at an elevation of about 1,200–1,300 meters above sea level. Average annual temperatures range between 21–23°C, with only slight seasonal variation due to the equatorial position and the regulating influence of Lake Victoria.

The warmest months are generally February and March, when mean daily maximum temperatures reach 30–31°C, and daily minimums average 18–19°C. These months often coincide with the end of the drier season, leading to hot and sometimes humid conditions. April to June records slightly cooler conditions (daily maximums of about 27–28°C) due to heavy cloud cover and rainfall during the long rains, while night temperatures remain relatively mild.

The coolest months are typically July and August, when mean daily maximums average 26–27°C and minimums dip to about 17–18°C. This is attributed to increased cloudiness and cool breezes influenced by the lake and the regional wind systems. From September to December, temperatures gradually rise again, with maximums stabilizing at 28–30°C during the short rains season.

Overall, Awasi's temperature regime is described as moderately warm with minimal extremes. Daily temperature fluctuations (diurnal range) are usually about 10–12°C, creating relatively comfortable conditions for both human activities and industrial operations. The absence of very high or very low temperatures makes the area suitable for year-round industrial operations, such as cement manufacturing, with minimal risk of climate-related shutdowns due to heat stress.

From a project planning perspective, temperature influences several operational aspects. High temperatures during February–March can lead to increased dust emissions from exposed soils and quarrying activities, requiring enhanced dust suppression measures. Cooler and wetter months (April–June, October–December) may reduce dust risks but can increase challenges with soil stability and construction curing times for concrete and masonry. For worker health and safety, temperatures are within tolerable limits, though hydration measures and shaded rest areas should be provided during hotter months.

In terms of climate change, Kisumu County reports indicate a gradual rise in mean annual temperatures, with projections of +1.5°C to +2.0°C by 2050. This warming trend may increase evaporation rates, alter water availability, and heighten heat-related stress for both workers and machinery. Adaptive measures, such as energy-efficient cooling systems for plant equipment, adequate water management, and worker welfare provisions, will help safeguard against these future risks.

3.3.3. Ambient Air Quality

Awasi lies in an emerging industrial corridor within Nyando Sub-County, Kisumu County, where air quality is influenced by multiple anthropogenic activities. These include quarrying, cement production at Rai Cement, operations at Prime Steel Mills, road traffic along the Kisumu–Nairobi highway, small-scale brick and block making, and biomass combustion at the household level. Baseline ambient air is therefore expected to carry moderate loads of particulate matter (PM₁₀ and PM_{2.5}), along with gaseous pollutants such as sulfur oxides (SO_x) and nitrogen oxides (NO_x) arising from fuel combustion in transport and industry. Natural dust from exposed soils and unpaved roads also contributes significantly to particulate levels, especially during the drier months.

Particulate matter (PM)

Particulate matter, particularly PM₁₀ and PM_{2.5}, is of primary concern in the Awasi area due to quarrying, haulage, and cement-related activities. Fine particles (PM_{2.5}) pose the most significant health risks, as they penetrate deep into the respiratory tract. Current WHO Air Quality Guidelines (2021) recommend an annual mean of 5 µg/m³ for PM_{2.5} and 15 µg/m³ for PM₁₀, with 24-hour means of 15 µg/m³ and 45 µg/m³ respectively. Kenya’s NEMA standards (2014) are less stringent, setting limits of 50 µg/m³ (24-hour) for PM_{2.5} and 100 µg/m³ (24-

hour) for PM₁₀ in ambient air. Given the dusty environment, exceedances of the WHO thresholds are highly probable, particularly near quarry sites and unpaved haul roads.

Cement manufacturing processes are known for generating dust, particularly PM₁₀ and PM_{2.5}, which can originate from raw material crushing, clinker grinding, cement milling, and fugitive emissions from haul roads. These fine particles pose health risks such as respiratory illnesses, cardiovascular stress, and eye and skin irritation, particularly for vulnerable groups including children, the elderly, and individuals with pre-existing conditions like asthma. Deposition of dust on vegetation and crops can also reduce agricultural productivity in nearby areas.

Sulfur Oxides (SO_x)

SO_x emissions in Awasi mainly originate from industrial combustion of heavy fuels and diesel engines. WHO (2021) sets a 24-hour guideline of 40 µg/m³ for SO₂, while NEMA prescribes an hourly limit of 350 µg/m³ not to be exceeded more than 24 times per year. SO_x emissions mainly result from the combustion of fossil fuels in kiln operations. In the atmosphere, SO₂ can react with water vapor to form acidic aerosols, contributing to acid rain, which damages vegetation, soils, and built infrastructure.

Nitrogen Oxides (NO_x)

NO_x (mainly NO₂) arise from combustion processes in transport, quarry machinery, and nearby steel and cement industries. WHO's guideline for NO₂ is 10 µg/m³ annual mean and 25 µg/m³ (24-hour), while NEMA prescribes 200 µg/m³ (1-hour mean). Road traffic along the Kisumu–Nairobi highway and heavy trucks serving the quarries are significant contributors, with potential local exceedances during peak haulage times. NO_x are generated from high-temperature combustion in kilns and transport fleets. NO_x contributes to ground-level ozone and secondary particulate formation, which can exacerbate respiratory problems and impair visibility.

Volatile Organic Compounds (VOCs)

Though not emitted in as large quantities as PM, SO_x, or NO_x, VOCs can be released from fuels and additives. VOCs contribute to the formation of tropospheric ozone (smog), which affects both air quality and human health.

3.3.3.1.Receptors of special interest

Sensitive receptors near Awasi include residential settlements, schools, health facilities, local markets, agricultural fields, and religious institutions within a 1–2 km radius. Dust deposition can affect crop yields and livestock health, while emissions of PM, SO_x, and NO_x may impact community health if not properly managed. Workers within the plant are also a key receptor group, requiring occupational exposure controls.

Environmental and social risks:

Inadequate air quality management could lead to negative social outcomes such as increased health expenditures, reduced agricultural productivity, and strained community relations due to perceived or actual pollution. From an ecological perspective, nearby vegetation and soils could be impacted by dust loading and acidifying emissions.

Mitigation measures:

To safeguard air quality, the proposed project should adopt advanced emission control technologies, including fabric filters, baghouse systems, electrostatic precipitators, and low-NO_x burners. Fugitive dust can be managed through regular water spraying, covering of transport vehicles, and paved access roads. Continuous air quality monitoring should be undertaken to ensure compliance with both WHO and NEMA guidelines, and results should be shared transparently with stakeholders. Green buffer zones with trees can provide additional dust filtration and aesthetic benefits. Worker safety will be supported through provision of PPE and adherence to occupational health standards.

3.3.3.2.Air Dispersion Model

Using a Gaussian plume steady-state screening model (centerline concentrations) to estimate ambient concentrations from a single point source (stack) at the proposed plan, we developed an air dispersion model. Inputs used were the receptor distances provided (distances from project site to nearby quarries, industries and Awasi town), and the model used standard Pasquill-Gifford dispersion parameterisations for stability class D (neutral) with a representative wind speed of 3 m/s. We assumed an effective stack height of 60 m and receptor breathing height 1.5 m.

Key assumptions:

1. Results are sensitive to the emission rates, stack height, local wind statistics, and atmospheric stability; providing measured stack/source data will likely change results substantially.
2. The model assumes receptors lie along the downwind centerline. Real worst-case locations may be crosswind; a full model uses wind rose data and hourly meteorology to find real worst-case exceedances.

Table 3.2: Results (screening concentrations at listed receptors)

Receptor	Distance (m)	PM _{2.5} (µg/m ³)	NO ₂ _eq (µg/m ³)	SO ₂ (µg/m ³)
Ceabud (Gogni) Quarry	1,439.5	0.47	9.46	4.73
Stone Field Quarry	1,939.3	0.38	7.55	3.78
Vic Block	1,637.9	0.43	8.68	4.34
Awasi Town	5,012.5	0.13	2.66	1.33
Rai Cement	2,908.5	0.25	5.01	2.50
Prime Steel Mills	1,766.2	0.41	8.18	4.09
SBI Awasi	1,399.8	0.48	9.62	4.81
H. Young	1,595.2	0.44	8.85	4.42

Discussion: How these compare to guidelines:

WHO (2021) guideline for annual PM_{2.5} is 5 µg/m³ (very stringent); the screening concentrations above (instantaneous centreline values) are below the WHO annual number at these receptor distances.

WHO 24-hour guideline for PM_{2.5} is 15 µg/m³. Screening values here are lower, but again this does not replace an hourly/24-hr modelling that accounts for worst-case meteorology and fugitive emissions.

NEMA Kenya ambient limits (2014) are less stringent than WHO; typical NEMA 24-hour ambient limits are higher (e.g., PM_{2.5} ~50 µg/m³ 24-hr). The screening concentrations are well below NEMA ambient limits.

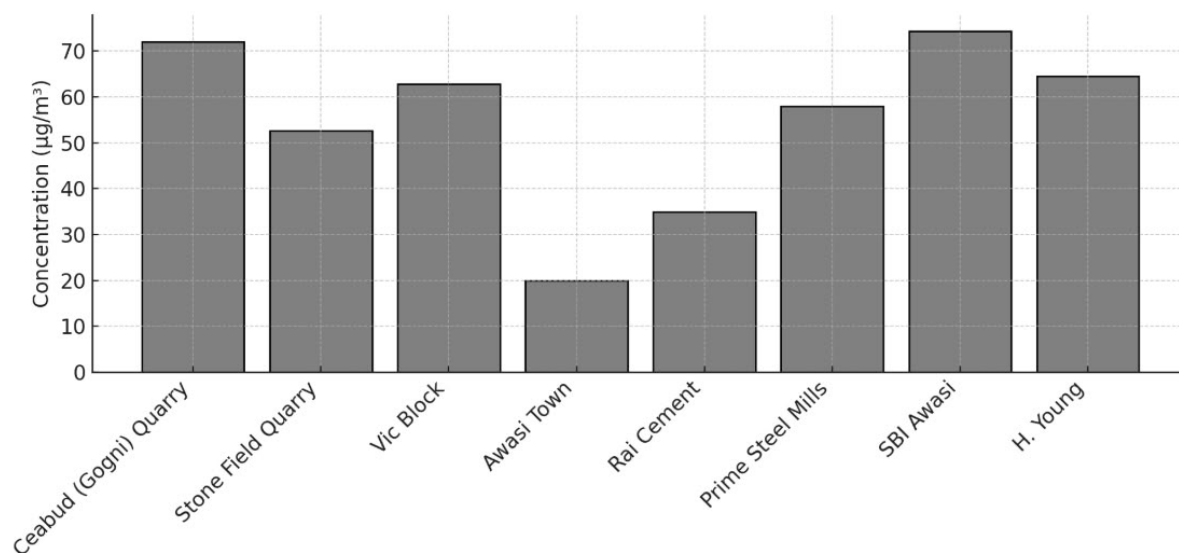


Plate 6: Conservative screening concentrations – PM_{2.5}

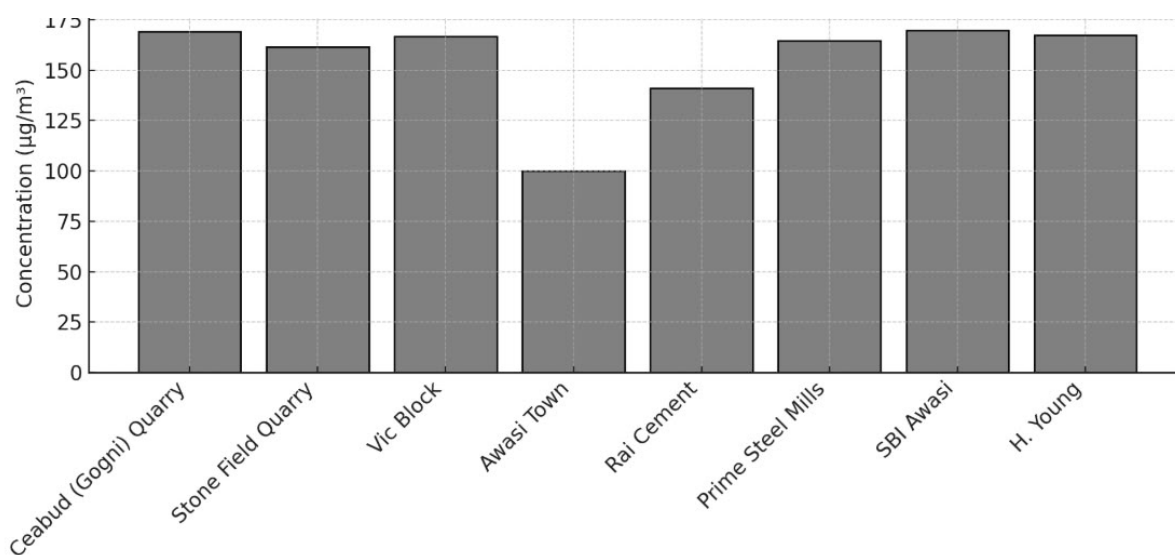


Plate 7: Conservative Screening Concentrations – NO₂

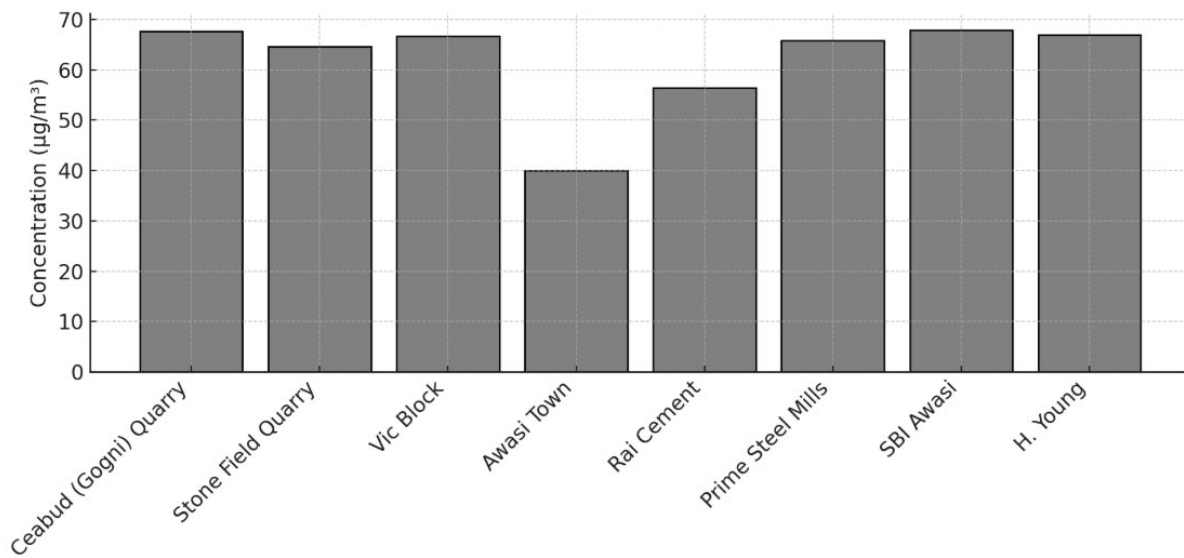


Plate 8: Conservative Screening Concentrations – SO₂

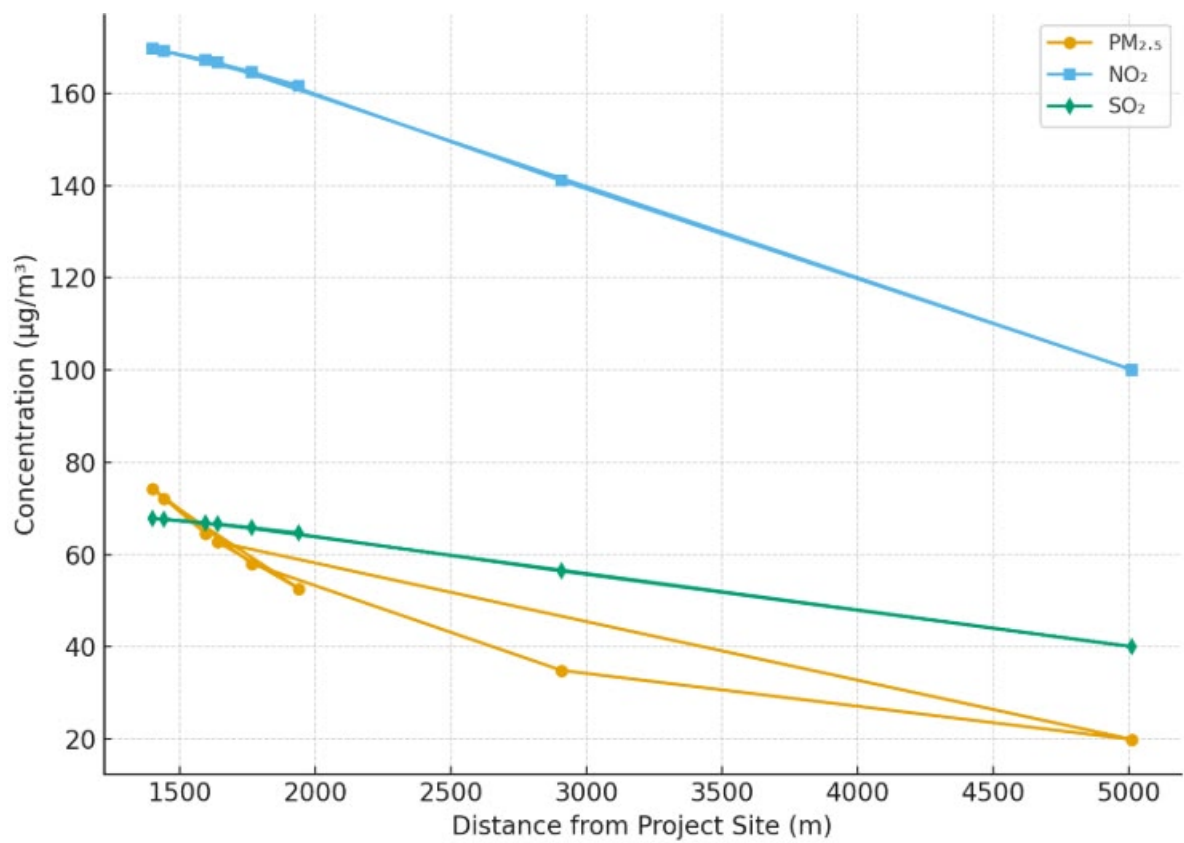


Plate 9: Decay of concentrations with Distance (Conservative Screening)

From the diagrams visualizing the conservative screening assessment:

- i. The bar plots show predicted concentrations of PM_{2.5}, NO₂, and SO₂ at each receptor location.
- ii. The scatter/line plot shows how concentrations decay with increasing distance from the project site for all three pollutants.

These make it clear that:

- i. Closer receptors and anything in between (e.g., SBI Awasi, Ceabud Quarry, Prime Steel Mills) show the highest predicted impacts.
- ii. Awasi Town, being farther away, has much lower concentrations.

Concentrations for NO₂ and SO₂ remain relatively elevated at intermediate distances compared to PM_{2.5}, which drops off faster.

3.4. Climate Risk & Vulnerability Assessment

The proposed Mamba Cement Manufacturing Plant in Awasi is situated in a region that is increasingly vulnerable to the impacts of climate change. Awasi, located in Nyando Sub-County, Kisumu County, experiences a tropical climate characterized by a bimodal rainfall pattern, with long rains occurring between March and May, and short rains between October and December. However, with changing climatic conditions, the frequency and intensity of extreme weather events have become less predictable and more severe. A comprehensive climate risk and vulnerability assessment is essential to inform adaptive management strategies and ensure long-term sustainability of the plant's operations.

Table 3.3: Climate change vulnerability assessment

Project Phase	Potential Climate Impact	Potential Vulnerabilities	Adaptation Plan	Mitigation Strategies
Construction	Extreme heat and heatwaves	Health risks for construction workers; overheating of machinery and delayed curing of concrete	Schedule heavy labor during cooler hours; provide shaded rest areas and drinking water; use climate-resilient construction materials	Use heat-tolerant equipment; enforce health & safety guidelines; apply curing compounds for concrete
	Intense rainfall and flooding	Damage to construction materials and machinery; waterlogging of site; erosion of exposed soils	Elevate stockpiles and site offices; implement stormwater drainage; use raised platforms for equipment	Construct temporary drainage channels; protect exposed soils with geotextiles or grass cover

	Drought and water scarcity	Limited water for dust control and construction processes	Use water-efficient construction techniques; collect and store rainwater	Install mobile water tanks; prioritize use of recycled water where feasible
	Strong winds/storms	Collapse of temporary structures; dust pollution from loose materials	Secure scaffolding and light structures; install windbreaks	Cover material stockpiles and regularly water haul roads
Operation	Prolonged heat periods	Reduced worker productivity; increased energy consumption for cooling systems	Install passive cooling designs; adopt rotational shifts for workers	Insulate buildings; use energy-efficient equipment
	Drought and water shortages	Reduced availability of water for industrial use (dust suppression, sanitation)	Develop water harvesting and recycling systems; partner with local authorities for sustainable water access	Use water-efficient technologies; regular water audits
	Heavy rainfall/flooding	Disruption in raw material supply and product delivery; site flooding	Elevate critical infrastructure; maintain robust drainage systems	Build flood barriers; routine inspection and maintenance of drainage
	Increased ambient dust due to dry conditions	Increased air pollution and health impacts	Install high-efficiency dust collection systems and air monitoring sensors	Green buffer zones; routine maintenance of dust filters

	Supply chain disruptions from climate events	Delay in delivery of clinker, gypsum, and pozzolana	Maintain buffer stock of key inputs; diversify supplier base	Develop risk-informed procurement plans
Decommissioning	Heavy rains and flooding	Erosion of decommissioned structures; spread of residual contaminants	Phase-wise dismantling; erosion control measures	Backfill excavated areas; establish vegetation cover
	Drought	Dust generation from exposed surfaces	Spray water on decommissioned surfaces; revegetation to stabilize soils	Use of biodegradable dust suppressants
	High temperatures	Health risks for dismantling crews	Follow occupational health protocols; schedule work during cooler times	Provide PPE and hydration
	Storms and strong winds	Debris dispersal and environmental hazards	Implement debris management plan; secure loose structures	Temporary fencing and protective netting

3.5. Physical & Topographic features

Awasi is situated within Nyando Sub-County at an elevation of approximately 1,290–1,300 metres above sea level. The area is characterized by gently undulating terrain with occasional ridges and shallow valleys, creating a landscape of moderate relief. While the land is generally suitable for development, the presence of natural slopes influences surface runoff and drainage patterns, making soil erosion a potential concern during heavy rainfall if not adequately managed. To the east and northeast, the Nyando Escarpment rises to higher altitudes of about 1,800 metres, forming a notable physiographic feature that contributes to watershed dynamics and influences local microclimatic conditions. The terrain gradually descends westwards towards the Kano Plains and ultimately to Lake Victoria, with Awasi occupying an intermediate upland zone that enjoys relatively cooler temperatures and well-drained soils compared to the low-lying plains.

The soils in the region are largely derived from volcanic and basement rock formations, weathering into fertile loams and clays of varying depth and stability. These soils, combined with the topographic gradient, support agriculture but are also prone to runoff and gully formation when vegetation cover is disturbed. The area is traversed by small streams and seasonal drainage lines that channel water from the uplands towards the Nyando River and other downstream catchments. This drainage system underscores the importance of carefully designed stormwater management structures for any development in order to minimize siltation, localized flooding, and downstream impacts. The Nairobi–Kisumu highway passes through Awasi, reflecting the accessibility of the area and the relative suitability of the terrain for road and industrial infrastructure. Overall, the physical and topographic characteristics of Awasi present favorable conditions for industrial development such as the proposed cement factory, provided that appropriate geotechnical investigations, slope stabilization, and erosion control measures are incorporated into the project design.

The area is fairly flat to gently sloping with predominantly black cotton soil, which is poorly drained. At the time of the field investigation, the site was waterlogged due to rain water, giving the site team operational challenges.

3.5.1. Soils and Geology

The site (Awasi) is known for its volcanic nature and the presence of quaternary sediments. The region also features alkaline soils with high exchangeable sodium percentage, fragile soil structure, and low infiltration rates, which contribute to soil erosion.

The soil types and distribution in the area have been influenced by topography, which is a low-lying area. The flat to gentle slope terrain led to the formation of cambisols, which are sandy clay loam to gravelly clay in texture and are of moderate to low fertility.

Adjacent to the site, the geology is hilly with carbonatite rocks, with several active commercial crushers. These hills were likely formed by a combination of volcanic activity and subsequent erosion over time.

For reference, the following Table gives the soil description of the cohesive and granular soils based on the Dynamic Cone Penetration Test (DCP-T) that were referenced for soil description from the trial pits.

Table 3.4: Soil classification based on DCP

Granular Soils		Cohesive Soils	
N-Count/30cm Penetration	Density	N-Count/30cm Penetration	Consistency
<4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Firm/Medium Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

Table 3.5: Summary of Laboratory tests

Test Category	Parameter Measured	Standard Method	Remarks
a). Index Test			
Classification tests	Utterberg Limits	BS 1377-2	To classify fine-grained soil and the fine fraction of mixed soil.
Moisture Content	BS 1377-2	Frequently carried out as a part of other soil tests. Read in conjunction with liquid and plastic limits, it indicates undrained strength.	
Unit weight	BS 1377-2	Used in the calculation of forces exerted by soil.	Determination of the Dry density of the soil
Grain Size Analysis a) Sieving	BS 1377 BS 1377-2 BS 1377-2	Sieving methods give the grading of soil coarser than silt, and the proportion passing the the finest sieve represents the combined silt/clay fraction. When the sample contains silt or clay the test will be done by wet sieving.	
Triaxial Shear Test	1377-7	Determination of the soil shear strength	



Trial Pit 1 Logging



DCP Test on Trial Pit 1



Trial Pit 2 Logging



Trial Pit 3 logged with surface water infiltration

Plate 10: photos showing soil sampling

3.5.2. Vegetation Type(s) within the project area

The natural vegetation of Awasi has been extensively modified due to human activities such as farming, settlement, and quarrying. Originally, the area was covered by savanna grasslands with scattered acacia species. Presently, much of the native vegetation has been replaced with cultivated crops and exotic trees such as eucalyptus and grevillea. Along watercourses and seasonal wetlands, patches of papyrus, reeds, and other hydrophilic plants still persist. Common crops grown in the region include maize, beans, sugarcane, and vegetables, while boundary trees and shrubs serve agroforestry and fencing purposes. Invasive plant species such as *Lantana camara* have also taken root in disturbed areas, particularly around abandoned farms and quarry sites.

3.5.3. Water sources and access

Awasi experiences persistent challenges with water access, with most households relying on a mix of boreholes, rainwater harvesting, and water vendors to meet their daily needs. Communal boreholes, some drilled by residents and others supported by county interventions, provide a critical source of water, although breakdowns and limited maintenance often compromise reliability. During rainy seasons, rainwater harvesting offers temporary relief, but supply is constrained by the storage capacity of tanks and variability in rainfall. In dry seasons, residents frequently depend on vendors who supply water at relatively high costs, making access both unreliable and expensive for low-income households. Surface water sources such as streams and seasonal rivers supplement these supplies but are prone to drying up during droughts and carry risks of contamination, thereby presenting health hazards if consumed without treatment. Plans such as the Soin–Koru Multipurpose Dam project promise long-term improvements in water supply for Awasi and the surrounding region, but current access remains highly constrained.

The proposed cement factory will require a substantial and consistent water supply for activities including raw material processing, cooling, and dust suppression, as well as provision of potable water for workers. Given the already stressed water environment in Awasi, direct reliance on the existing communal sources could exacerbate competition for limited resources, leading to significant social conflict with the surrounding community. Furthermore, increased abstraction from groundwater sources, if not managed sustainably, may accelerate depletion of aquifers, contribute to borehole failures, or alter the natural hydrological balance. On the

environmental front, over-abstraction risks reducing water availability for downstream ecosystems and agriculture, which would in turn heighten the vulnerability of local livelihoods already impacted by periodic water shortages.

To minimize these risks, the project should integrate climate-sensitive and socially responsive water management measures. Options include the development of a dedicated borehole system with appropriate abstraction permits, installation of large-capacity water storage tanks to buffer against supply interruptions, and incorporation of rainwater harvesting into the plant's design. Wastewater recycling for dust suppression and non-potable applications can also reduce overall consumption. Importantly, the project should avoid drawing from existing community boreholes or communal water points to prevent direct competition with residents. From a social responsibility perspective, the factory could contribute to the enhancement of local water infrastructure, for instance by supporting borehole rehabilitation or contributing to county-level supply programs such as the upcoming Soin–Koru dam. By proactively addressing water demand and ensuring equitable access, the project can mitigate potential environmental and social conflicts, strengthen community relations, and align with both NEMA requirements and sustainable development goals.

3.5.4. Land ownership categories/ classification

Land ownership and classification in Awasi reflect a mixture of customary and statutory systems. A significant portion of land is held under customary tenure, whereby land is inherited through family lineage and managed according to traditional norms. This system, while socially embedded, often lacks formal documentation, leading to disputes and tenure insecurity. Some parcels are under freehold tenure, offering legal ownership and the potential for land transactions and development, while others fall under leasehold arrangements, typically for industrial or commercial use.

Challenges in land administration are exacerbated by overlapping claims, limited access to land title deeds, and fragmented land use planning. Encroachment on wetlands and floodplains, driven by population pressure and inadequate enforcement of zoning regulations, has further complicated land management. These areas are especially vulnerable due to the absence of gazetted protections, leading to increased risks of flooding and environmental degradation.

Therefore, a harmonized approach to land governance that integrates both traditional and statutory frameworks is critical for sustainable development in the region.

3.5.5. Demographic Patterns:

For broader administrative context, Nyando (Awasi) as an administrative division historically reported populations in the tens of thousands (Nyando administrative figures in older district summaries place the Nyando/Awasi division population many times larger than the town core). For county-scale context, Kisumu County covers roughly ~2,085–2,677 km² depending on source definitions, with a 2019 census population of about 1.15 million.

According to the 2019 Kenya Population and Housing Census, Awasi had a core urban population of 5,052, with a gender distribution of 2,377 males, 2,673 females, and 2 intersex individuals. However, broader statistics indicate that Awasi is the second-largest town in Kisumu County, with a total population of approximately 93,369, comprising 2,488 in the core urban area and 90,881 in the peri-urban regions. The Awasi/Onjiko Ward itself has an estimated population of 30,937.

3.5.6. Similar developments and economic perspective

The proposed cement factory is strategically located within an area that is already characterized by significant industrial and commercial activity. The project site lies in close proximity to several established quarries and industrial facilities, including Gogni (Seabud) Quarry, Stone Field Quarry, Vic Block, SBI Awasi, H. Young Quarry, Rai Cement, and Prime Steel Mills. The presence of these operations demonstrates that the surrounding environment is already industrial in nature, making the proposed cement factory compatible with the existing land use. Because quarries and manufacturing already operate within the immediate area, the marginal change in industrial character is limited. The proposed factory is part of a pre-existing industrial landscape rather than a new intrusion into rural/residential land. Furthermore, the project site is well connected by the Kisumu–Nairobi highway and supported by feeder earth roads, facilitating efficient transportation of raw materials and finished products.

Table 3.6. Similar establishments and their relative distances

Location	Distance from Project Site (m)
Stone Field Quarry	1,939 m
Ceabud (Gogni) Quarry	1,440 m
Vic Block	1,638 m
Awasi Town	5,012 m
Rai Cement	2,908 m
Prime Steel Mills	1,766 m
SBI Awasi Quarry	1,400 m
H. Young Quarry	1,595 m

From an economic perspective, the establishment of the cement factory will enhance the industrial profile of Awasi town and Kisumu County at large. The project will leverage nearby quarries for raw material supply, thereby reducing transportation costs, improving operational efficiency, and creating market linkages with local extractive enterprises. In addition, the proximity of Rai Cement and Prime Steel Mills underscores the growing industrial hub in Awasi, making the proposed development not only viable but also complementary to the regional economic ecosystem. The clustering of related industries in the area provides opportunities for synergies, including shared infrastructure, a steady labor market, and enhanced investor confidence.

The cement factory will generate direct and indirect employment opportunities, stimulate local businesses, and expand the tax base of Kisumu County. By positioning itself within an already active industrial corridor, the project aligns with the broader county and national development goals of promoting manufacturing and industrialization. Importantly, the presence of existing quarries and cement plants in the area affirms that the proposed project is not out of character with its environment but rather a natural extension of ongoing industrial development. This concentration of industries in Awasi will transform the locality into a competitive commercial hub, reinforcing Kisumu County's role as a driver of economic growth in the region.

CHAPTER FOUR: ENVIRONMENTAL LEGISLATIVE AND REGULATORY FRAMEWORK

4.0 Introduction

The implementation of this project is guided and governed by a number of laws and policies of the country and region. The government has long been concerned with environmental conservation and protection of human health. It has therefore; put in place all the frameworks necessary for the legislative and regulatory controls of environmental management. EMCA, 2015 was amended to comprehensively address environmental issues which were being governed differently by the various sectoral acts in place.

4.1 Policy framework

4.1.2. Environmental Policy

The Kenya Government's environmental policy aims at integrating environmental aspects into national development plans. The broad objectives of the national environmental policy include:

- Optimal use of natural land and water resources in improving the quality of the human environment;
- Sustainable use of natural resources to meet the needs of the present generation while preserving their ability to meet the needs of future generations;
- Integrate environmental conservation and economic activities into the process of sustainable development;
- Meet national goals and international obligations by conserving bio-diversity, arresting desertification, mitigating the effects of disasters, protecting the ozone layer and maintaining an ecological balance on earth.

4.1.3. The National Industrialization Policy framework

The National Industrialization Policy Framework (2012–2030) is also relevant, as it seeks to position Kenya as a globally competitive industrial hub. It supports the development of industrial parks, resource-based manufacturing, and environmentally sound technologies. The policy encourages private sector investment in rural areas to promote inclusive growth, a vision consistent with locating the cement plant in Awasi.

4.1.4. The Kenya Vision 2030 and the “Big Four” Blueprint

The Kenya Vision 2030 is the national long-term development policy that aims to transform Kenya into a newly industrialized, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment.

The Big Four is an economic blueprint that was developed by the government to foster economic development and provide a solution to the various socio-economic problems facing Kenyans. The four items that are intended for delivery include Food Security and Nutrition, Universal Health Care, Affordable Housing and enhancing the Local Manufacturing industry. Mamba Cement Limited will explicitly play a big role in the realization of the local manufacturing pillar as soon as it starts its operations in Kisumu County.

4.1.5. Sustainable Development Goals (SDGs)

MDGs are eight internationally-agreed goals for socio-economic development that emphasize the following: elimination of extreme poverty and hunger; universal primary education; gender equality; reduction in child mortality; improvement in maternal health; lower HIV/AIDS and major disease incidence; environmental sustainability; and better partnerships with international development partners. The facility has an opportunity to contribute towards the local achievement of some of these goals via employment opportunities creation, corporate support to community initiatives and contribution towards achieving environmental sustainability goals.

4.1.6. Climate and Environment Protection Policies

In terms of climate and environmental protection, the National Climate Change Response Strategy (NCCRS, 2010) and the National Climate Change Action Plan (NCCAP, 2018–2022) provide strategies for climate-resilient development. They encourage low-carbon, resource-efficient industrial processes and promote energy efficiency in production, both of which are essential considerations in the design and operation of a cement plant.

4.1.7. Kisumu County Integrated Development Plan (CIDP) 2023–2027

At the county level, the Kisumu County Integrated Development Plan (CIDP) 2023–2027 outlines the county’s development priorities and spatial planning goals. It encourages industrial

investments that are environmentally sound and socially inclusive, with an emphasis on harnessing local resources to spur economic development. The project is aligned with CIDP objectives to promote agro-industrial zones and infrastructure development in Nyando Sub-County.

4.2. Institutional and Regulatory Framework

The Environmental and Social Impact Assessment (ESIA) process for the proposed cement manufacturing plant in Awasi, Nyando Sub-County, Kisumu County is governed by a multi-agency institutional framework involving both national and county-level authorities. At the national level, the National Environment Management Authority (NEMA) is the lead agency mandated under the Environmental Management and Coordination Act (EMCA), Cap 387 to oversee the entire ESIA process. NEMA is responsible for the review and approval of the ESIA Study Report, issuance of the EIA license, monitoring compliance with environmental conditions throughout the project lifecycle, and ensuring that environmental audits are conducted post-implementation.

The Ministry of Environment, Climate Change and Forestry plays a critical policy and oversight role by providing strategic direction to ensure that all industrial developments, including cement manufacturing, align with the National Climate Change Action Plan (NCCAP), sustainable development goals, and the country's green growth agenda.

At the county level, the Kisumu County Government, through its relevant departments, also plays a pivotal role in environmental and land-use regulation. The Department of Physical Planning and Urban Development ensures compliance with zoning requirements and land-use plans, while the Department of Water, Environment, and Natural Resources provides support in environmental management, particularly at the grassroots level. The County Environment Committee, chaired by the County Commissioner or a delegated official, provides advisory input into the ESIA approval process, particularly in ensuring that community concerns are adequately addressed.

Other regulatory institutions include the Water Resources Authority (WRA), which oversees water abstraction licensing, regulation of effluent discharge, and protection of water catchments and aquifers that may be impacted by the proposed project. The Directorate of

Occupational Safety and Health Services (DOSHS), under the Ministry of Labour, is mandated to review the proposed project's occupational safety and health measures, inspect workplaces during construction and operation phases, and ensure compliance with the Occupational Safety and Health Act (OSHA), 2007. If the project activities affect forested areas, wetlands, or wildlife corridors, the Kenya Forest Service (KFS) and Kenya Wildlife Service (KWS) must be consulted for guidance and any necessary approvals.

The National Land Commission (NLC) may become involved if land acquisition is necessary, particularly in ensuring fair compensation, regularization of tenure, and conflict resolution in line with Kenya's land laws.

Equally important are local stakeholders, including village elders, local residents, Community-Based Organizations (CBOs), and Non-Governmental Organizations (NGOs). Their participation is a statutory requirement and is essential in identifying potential social risks, formulating mitigation measures, and enhancing project acceptance among the host communities. Public institutions such as schools and health centers within the project's area of influence are also key informants during stakeholder engagement. In summary, the institutional framework for this ESIA integrates a broad range of actors whose coordinated roles ensure the proposed cement plant complies with legal, environmental, and social standards, thereby enhancing the sustainability and community ownership of the project.

Table 4.1: Legislative Framework

Principal Legislation/Policy	Relevant Environmental Obligations
The Constitution of Kenya, 2010	Article 42 of the Constitution states that every person has the right to a clean and healthy environment, which includes the right: a) to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69; and b) to have obligations relating to the environment fulfilled under Article 70. Article 69(2) states that every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources. Article 70 (1) states that If a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.
The Environment Management and Coordination Act (EMCA)-1999 (rev. 2015)	The Environmental Management and Coordination Act (EMCA), Cap. 387, serves as the principal legislation for environmental governance in Kenya. It establishes the legal and institutional framework for environmental management and conservation. Under Section 58, EMCA mandates that any project likely to have a significant impact on the environment must undergo an Environmental Impact Assessment (EIA) before commencement. This requirement is particularly relevant to cement manufacturing, given the potential environmental implications associated with such operations.

Furthermore, EMCA empowers the National Environment Management Authority (NEMA) to oversee the EIA process, including the review and approval of EIA reports, issuance of licenses, and monitoring of compliance. Section 68 of the Act requires project proponents to conduct annual environmental audits to ensure ongoing adherence to environmental standards.

The Kenya Mining Act 2016	The establishment of Mamba Cement Manufacturing Plant in Awasi must be aligned with the Kenya Mining Act, 2016, which governs all mineral exploration, extraction, and utilization activities in Kenya. Since cement production relies on key raw materials such as limestone, pozzolana, gypsum, and laterite, any mining of these minerals—whether on-site or off-site—must strictly adhere to the provisions of this Act. The Act defines these materials as industrial minerals, and thus their extraction requires mineral rights granted through a transparent, computerized mineral cadastre system managed by the State Department for Mining under the Ministry of Mining, Blue Economy, and Maritime Affairs.
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Under the Act, the proponent of the cement plant must obtain appropriate mineral rights, such as a prospecting license or a mining license, depending on the stage and scale of operations. These rights are issued following a public and competitive process that includes the submission of a mining proposal, work program, and proof of technical and financial capacity. In the case of the Mamba Cement Plant, if the raw materials are to be sourced from a captive mine (i.e., within the project site), the investor must secure a mining lease, which is only granted after the successful completion of a mineral exploration phase and upon approval by the Mineral Rights Board. If

raw materials are outsourced, then supply contracts must be from licensed miners, and the cement plant must ensure traceability and regulatory compliance from source to plant.

Environmental and community safeguards form a critical part of the Act. Before a mining right is granted, the proponent must carry out a comprehensive Environmental and Social Impact Assessment (ESIA) and obtain approval under the Environmental Management and Coordination Act (EMCA). This includes submitting an Environmental Management Plan (EMP), conducting public participation, and outlining mitigation strategies. Additionally, the Mining Act requires proponents to post an environmental bond to cover mine closure, rehabilitation, and any unforeseen ecological damage. In the case of the Mamba Cement Plant, this means that any mining activities linked to the project must include detailed post-closure reclamation plans and clearly define how land will be restored.

Sustainable Management Act, 2022	Waste	The Sustainable Waste Management Act, 2022, establishes a legal and institutional framework for sustainable waste management in Kenya. It emphasizes the principles of a circular economy, aiming to minimize waste generation and promote recycling and reuse.
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For cement manufacturing, the Act introduces the concept of Extended Producer Responsibility (EPR), which holds producers accountable for the entire lifecycle of their products, including post-consumer waste management. This means that cement manufacturers are responsible for ensuring that their products do not adversely impact the environment throughout their lifecycle.

	Additionally, the Act mandates the development of county-specific waste management plans, aligning with national strategies to ensure localized and effective waste management practices.
The Environment (Impact Assessment and Audit) (amendment) Regulations, 2019	Regulation 11 (1) states that an environmental impact assessment study shall be conducted in accordance with terms of reference developed during the scoping exercise by the proponent and approved by the Authority. Regulation 13 (2) states that every environmental impact assessment study shall be carried out by a lead expert qualified in accordance with the criteria of listing of experts specified in the Fourth Schedule to these Regulations. Regulation 24 on EIA licensing states that environmental Impact License shall be issued after the authority approves the study report under regulations 23, and shall be issued in form and accompanied by the prescribed fee.
Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009	These regulations aim to control noise and excessive vibrations that may be harmful to human health and the environment. Cement manufacturing plants, which involve heavy machinery and blasting activities, must obtain permits if their operations are likely to emit noise or vibrations beyond permissible levels. The regulations specify allowable noise levels for different zones and times, and require the implementation of noise mitigation measures.
The Customs and Excise Act	Section 90. (1), states that, No person shall manufacture excisable goods unless he is licensed by the Commissioner to manufacture them. Section 91. (1), states that, Subject to this Act, the Commissioner may on application grant a licence to a person to manufacture excisable goods; and the Commissioner may, without assigning any reason, refuse to grant the application.

Standards Act Chapter 496	Section 9 (2), states that, where a Kenya Standard has been declared under subsection (1), the Minister, on the advice of the Council, shall, by order in the Gazette, prescribe a date after which no person shall manufacture or sell any commodity, method or procedure to which the relevant specification or code of practice relates unless it complies with that specification or code of practice. (3) Where, after the publication of an order under section 9. Section 10 (2), states that, any person intends to manufacture any commodity to which that order refers after the date specified therein he shall notify the Bureau in the prescribed form of his intention and the Bureau, if it is satisfied that he is capable of manufacturing the commodity in accordance with the relevant Kenya Standard, shall issue him with a permit to use the standardization mark referred to in paragraph (a) of subsection (1).
County Governments Act, 2012	The County Governments Act, 2012, provides the legal framework for the establishment and functioning of county governments. Under this Act, county governments are responsible for planning and development control within their jurisdictions. The proposed cement manufacturing plant must therefore align with the Kisumu County Integrated Development Plan (CIDP) and obtain necessary approvals and licenses from the county government.
Air Quality Regulations, 2014	The establishment of Mamba Cement Manufacturing Plant in Awasi must comply with Kenya's air quality regulations under the Environmental Management and Coordination Act (EMCA), 1999 and the updated Environmental Management and Coordination (Air Quality) Regulations, 2014 (as amended under Legal Notice No. 180 of 2024). These laws empower the National Environment Management Authority (NEMA) to oversee air quality standards, regulate emissions, and ensure that industrial developments like cement plants do not degrade ambient air quality. Any proponent of such a plant is required to undertake an Environmental Impact Assessment

(EIA) and obtain an EIA license before construction begins. Within the first 12 months of operation, the plant must also apply for a stationary-source emission license, submitting detailed reports that include baseline emissions data, proposed pollution control technologies (Best Available Technologies - BAT), and a monitoring protocol.

The plant's emissions must conform to strict standards outlined in the Third Schedule of the Air Quality Regulations. These include maximum permissible levels of particulate matter (400 mg/Nm³), sulphur oxides (1,500 mg/Nm³), carbon monoxide (500 mg/Nm³), and carbon dioxide (300 mg/Nm³). The opacity of emissions should not exceed 50%. These standards are intended to control emissions from both point sources (e.g., stacks and chimneys) and fugitive sources (e.g., raw material stockpiles and loading areas), ensuring that the facility does not cause harmful concentrations of pollutants in surrounding communities.

In addition to emission limits, the regulations require regular monitoring and reporting. Stack emissions must be tested quarterly using approved methods. Visible emissions should be monitored using the Ringlemann scale or equivalent, while fugitive dust must be controlled through adequate suppression measures such as water spraying or enclosures. If Awasi is declared a "controlled area" due to increased industrial activity, Mamba Cement will also be required to install ambient air quality monitoring stations around the plant. Reports from these monitoring activities must be submitted to NEMA on a quarterly basis, and records must be maintained for at least two years.

The design of the plant's stack system must comply with dispersion modeling criteria to ensure adequate pollutant dispersion and prevent ground-level concentration hotspots. Technologies such as baghouse filters, electrostatic precipitators, and flue gas desulphurization units should be incorporated based on BAT principles. These

technologies are essential for reducing emissions of dust, nitrogen oxides, and sulphur oxides, which are commonly associated with cement production.

Furthermore, mobile sources of pollution such as trucks and earthmovers used in the plant’s operations must comply with emissions standards set under the East African Standard (EAS 1047). The regulations also prohibit open burning of waste or raw materials within the facility and require measures to prevent transboundary air pollution. The plant must ensure occupational safety by monitoring indoor air quality and training staff on safe handling of hazardous substances.

Environmental Management and Coordination (Waste Management) Regulations, 2023	The Environmental Management and Coordination (Waste Management) Regulations, 2023, provide a comprehensive framework for waste management in Kenya. These regulations are crucial for cement manufacturing plants, which generate various types of waste, including solid, liquid, and gaseous emissions. Key provisions relevant to cement manufacturing include: Licensing Requirements: Operators of waste storage, processing, treatment, or disposal facilities must obtain licenses from NEMA, as stipulated in Regulation 10. This ensures that waste management practices meet environmental standards. Industrial Symbiosis: Regulation 13 encourages the reuse of non-hazardous waste as raw materials in other industrial processes, promoting resource efficiency and waste reduction.
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Environmental Audits: Regulation 12 mandates annual environmental audits for licensed waste management facilities, ensuring continuous compliance and environmental protection.

Climate Change Act, 2016 The Climate Change Act, 2016 is a key legislative instrument in Kenya that aims to promote climate-resilient, low-carbon development pathways across all sectors of the economy. With the establishment of the Mamba Cement Manufacturing Plant in Awasi, the Act imposes critical obligations on the proponent to integrate climate change mitigation and adaptation strategies into the planning, construction, and operation of the facility. Cement manufacturing is widely known to be energy-intensive and a significant emitter of greenhouse gases (GHGs)—especially carbon dioxide (CO₂)—due to the calcination of limestone and use of fossil fuels. As such, the Climate Change Act plays a central role in regulating how the project aligns with Kenya’s national climate goals.

Under the Act, all private entities whose activities are likely to have a significant impact on climate change are required to monitor, report, and verify (MRV) their greenhouse gas emissions. This places a legal responsibility on Mamba Cement to quantify its emissions from energy use, clinker production, and transportation logistics, and to report these figures to the Climate Change Directorate housed within the Ministry of Environment, Climate Change and Forestry. This process must adhere to internationally accepted standards, such as the Intergovernmental Panel on Climate Change (IPCC) guidelines or the ISO 14064 standard.

Additionally, the Act requires that large-scale industrial projects like cement plants adopt climate change mitigation measures, including the use of clean technologies, energy efficiency, and sustainable raw materials. For Mamba Cement, this could mean investing in waste heat recovery systems, using renewable energy sources (such as solar

or biomass), blending clinker with low-carbon alternatives like pozzolana, and adopting carbon capture technologies. These interventions not only reduce the plant's carbon footprint but also align the project with Kenya's National Climate Change Action Plan (NCCAP) and the Nationally Determined Contributions (NDCs) under the Paris Agreement.

Another critical provision of the Act is the requirement for mainstreaming climate change into environmental impact assessments (EIAs). Therefore, the ESIA for Mamba Cement must include a detailed climate risk and vulnerability assessment, identifying how the project may be impacted by changing climatic conditions such as extreme heat, drought, or flooding in Awasi. It must also explain how the project will contribute to or reduce climate vulnerability in the surrounding community. This ensures that the development does not exacerbate existing climate challenges in Kisumu County, and instead supports local adaptation strategies, particularly in relation to water use, biodiversity, and air quality.

Water Quality**Regulations, 2006**

These regulations apply to drinking water, water used for industrial purposes, agriculture purposes, fisheries and wildlife and water used for any other purpose. The objective of the water quality regulations is to prevent water pollution by prescribing threshold levels of various elements that are permissible in effluent water. Provides the permissible limits for wastewater discharge to environment i.e. water body, sewer and land. It is thus the benchmark for adoption of wastewater treatment technologies and best practice to avoid water pollution. It also creates riparian zones along rivers and streams alongside providing for the daily monitoring of effluent discharge both in terms of quality and quantity to the environment. The regulations provides for the sound and integrated management of

waste across the sectors in Kenya. The First Schedule of the regulations gives quality standards for sources of domestic water. The Third Schedule of the regulations gives standards for effluent discharge into the environment.

The Water Act, 2016

The Water Act, 2016, governs the management and conservation of water resources in Kenya. Cement manufacturing requires substantial water usage and has the potential to impact water quality through effluent discharge.

Key provisions include:

- Water Use Permits: Section 36 requires entities to obtain permits for water abstraction, ensuring sustainable utilization of water resources.
- Effluent Discharge Licensing: Section 75 mandates that any discharge of wastewater into water bodies must be licensed, with strict adherence to quality standards to prevent pollution.
- Catchment Protection: The Act emphasizes the protection of water catchment areas, ensuring that industrial activities do not compromise water sources.

Occupational Health and Safety Act, 2007

This act was signed into law in October 2007 to repeal and replace the Factories and Other Places of Work Act Cap 514. It came into force on December 20, 2007. The Act makes provision for safety and health of workers in all workplaces in Kenya. All rules made under the previous Act remain in force under the new Act. The Act requires developers to notify the Director of Occupational Health and Safety of their intended development before

	commencement. The act also sets minimum standards that are to be maintained in such workplaces to safeguard health, safety and welfare of workers. These are all aimed at elimination of hazards from workplaces. The act further requires all workplaces to display the abstract of the act for all workers to read and remind themselves on how to protect themselves from hazards. The Act also makes it mandatory for occupiers or employers to provide personal protective equipment and all practicable means to prevent injury to health of workers who are exposed to any potentially harmful substances or conditions.
Energy Act, 2019	The Energy Act, 2019, provides a comprehensive legal framework for the regulation of energy in Kenya. Cement manufacturing is energy-intensive, making energy efficiency and sustainability critical considerations. Under this Act: • Energy Audits: Industrial facilities are required to conduct regular energy audits to identify opportunities for energy conservation and efficiency improvements. • Renewable Energy Integration: The Act promotes the adoption of renewable energy sources, encouraging industries to integrate sustainable energy solutions into their operations. • Energy Management Plans: Entities must develop and implement energy management plans, outlining strategies to optimize energy use and reduce environmental impact.
Noise and Excessive Vibration (Control) Regulations, 2009	Regulation 3(1) states that except as otherwise provided in these Regulations, no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Regulation 4 (1) states that except as otherwise provided in these Regulations, no person shall-

	(a) make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or (b) Cause to be made excessive vibrations which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source; Regulation 4(2) states that any person who contravenes the provisions of this Regulation commits an offence.
The Malaria Prevention Act (Cap. 246)	Section 5 on Drainage System states that no occupations at the construction phase that shall obstruct flow of water into or out of any drainage. The contractor shall be required to maintain drainage system within the area of the project for removal of water from any land around the project to prevent larvae breeding.
Physical and Land Use Planning Act, 2019	The Physical and Land Use Planning Act, 2019, provides a framework for the preparation and implementation of physical and land use development plans. For the proposed cement manufacturing plant, this Act ensures that land use aligns with designated zoning regulations and that development projects are sustainable and environmentally sound. The Act mandates that developers obtain development permission from relevant authorities, ensuring that the proposed land use is compatible with existing plans and does not adversely affect the environment or local communities.
The Land Registration Act, No.5 of 2012	An Act of Parliament to revise, consolidate and rationalize the registration of titles to land, to give effect to the principles and objects of devolved government in land registration, and for connected purposes

The Act has repealed the following land related laws:

- i. The Indian Transfer of Property Act 1882
- ii. The Government Lands Act, (Cap 280)
- iii. The Registration of Titles Act, (Cap 281)
- iv. The Land Titles Act, (Chapter 282)
- v. The Registered Land Act, (Cap. 300)

Section 26 of the Act states that Certificate of title to be held as conclusive evidence of proprietorship, except:

- a) on the ground of fraud or misrepresentation to which the person is proved to be a party; or
- b) Where the certificate of title has been acquired illegally, un-procedurally or through a corrupt scheme.

Public Health Act, 2012

The Public Health Act, Cap. 242, focuses on safeguarding public health in Kenya. Cement manufacturing can impact public health through emissions, dust, and noise pollution. Under this Act, the Ministry of Health has the authority to:

- **Inspect Industrial Facilities:** Conduct inspections to ensure that industrial operations do not pose health risks to workers or nearby communities.
 - **Enforce Sanitation Standards:** Mandate the implementation of sanitation measures to prevent the spread of diseases associated with industrial activities.
 - **Issue Health Notices:** Require corrective actions if industrial operations are found to be detrimental to public health.
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Wildlife (Conservation and Management) Act Cap 376 of 1976, 1989 & Bill, 2013 (GoK, 2013)	Section 30 of part VI: Prevention of adverse effects on the environment, including the seepage of toxic waste into streams, rivers, lakes and wetlands.
Weights and Measures Act, Cap 513.	The above-named Act mandates the Weights and Measures Department to annually certify the mechanical pumps and dispensers in order to ensure that they are properly calibrated to dispense the right amounts of the petroleum products. During the certification exercise, the measuring mechanisms inside the pumps are sealed with a seal-mark of quality assurance. The Weights and Measures Department issues a Certificate of Verification for all the mechanical pumps which is usually valid for 1 year.
The Traffic Act, Cap 403	The Traffic Act consolidates the law relating to traffic on all public roads. The Act prohibits encroachment on and damage to roads including land reserved for roads.
The Employment Act, 2007	An Act of Parliament to repeal the Employment Act, 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 matters connected with the foregoing.

CHAPTER FIVE: ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.0. Impact description & mitigation

This chapter presents an assessment of environmental impacts from the planned project design and activities, and proposes mitigation and management measures to prevent and control these impacts.

The environmental impact assessment and analysis was done using a number of methods and tools. While identifying impacts, a checklist was used. This indicated all possible impacts that would accrue from implementation of this project.

5.1. Legal and regulatory compliance

The national laws and regulations relevant to the development and their relevance to the process project have been discussed.

5.2. Construction and Equipment installation

Key aspects to be considered during construction are:

- Procurement of construction materials.
- Installation of services and interiors of the building;
- Use of heavy and light machinery.
- Energy utilisation, major energy consuming activities include:
 - Lighting;
 - Excavation;
 - Transportation;
 - Hauling and hoisting of materials;
- Mixing raw materials;
- Waste handling trucking and disposal;
- Testing and commissioning of the development.
- Energy sources for these activities include grid electricity and diesel or petrol fuel for machinery/vehicles.
- Water utilisation, including use for the following activities:
 - Washing of machinery and equipment;
 - Preparing of mixtures, including water based emulsion paints;

- Concrete works, including curing;
- General cleaning;
- Landscaping;
- Controlling dust on site;
- Domestic utilisation (sanitary facilities).
- Construction waste will include the following:
 - Timber from used formwork;
 - Paints, lubricants and petroleum wastes;
 - Containers, cement paper bags and other packaging materials;
 - Metal, glass, plastic containers and other unwanted materials.
- Socio-economic effects;
 - Labour;
 - Security;
 - Transport.
 - Archaeological findings and aesthetics.

Table 5.1: Summarises the anticipated impacts and recommended mitigation measures during the construction and equipment installation stage.

Activity	Anticipated Impact	Recommended Mitigation Measures
Procurement of construction materials:	Natural resource depletion if not rationally done through activities such as quarrying, mining, timber logging.	• The tender documents should specify required standards and certification for procurement of all materials and appliances; • All construction materials should be from approved sources; for example, hardstone for building should be obtained from bona fide commercial quarries; • As far as possible, environmentally friendly and sustainable materials should be used. Materials not to be used for the construction of the buildings include: • High alumina cement; • Wood wool slab in permanent formwork to concrete;

Building works:

Health and safety risk from accident and incidents;
Noise and dust.

- Calcium silicate bricks or tiles;
 - Asbestos in any form;
 - Asbestos substitutes or any naturally occurring or man-made mineral fibres;
 - Lead, lead paint or any other materials containing lead which may be inhaled, ingested or absorbed;
Vermiculite, unless it is established as being fibre-free;
Any products containing cadmium that are regarded as being injurious substances;
 - Any other substances regarded as being deleterious building materials which are not in accordance with statutory requirements or with current accepted good building practice at the time of specification or construction.
 - The Project Manager should ensure that the Contractors are instructed in the use of all materials that may have negative environmental (including health) effects;
 - If any material or substance is used that is at any point in the future deemed to be deleterious to health, then it must be replaced with an acceptable alternative.
-
- Adhere to safety regulations outlined in the Local Government Adoptive by-laws, Building Order 1968 (Building Code) and the Building Operations and Works of Engineering
 - The Project Manager should ensure strict safety management through close attention to

**Energy
utilisation:**

Energy consumption.

- design, work procedures, materials and equipment;
- Schedule noisy construction
- Develop a site safety action plan detailing safety equipment to be used, emergency procedures, restrictions on site, frequency and personnel responsible for safety inspections and controls;
- All workmen should be provided with personal protective equipment (e.g. nose masks, ear muffs, helmets, overalls, industrial boots, etc);
- There should be regular site reporting on health, safety and environment (HSE) issues by an appointed HSE representative, daily site inspections should be done to ensure safe work practises are adhered to;
- All injuries that occur on site must be recorded in the accident registers and corrective actions for their prevention be instigated as appropriate;
- Statistical records on accidents and incidents should be collated and analysed on a monthly basis and forwarded to the Project Manager and / or displayed on the notice boards;
- Site personnel should be encouraged to report “near-miss incidents” in order to avoid potential problems and increase safety awareness.
- Develop an energy management plan;
- Construction machinery and vehicles should be maintained and used in accordance with manufacturer’s specifications, to maximise

		efficiency and lower use of energy, e.g. drivers of construction vehicles should be instructed not to leave them idling for extended periods; • Construction workers should be sensitised on the importance of energy management.
Water utilisation:	Water consumption; Hygiene and sanitation challenges.	• Monitor water consumption and utilisation; • Sensitise construction workers on the importance of proper water management; • All wastewater should be drained into approved drainage facilities.
Waste production:	Littering, soil and surface water pollution potential.	• The tender documents should specify the proper disposal of waste during construction and should also ensure that the Contractor leaves the site in a clean and safe condition on completion of the Works; • The Contractor should be required to restore and landscape all areas to the satisfaction of the Project Manager; • All solid waste generated during construction should be collected, stored, and taken away for disposal; • There should be controlled use of raw materials; • Procedures for handling of special wastes, such as waste fuel oil, should be specified; • Comply with guidelines on solid waste disposal and Waste Management Regulations 2006.
Influx of construction workers into the area:	Proliferation of informal kiosks in the area; Increase in transport demand.	• Develop a catering program on site for construction staff; • Provide transportation for the workforce to and from the site.

Construction traffic:	Disruption of local traffic; Potential for accidents.	• The Contractor should plan itineraries for site traffic.
Archaeological findings:	Destruction of natural heritage/loss of archaeological findings.	• In the event of an archaeological finding, the Contractor should secure the location ‘as is’ and immediately call the National Museums of Kenya’s Archaeology Section.

5.3. Operation Stage

The key environmental issues during commissioning and operation are as follows:

- Water supply and consumption;
- Energy consumption and management;
- Effluent Management
- Solid and Hazardous Waste Generation
- Air Pollution
- Visual and Aesthetic Impacts;
- Increased Traffic and Road Safety Risks;
- Health and safety;
- Noise.
- Cumulative and Long-Term Environmental Effects

5.3.1. Operational Phase Negative Impacts

5.3.1.1. Increased pressure on infrastructure – Stressed up service provision

The additional facility will lead to increased pressure on existing infrastructure such as roads, water abstracted from the nearby river, etc due to the increased number of users. In turn, this may directly translate into increased use of facilities and services.

Recommended Mitigation Measures

- Relevant authorities such as the Kenya Power and Lighting, and WRA should be informed of the capacity of the development
- The proponent will install water-conserving automatic taps and toilets, as well as energy-saving electrical fittings to optimize the use of public resources.

- iii. Water leaks through damaged pipes and faulty taps will be fixed promptly by qualified staff.
- iv. Occupants of the facility should be sensitized to use water efficiently.

5.3.1.2. Air pollution

The manufacturing of cement is associated with significant air quality degradation due to emissions from raw material handling, kilns, and packaging. Particulate matter (PM10 and PM2.5) from grinding, crushing, and storage can result in respiratory issues among workers and neighboring communities. Gaseous pollutants such as sulfur dioxide (SO₂), nitrogen oxides (NO_x), and carbon dioxide (CO₂) from fuel combustion also contribute to climate change and acid rain.

The proposed plant includes the installation of high-efficiency dust collectors at key emission points such as the ball mill, classifier, and silos. These systems will ensure that dust emissions are kept well below the permissible limits set by the Environmental Management and Coordination (Air Quality) Regulations, 2014. The collected dust will be recycled back into the process, eliminating the generation of by-products or solid waste.

Recommended Mitigation Measures

- Install baghouse filters, electrostatic precipitators, and cyclone dust collectors at all dust-generating points.
- Use low-NO_x burners and alternative fuels with lower sulfur content.
- Conduct continuous emissions monitoring (CEMS) and comply with NEMA Air Quality Regulations, 2014.
- Pave and regularly water roads to minimize fugitive dust.
- Provide respiratory PPE and regular medical checks for workers.
- Establish vegetative buffer zones around the plant.

5.3.1.3. Increased traffic flow – Unnecessary congestion

An increase in the number of vehicles within the area is anticipated which may lead to congestion and pose a threat to accidental occurrences.

Recommended Mitigation Measures

- i. In case of heavy traffic, an attendant should be employed to direct vehicles during peak periods.

5.3.1.4. Drain blockages – Back flooding

Poor surface drain management or large amounts of effluents may lead to blockage of drains which in turn could result in flooding and unsanitary conditions within the neighborhood. Blocked drains produce a bad odour and are a threat to general health, hence are environmentally unfriendly.

Recommended Mitigation Measures

- i. The proponent should ensure that there are adequate means of handling the large quantities of sewage generated at the facility.
- ii. It will also be important to ensure that septic pipes are not blocked or damaged since such occurrences can lead to the release of the effluent, resulting in land and water contamination.
- iii. Such blockages or damages will be fixed expeditiously

5.3.1.5. Vector and rodents breeding grounds – Vulnerability to diseases

If the project does not have well-designed storm water drains, the rainwater may end up stagnating or intruding neighbouring facilities and hence creating conducive breeding areas for mosquitoes and other water-based vectors leading to human diseases like malaria. Poor solid waste management practices may also lead to breeding grounds for pests such as rats and other scavenging animals.

Recommended Mitigation Measures

- i. The design of the construction should ensure that no space for stagnant water will be retained.
- ii. A well maintained trash collection point should be set aside.
- iii. The proponent should put in place efficient storm water and waste management systems that will prevent the accumulation of rain water and uncontrolled waste, as well as an efficient collection system and off-site disposal.
- iv. Proper monitoring of the premise should be effected for maintenance of health and hygiene.

5.3.1.6. Electricity consumption – pressure on supply

The project shall consume large amount of electricity due to activities that will take place once the project is complete. Since electric energy in Kenya is generated mainly through natural

resources, namely water and geothermal resources, increased use of electricity have adverse impacts on these natural resources base and their sustainability.

Recommended mitigation measures:

- i. Maximize the contribution of daylight to reduce use of artificial lighting in the buildings;
- ii. Select the most efficient lighting system design and minimum lighting level appropriate for the required application;
- iii. Install energy saving appliances;
- iv. Select the most effective lighting controls for optimal operating efficiency and minimum energy wastage.
- v. The project design should consider use of solar energy for water heating.
- vi. Monitor energy consumption to establish trend;
- vii. Maintain records;
- viii. Develop an energy management plan.

5.3.1.7. Water supply and consumption

Table 5.2: The issues and recommended mitigation measures are:

Issue	Recommended mitigation measure
Water consumption:	• Monitor water consumption • Install internal water meters.
Rainwater harvesting	• Incorporate rainwater harvesting measures.
Estimated water demand:	• Manage consumption rigorously.
Water conservation.	• Installing plumbing fittings, appliances and devices to optimise water use efficiency; • Recycling of wastewater to reduce water consumption.

5.3.1.8. Noise and Vibration

Operation of heavy equipment and traffic can generate significant noise and ground vibrations. Prolonged exposure may lead to hearing loss in workers, discomfort among nearby residents, and disruption of local fauna.

Recommended Mitigation Measures

- Install noise suppressors and vibration dampeners on equipment.
- Erect acoustic barriers or earth berms near sensitive areas.
- Schedule noisy operations during daylight hours.
- Conduct periodic noise level monitoring as per Noise and Excessive Vibration Pollution Control Regulations, 2009.
- Provide ear protection and enforce shift rotation to reduce exposure.
- Engage local communities and establish a grievance redress mechanism.

5.3.1.9. Water pollution and Usage

Cement production requires significant amounts of water for cooling and dust suppression. Without proper treatment, effluent may contain suspended solids, heavy metals, or oil residues, which can contaminate water bodies.

Recommended mitigation measures:

- Install an Effluent Treatment Plant (ETP) compliant with Water Quality Regulations, 2006.
- Recycle process water through closed-loop systems to minimize abstraction.
- Store chemicals in bunded areas to prevent accidental spills.
- Design storm water channels with oil interceptors before discharge.
- Apply for water abstraction permits from WRA and monitor usage.

5.3.1.10. Soil Degradation and Land Use Change

Land clearing and excavation can lead to erosion, soil compaction, and loss of productive agricultural land. Poor handling of construction debris may also cause contamination.

Mitigation measures

- Minimize land clearance and preserve topsoil for later restoration.
- Construct gabions, silt traps, and retaining walls on sloped areas.
- Develop and implement a site restoration and landscaping plan post-construction.
- Align project with Kisumu County Physical and Land Use Development Plans.
- Reuse excavated materials where appropriate to reduce waste.

5.3.1.11. Solid and Hazardous Waste Generation

Solid waste from maintenance activities, packaging, and off-spec production can include both non-hazardous and hazardous materials. Improper disposal could pose risks to public health and the environment.

A key environmental strength of the proposed technology is that the process generates no by-products. The use of a closed-loop dust collection system and the application of cement additives minimizes waste generation. Additionally, process water recycling and material efficiency reduce the potential for environmental contamination.

Mitigation measures

- Segregate waste at source into recyclable, reusable, and hazardous categories.
- Partner with licensed waste handlers under the Waste Management Regulations, 2023.
- Store hazardous waste in clearly labeled, weatherproof containers.
- Prepare a Waste Management Plan (WMP) that includes take-back programs for packaging.
- Comply with Extended Producer Responsibility (EPR) obligations.

5.3.1.12. Biodiversity Loss

Clearing of vegetation and noise/light from operations can disturb local wildlife and cause habitat fragmentation. In Awasi, potential disruption of wetland or riverine ecosystems should be considered.

Mitigation Measures:

- Conduct a baseline biodiversity assessment and identify sensitive species.
- Retain green corridors and native vegetation where possible.
- Rehabilitate disturbed areas using indigenous tree species.
- Implement lighting protocols to reduce nighttime disruption to fauna.
- Follow EMCA (Conservation of Biological Diversity and Resources) Regulations, 2006.

5.3.1.13. Traffic and Road Safety Risks

The movement of raw materials and cement products will increase traffic congestion, raise accident risks, and deteriorate local road infrastructure.

Mitigation Measures:

- Prepare and implement a Traffic Management Plan in coordination with KeNHA and county authorities.
- Limit heavy truck movement to off-peak hours.
- Use escort vehicles and road signage near schools or market centers.
- Train drivers on defensive driving and vehicle maintenance.
- Upgrade access roads and maintain them regularly.

5.3.1.14. Visual and Aesthetic Impacts

The large physical footprint and industrial appearance of the cement factory may reduce the visual appeal of the surrounding landscape, especially if adjacent to residential or agricultural areas.

Mitigation Measures:

- Apply architectural screening, paint schemes, and landscaping to blend the structure with the environment.
- Plant tree buffers and install perimeter fencing with aesthetic elements.
- Design structures with low profile roofing and compact footprints.
- Engage the community in design considerations for better social acceptance.

5.3.1.15. Occupational Health and Safety Risks

Workers in cement plants are exposed to high temperatures, machinery accidents, dust inhalation, and chemical handling, posing significant health risks.

Mitigation Measures:

- Conduct risk assessments and implement Health, Safety, and Environment (HSE) plans.
- Provide Personal Protective Equipment (PPE) and train all staff in Occupational Safety and Health Act, 2007 compliance.
- Install first aid stations, firefighting equipment, and emergency response systems.

- Carry out regular occupational health surveillance and safety drills.

5.4. Decommissioning

Decommissioning is the process of shutting down an operational facility in a manner that leaves the area in a safe and stable condition that is consistent with the surrounding physical and social environment. The Contractor will ensure that:

- The process of closure occurs in an orderly, cost effective and timely manner with the allocation of adequate resources;
- The anticipated cost of decommissioning is adequately provided for in the project costs.

The Contractor will be expected to:

- Carry out consultations with stakeholders
- Develop the action plan for demolition including the assigning of roles for the demolition crew;
- Isolate power at the main switch and remove cables up to that point;
- Dismantle, remove and dispose of construction camp equipment and structures in an appropriate environmentally friendly manner;
- Request utility service providers to disconnect the power, water and telephones as may be appropriate;
- Reinstatement of the land to its natural condition by filling excavations and planting suitable saplings.

The Contractor must obtain a Certificate of Satisfactory Decommissioning from the relevant Authorities. In the unlikely event that the facilities is closed down decommissioning would comprise the reduction of all buildings and facilities to a safe condition and the restoration of the land to its original condition. The following will be done:

- Notification of intent to all relevant regulatory agencies;
- Liaise with project Consultants including architects, engineers, and environmentalists to ascertain guidelines, anticipated de-commissioning impacts and mitigation measures.

5.4.1. Decommissioning phase Negative Impacts

During the decommissioning phase, another comprehensive EIA study based on the intended new use of the site will be conducted. Decommissioning may involve one of the following

options: facing out operations and evacuating the premise without carrying out any other plans; change of use of the facility; demolition of the property to restore it to the current or better status.

5.4.1.1. Solid Waste Generation

Demolition of the facilities and related infrastructure will result in large quantities of solid waste. The waste will contain the materials used in construction including concrete, metal, drywall, wood, glass, paints, adhesives, sealants and fasteners. Although demolition waste is generally considered as less harmful to the environment since they are composed of inert materials, there is growing evidence that large quantities of such waste may lead to release of certain hazardous chemicals into the environment. In addition, even the generally non-toxic chemicals such as chloride, sodium, sulphate and ammonia which may be released as a result of leaching of demolition waste, are known to lead to degradation of groundwater quality.

5.4.1.2. Dust

Large quantities of dust will be generated during demolition works. This will affect demolition staff as well as the neighbouring residents.

5.4.1.3. Noise and Vibration

The demolition works will lead to significant deterioration of the acoustic environment within the project site and the surrounding areas. This will be as a result of the noise and vibration that will be experienced as a result of demolishing the proposed project.

Table 5.3: Summary of impacts and their proposed mitigation measures

PROJECT PHASE	ASPECT/ACTIVITY	POTENTIAL IMPACT	PROPOSED MITIGATION MEASURES
CONSTRUCTION & EQUIPMENT INSTALLATION	Site clearance and earthworks	• Loss of vegetation • Soil erosion- Visual scarring	• Limit vegetation clearance to designated areas • Erect soil erosion controls- Replant native vegetation
	Construction machinery and equipment use	• Noise and excessive vibration • Occupational injuries	• Use of modern, well-maintained machinery- Limit construction to daytime hours • Provide PPE and safety training
	Transportation of materials and equipment	• Traffic congestion • Road degradation- Accidents	• Develop traffic management plan- Schedule off-peak transport • Use trained drivers and maintain vehicles

	Temporary worker housing & sanitation	• Pressure on water & sanitation systems • Social tensions	• Provide adequate sanitation facilities- Source water sustainably • Conduct community sensitization
	Aesthetics	• Visual intrusion from structures and dust	• Screen construction areas- Implement dust suppression measures • Use aesthetically compatible materials
	Occupational Safety & Health	• Risk of injury, exposure to noise and dust	• Site induction, PPE, signage, and first aid stations • Engage a safety officer- Enforce health & safety protocols
	Fire risks from fuel storage	• Fire outbreaks or explosions	• Designate fire assembly areas- Install fire extinguishers and signage • Store fuels in approved containers, away from heat

OPERATION (RAW MATERIAL OUTSOURCING, PRODUCTION)	Outsourcing of raw materials	• Depletion of source areas • Environmental degradation at quarries	• Vet suppliers for environmental compliance • Promote sustainable mining practices
	Raw material transportation	• Emissions • Dust- Noise- Road safety risks	• Use covered trucks • Maintain access roads- Enforce speed limits and proper driver conduct
	Cement grinding, blending & packaging	• Dust emissions- Noise and Vibration • Solid waste (clinker dust, packaging)	• Install bag filters, noise dampeners • Enclose noisy equipment • Reuse packaging material, safely dispose of dust
	Water use (cooling, cleaning)	• Over-extraction • Competition with local users	• Install water meters • Recycle process water- Harvest rainwater
	Disposal of effluent	• Water pollution • Odour issues	• Treat wastewater before discharge • Acquire effluent discharge license from NEMA

			• Use sedimentation and oil separators • Monitor effluent regularly
	Solid waste management	• Nuisance, health hazards, illegal dumping	• Implement waste segregation • Contract NEMA licensed waste collectors • Encourage cement bag returns
	Aesthetics	• Industrial look may degrade landscape	• Landscape buffer zones • Use neutral paint colors and maintain cleanliness
	Occupational Safety & Health	• Exposure to cement dust • Slips, trips, machine hazards	• Regular training, enforce PPE use- Maintain clear walkways • Install emergency shutoff systems
	Fire risks (kilns, storage)	• Potential explosions or equipment fires	• Install fire alarms, extinguishers, hydrants • Conduct regular fire drills and system checks
DECOMMISSIONING	Equipment dismantling and demolition	• Dust, noise- Safety risks	• Use dust suppressants • Engage trained demolition experts

			• Provide protective equipment
	Disposal of demolition waste	• Visual pollution- Soil contamination	• Recycle materials where feasible- Dispose at designated sites • Maintain waste manifests
	Restoration and landscaping	• Visual and ecological degradation if abandoned	• Rehabilitate site (grass, trees) • Remove all concrete structures • Monitor post-closure land use
	Loss of jobs	• Unemployment, reduced local spending	• Provide adequate notice • Engage in retraining or transition support • Collaborate with county for development projects
	Fire and security risks (during idle phase)	• Vandalism, arson, trespassing	• Secure the site with fencing • Engage local security • Remove flammable materials

CHAPTER SIX PROJECT ALTERNATIVES

6.0 The Proposed Alternatives

This section discusses the potential impacts (both positive and negative) and proposes alternatives to the execution of the project based on the information generated by the analysis of the environmental issues above.

6.1 Alternatives to development

6.1.1. Site alternative

In the Environmental and Social Impact Assessment (ESIA) process, evaluating site alternatives is a critical step in ensuring that the location selected for a project is environmentally, economically, and socially viable. For the proposed Mamba Cement Factory in Awasi, the proponent has already identified and partially acquired land within an agricultural area. The necessary agreements are in place, and the process of securing title deeds is underway. This section outlines and discusses the site alternatives considered in the planning of the cement factory, including the rationale for the preferred location and an evaluation of environmental and socio-economic implications.

The Proposed Site (Preferred Alternative)

The proposed site for the Mamba Cement Factory is located in Awasi, Kisumu County, within an area currently zoned for agricultural use but earmarked for conversion to industrial use. It lies in close proximity to the Rai Cement Plant, Stonefield Quarry, and Gogni Rajoje Quarry. These neighboring industrial activities provide a strategic advantage for the proposed factory due to shared infrastructure, such as road networks and utility services. Additionally, sourcing raw materials like limestone and pozzolana from nearby NEMA-licensed quarries significantly reduces transportation costs and emissions, enhancing the environmental sustainability of the project. While the land is currently agricultural, the planned change of use aligns with Kisumu County's spatial planning agenda to promote industrial growth in the area. However, the site may experience moderate community resistance due to the conversion of farmland and potential cumulative environmental impacts, such as air and noise pollution from clustered industrial activity.

Alternative Industrial Locations

Another option is to site the factory within an already established industrial estate, possibly on the outskirts of Kisumu City. These areas are already zoned for industrial activity, which would reduce legal and administrative hurdles, and potentially lower the risk of public opposition. Such locations also benefit from pre-existing utility connections and access roads. However, the major drawback is their distance from primary raw material sources, which would increase transportation costs, energy consumption, and associated emissions. Additionally, the cost of land acquisition in established industrial parks is generally higher, and logistical complexities may arise due to urban congestion.

Greenfield Sites Nearby

Greenfield sites in the wider Awasi region could offer a blank slate for development, with the possibility of designing a factory layout optimized for environmental mitigation. Such sites may provide adequate space for buffer zones and future expansion. However, they come with significant drawbacks, including the need for complete infrastructure development and likely conversion of agricultural land, which might lead to public resistance. These sites would also increase the project's footprint and potentially impact biodiversity and ecosystems more severely.

Clustered Industrial Development

The option of clustering the Mamba Cement Factory directly with existing industrial operations such as Rai Cement and nearby quarries presents operational efficiencies. These include shared transportation corridors, power lines, and waste management systems. Clustered development also enables coordinated environmental monitoring, which can improve compliance and reduce cumulative impacts through joint mitigation measures. However, it may exacerbate localized environmental degradation due to the concentration of heavy industries. The risk of cumulative air and noise pollution, as well as strain on local infrastructure, must be carefully assessed and managed.

Conclusion and Justification

After evaluating the available site alternatives, the preferred site in Awasi stands out as the most viable location. Its proximity to raw materials, existing infrastructure, and complementary

industrial activities makes it economically efficient and environmentally preferable when compared to distant or isolated locations. Although there are environmental and social concerns related to land use conversion and cumulative impacts, these can be addressed through proper mitigation measures such as establishment of buffer zones, community engagement, phased development, and adherence to national regulations including the Physical and Land Use Planning Act, Environmental Management and Coordination Act (EMCA, 1999, revised 2015), and county spatial plans. Additionally, the proposed site contributes to the strategic goal of industrializing the region while leveraging economies of scale with minimal environmental trade-offs, when managed responsibly.

Table 6.1: Comparative matrix

Criterion	Proposal Site	Industrial Estate	Greenfield	Industrial Cluster
Proximity to raw materials	★ ★ ★ ★	★ ★ ★	★ ★	★ ★ ★ ★
Infrastructure availability	★ ★ ★	★ ★ ★ ★	★ ★	★ ★ ★ ★
Land acquisition friendliness	Moderate	High	Low	Moderate
Community & social impact	Medium	Low	High	High
Cumulative environmental risk	Medium–High	Medium	Low	Very High
Conversion & cost risk	Moderate	Low	High	Low

6.2 Technology Alternatives

In line with the requirements of the Environmental and Social Impact Assessment (ESIA) process, an evaluation of the technological alternatives is essential to ensure that the selected methods, equipment, and systems are environmentally sound, economically viable, and socially acceptable. The proposed Mamba Cement Factory in Awasi has adopted an innovative and sustainable technological approach aimed at producing green cement. This section provides a detailed discussion of the selected technology alternatives, their environmental performance, sustainability considerations, and alignment with national and international best practices.

Overview of Proposed Technology and Equipment

The Mamba Cement Factory plans to install a comprehensive set of modern industrial systems and equipment that support efficient and environmentally responsible cement manufacturing. These include a ball mill for grinding, classifier for particle separation, dust collectors for emission control, product silos for storage, and specialized facilities such as a humidity cabinet room, chemical room, sample testing room, and curing tank to support quality control and laboratory analysis. A weighbridge will be used to track material flows, while a store and power house will support logistical and energy needs. These components work in tandem to ensure that the production process is optimized for low emissions, precision, and efficiency.

Use of Cement Additives for Green Cement Production

One of the most progressive technological choices by the proponent is the incorporation of cement additives to reduce reliance on clinker a major contributor to CO₂ emissions in traditional cement manufacturing. By replacing a portion of clinker with supplementary cementitious materials (SCMs) such as fly ash, pozzolana, or slag, the factory will significantly lower its carbon footprint. This approach not only aligns with Kenya's Climate Change Act (2016) and National Climate Change Action Plan (NCCAP), but also complies with global industry standards such as the Cement Sustainability Initiative (CSI) under the World Business Council for Sustainable Development.

Advantages:

- Reduces greenhouse gas emissions.
- Promotes resource efficiency by using industrial by-products.
- Enhances durability and performance of cement products.
- Contributes to circular economy principles.

Dust Management Technology

The proposed plant includes the installation of high-efficiency dust collectors at key emission points such as the ball mill, classifier, and silos. These systems will ensure that dust emissions are kept well below the permissible limits set by the Environmental Management and Coordination (Air Quality) Regulations, 2014. The collected dust will be recycled back into the process, eliminating the generation of by-products or solid waste.

Environmental Benefits:

- No fugitive dust emissions to the surrounding environment.
- Improvement of workplace air quality, protecting workers' health.
- Compliance with NEMA air emission standards and IFC Performance Standard 3 on pollution prevention.

Power and Energy Use

The factory will install a power house equipped with energy-efficient machinery. The use of modern motors, variable speed drives, and energy recovery systems will optimize energy use. Opportunities for incorporating renewable energy solutions, such as solar panels for auxiliary services, can further enhance the plant's sustainability performance.

Best Practice Consideration:

- Energy-efficient technologies align with the Energy Management Regulations, 2012 under the Energy Act.
- Reduced operating costs and emissions.

Quality Control and Testing Infrastructure

The establishment of a sample testing room, chemical room, humidity-controlled cabinet, and curing tank demonstrates the proponent's commitment to product quality and compliance with Kenya Bureau of Standards (KEBS) requirements for cement products. These facilities will enable real-time monitoring of material properties and ensure consistent production of high-performance cement.

Contribution to ESIA Objectives:

- Ensures quality assurance and minimizes risk of defective products.
- Supports continuous environmental monitoring through sampling and lab analysis.

No By-products and Waste Minimization

A key environmental strength of the proposed technology is that the process generates no by-products. The use of a closed-loop dust collection system and the application of cement additives minimizes waste generation. Additionally, process water recycling and material efficiency reduce the potential for environmental contamination.

Sustainability Outcomes:

- Zero-waste approach consistent with the Environmental Management and Coordination (Waste Management) Regulations, 2023.
- Minimization of raw material usage through clinker substitution.

Conclusion and Justification of Preferred Technology

The technological setup chosen for the Mamba Cement Factory in Awasi reflects a strong alignment with Kenya's policy direction on low-carbon industrial development, environmental protection, and economic sustainability. By incorporating energy-efficient systems, emission control technologies, and clinker-reducing additives, the project not only complies with national environmental regulations but also promotes green industrialization. These technology alternatives are appropriate for the region's needs and provide an effective response to both market demands and environmental stewardship.

6.3. No project Alternative

The "No-Project" alternative considers the scenario where the proposed cement plant is not established, and the land continues to be used for agriculture. This alternative preserves the ecological and agricultural value of the land and avoids any potential displacement or disruption of local livelihoods. Additionally, it eliminates the risk of environmental degradation associated with cement production, such as dust emissions, water usage, and industrial waste. However, this alternative also forfeits substantial benefits, including employment opportunities, local economic development, infrastructure improvements, and contributions to national industrialization goals. While this option presents environmental and social advantages, it fails to address the growing demand for cement and regional development needs.

6.4. Preferred Option

For this project, there are limited alternatives for the project site because the proponent already owns the site after conducting a successful geotechnical survey. Therefore, emphasis is now placed on the technological approaches that the proponent will adopt in constructing and managing the proposed development.

CHAPTER SEVEN: PUBLIC PARTICIPATION

7.0. Overview

The project proposes mainly serve the public and the local people. Therefore it is imperative that the beneficiaries are involved in the project feasibility, planning, implementation and operation stages. In view of these, the ESIA team adopted a participatory approach during the study noting that stakeholders' participation in Kenya is entrenched in the constitution, several legal instruments and international instruments to which Kenya is a party.

The consultants endeavoured to ensure that due consideration is given to public values, concerns and preferences when decisions are made. It encompasses the public actively sharing in the decisions that government and other agencies make in their search for solutions to issues of public interest. Effective public participation requires the availability of adequate information in public in puts.

7.1. Legal Requirement for Public Participation

7.1.1. The Constitution of Kenya

Public participation is entrenched in several articles across the Kenya constitution 2010. Article 6 provided for devolution and access to services. Responsibilities in major decision-making process have been bestowed to the public (in the bill of rights, articles 118, 174, 196 and 201). The constitution further in article 21 section 3 requires safeguarding the rights and interests of marginalized groups for equity in public service provision. This can be effectively achieved through the active involvement of such groups in decision- making process at all levels. Hence need to involve the local people in the project area in the studies, design and implementation of the proposed project facilities.

7.1.2. Environmental Management and Coordination Act, 1999 (amended 2015)

Section 17 of the Environmental (Impact Assessment and Audit) Regulations of 2003 requires that all ESIA studies incorporate consultation with the public during the entire study process. The aim of public consultation in the project was to ensure that all stakeholders' issues and concerns in the proposed facilities are identified and their opinion considered during the project planning, design, implementation, operation and decommissioning phase.

7.1.3. County Government Act 2012

Public participation is integral in Kenya's development process as set out in the decentralized system of governance. The county government Act which sets out the service delivery procedure of county governments, has recognized local people involvement in decision making as key to governance. The Act in part VIII stipulates the principles of citizen participation and in part IX it guarantees the citizens' right to public communication as well as access to information. To ensure that there is optimal participation, the Act provides for civic education in part X to build the capacity of local people. Therefore, meaningful public consultation is significant during planning, implementing and operation of development projects hence the need for such consultations for the proposed development of the cement production project in Kisumu County.

7.1.4. International Convention (Aarhus Convention 1998)

The Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters entered into force in October 2001. The Convention grants the public rights regarding access to information, public participation and access to justice, in public decision-making processes on matters concerning the local, national and transboundary environment. It focuses on interactions between the public and public authorities.

7.2. Objectives of Public Consultations

Public participation is not a one-off event but a process throughout the project cycle that requires regular consultations. In regard to the preceding observation, the proposed project involved stakeholders' participation with the following objectives;

- Disseminate and inform the project stakeholders about the proposed project, its key components and activities, location and expected impacts with particular attention to potentially affected persons;
- Create awareness among the public and stakeholders on the need for the ESIA for the proposed project and its due process;
- To obtain information about the needs, concerns, comments, suggestions and priorities of the local people as well as their general reactions to proposed project activities;
- To obtain the cooperation and participation of the key stakeholders, affected persons and local communities in activities that were required to be undertaken for

designing, implementing and operating the proposed project or development of the project facilities;

- Create a sense of ownership, capacity build and ensure transparency in all activities related to the project including but not limited to designing, planning, implementing, environmental management, operation, monitoring and evaluation of the project by all key stakeholders; and
- To establish a clear communication channel, easily accessible and effective grievance procedure between the public, consultant team, the project proponent and the County government of Kisumu.

7.3. Stakeholders' Identification/Mapping

The public participation was an inclusive exercise that required proper planning and arrangements.

- The team ensured that the stakeholders identified are multi-sectorial touching on agriculture, lands, water, health, environment, county and national government. These stakeholders were consulted by use of a key stakeholders' meeting. To ensure that no major player is left out.
- The stakeholders were categorised into two groups of primary stakeholders and secondary stakeholders. Primary stakeholders are the beneficiaries of a development intervention or those directly affected (positively or negatively) by it. They included local populations (individuals and community-based organizations) in the project area, in particular, poor and marginalized groups who have traditionally been excluded from participating in development efforts. Secondary stakeholders are those who influence development intervention or are indirectly affected by it.

They included the proponent, government and county line ministry and departments, implementing agencies, civil society, NGOs and CBOs. The consultation programme developed and implemented taking into account the various areas of influence.

- Prior to the public meetings/barazas, the sites have been visited to identify all the stakeholders and appropriate meeting venues. This also presented a platform to consult with the area leaders and the residents hence developing a good rapport. The ESIA team

established contacts to enable proper planning and invitation of the public for the consultative meetings. The means of communication used to invite the public were verbal through the area chiefs/village elders and posters. The team in liaison with the Assistant County Commissioner settled on appropriate venues and dates for public meetings. The consultative meeting was held on 31st October 2025. The ESIA team documented the minutes and list of attendance.

7.4. Consultation Process

Legal Notice of 101 of June 2003 requires that all environmental and social assessment processes in Kenya incorporate Public Consultation. This a requirement informed by an awareness that the development and implementation of projects can occasion diverse impacts on stakeholders who should consequently be informed appropriately following which they can make an informed decision about the proposed development. It is also important to ensure that all stakeholder interests are identified and incorporated in project development, implementation and operation and, against such background, the consultation was undertaken far and wide both within the project area and outside with the following objectives; -

1. To disclose the Study to both primary, secondary and other stakeholders;
2. To obtain the reaction/comments/concerns of all stakeholders so as to understand their perceived view of the proposed project and assess the extent to which their views need to be taken into account. This is important as it helps to ensure that important social issues are not overlooked and there is ownership from the communities in all the project areas;
3. Improve project design by incorporating their views, thereby, minimize conflicts and delays in implementation;
4. Increase long term project sustainability and ownership of the project;
5. Identify local leaders with whom further dialogue can be continued in subsequent stages of the project.

7.5. Tools used in stakeholder and public consultations

7.5.1. Reconnaissance Visit

The ESIA study process commenced with a reconnaissance visit to the project area. The consultants alongside the proponent's representatives visited the proposed project site for a reconnaissance survey on diverse dates. The goal of the visits have been to familiarize the team with the project site and assess the status of the construction site and the farms. The proponent

explained the origin and justification of the project as well as the planning activities that had so far taken place in relation to the proposed project.

7.5.2. Feasibility

A feasibility study of the project had already been done. The proponent also confirmed that they had already acquired the 5-acre piece of land in the area that was earmarked for the construction of the proposed cement factory.

7.5.3. License

An Environmental and Social Impact Assessment study is necessary before a decision to issue a NEMA licence can be made. The proponent had authorized the consultants to prepare a Terms of Reference (TOR) for the consultancy assignment and to further undertake the study.

7.5.4. Meeting with NEMA County Director

The consultants and the proponent held a joint meeting with the NEMA County Director of Environment at Kisumu County. The purpose of the meeting was to appraise the office on the proposed project and to identify the broad environmental concerns.

7.5.5. Meeting with area chiefs

The consultant's and proponents' team have also had a meeting with the area chief on 9th October 2025 to inform him about the project and seek his support in mobilizing the public during the public consultation forums. It was agreed that the consultant and proponent would hold one huge meeting on 31st October 2025 at the proposed project site.

7.5.6. Public Consultation Meeting

PCM – The Consultants in collaboration with the national government led by the Area Chief and the assistant chief carried out public participation on the proposed cement manufacturing project at the proposed site. During the meetings, Mamba Cement Limited representatives and the consultants explained the salient features of the project including geographical scope, infrastructure, expected benefits that was cross-checked with the communities and environmental aspects. The community members was given an opportunity to air their views and bring out the issues that were of concern to them. The meetings addressed the following topics: Overview of the project; environmental aspects; socio-economic aspects including anticipated project benefits; community participation in the project; natural resources including

water, land and environmental and social issues including likely negative impacts and the proposed mitigation measures.

7.5.7. Kenya Gazette and Mass Media Public Notice

After the EIA report is finalized and submitted to NEMA, in line with EMCA, NEMA will prepare public notices to be advertised in the Kenya Gazette and the mass media (print media and radio) inviting public comments and views about the proposed development.

CHAPTER EIGHT: ENVIRONMENTAL MANAGEMENT PLAN

8.0 Introduction

The Environmental Management Plan involves the protection, conservation and sustainable use of the various elements of the environment. The EMP for the proposed project provides all the details of its activities, impacts, mitigation measures and expected costs during implementation and decommissioning phases of the project. This project bears the potential of a number of negative impacts on the environment. With proper environmental management procedures in place and adhered to then there should be minimal negative impact of concern emanating from it. Key areas that require mitigation measures include wastewater, solid wastes, maintaining good air quality, safety, and storm water management.

Table 8.1. below indicates measure for Environmental Management Plan

Table 18: Environmental Management Plan (EMP)

CONSTRUCTION PHASE					
Environmental parameter	Impact	Mitigation measure	Responsible party	Time frame	Cost (Ksh.)
Air / Dust (site clearance, earthworks, material handling)	Fugitive dust causing reduced air quality, nuisance to neighbors, health risk to workers	• Water suppression (water bowser) during earthworks and unpaved roads (daily). • Limit stockpile heights • Cover or apply surface stabiliser when inactive (>7 days). • Vehicle speed limits (≤ 20 km/h) on-site • Truck covers for loads off-site. • Vegetative buffer strips and temporary windbreak fencing around stockpiles.	Contractor (Site Manager); Environmental Officer (EO)	During earthworks & installation (daily controls during construction season)	600,000
Air / Point sources (temporary generators, diesel engines)	Emissions (NO _x , SO _x , PM), odour, GHG	• Use properly maintained engines • Install low-sulphur diesel use policy • Locate generators and workshops downwind of sensitive receptors • Temporary exhaust silencers.	Contractor; Plant Procurement	Continuous during equipment commissioning & temporary power use	< 300,000

Surface water / Sediment (runoff from cleared areas)	Increased turbidity and sedimentation in nearby drains and watercourses	• Temporary drainage diversion • Silt fences, sediment traps and lined sedimentation ponds at low point • Stabilise soil with mulch/geo-fabric and revegetate disturbed areas • Spill response kit and bunding around fuel storage.	Contractor; Project Manager County Public Works liaison	During construction & rainy seasons; inspect after storms	700,000
Groundwater / Fuel & chemical spills	Soil and groundwater contamination from fuel, oils, lubricants	• Designated fuel delivery area with impermeable bunded pad (100% capacity) and oil interceptors • Secondary containment for drums • drip trays during maintenance • Maintain MSDS and emergency spill response plan • Train staff. • Provision of PPE	Contractor; Fuel supplier; EO	From fuel storage installation throughout construction	200,000
Solid & hazardous waste (construction debris, packaging, used oil)	Littering, illegal dumping, contamination	• Waste segregation (inert, recyclable, hazardous) and labelled bins • contract licensed waste handler for hazardous wastes	Contractor	Continuous during construction	260,000
Noise & vibrations (plant, piling, heavy equipment)	Worker & community disturbance;	• Schedule high-noise activities during daytime • provide PPE (ear defenders)	Contractor Project manager	During noisy activities; continuous monitoring weekly	150,000

	potential structural damage	• Use newer equipment with silencers • Maintain engines • Noise barriers where near residences. • Community notification & complaint register.	Community Liaison Officer (CLO)		
Biodiversity & vegetation clearing	Loss of habitat, increased erosion; disturbance to fauna	• Pre-Clearing Ecological Walkover • Mark and avoid sensitive trees • Transplant native seedlings where feasible • Minimise clearing footprint and reinstate topsoil for replanting.	Contractor; Environmental Specialist	Pre-construction & during clearing	100,000
Traffic & community safety (construction vehicles on public roads)	Road safety risk, congestion, dust, damage to roads	• Traffic Management Plan (TMP) • Flaggers • Signage • Agreed haul routes • Off-peak deliveries • Repair damaged public roads by contractor.	Contractor Community Liason Officer (CLO)	Throughout construction, especially peak delivery periods	250,000
Socio-economic (local employment, influx)	Local benefits but also social tensions, housing pressure	• Local hiring policy • skills training program • grievance mechanism • workforce code of conduct.	Contractor HR CLO	Recruitment and entire construction period	350,000

Archaeology & cultural heritage	Chance finds during excavation	• Chance-find procedure: stop works, secure area, notify County and NEMA; • Record & protect.	Contractor Project Manager (PM) County Cultural Officer	During earthworks	100,000
Environmental Management (monitoring & compliance)	Non-compliance risk, poor implementation	• Full-time Environmental Officer on site • weekly inspections and monthly compliance reports • Ambient dust (PM10) monitoring • Water quality sampling (upstream/downstream). • Budget for NEMA liaison and permit fees.	proponent	Throughout construction + 12 months post-installation	360,000

OPERATION PHASE					
Environmental parameter	Impact	Mitigation measure	Responsible party	Time frame	Cost (Ksh.)
Air quality; fugitive dust (crushing, grinding, transfer, stockpiles)	PM10/PM2.5 and dust nuisance; health risks; non-compliance with Air Quality Regulations	• Install fabric filters (baghouses) / electrostatic precipitators on mill and clinker cooler stacks; • Enclosed conveyors; • Transfer point enclosures and local extraction. • Continuous dust suppression (sprays) at transfer and loading points. • Regular maintenance schedule for baghouse filters, leak detection and housekeeping. • Ambient air quality monitoring (PM10/PM2.5) at plant perimeter and at sensitive receptors.	Plant Operations Manager; Maintenance; EO	Continuous during operations; monitoring monthly	2,000,000
Air emissions; stack emissions (NO _x , SO ₂ , PM) from kiln & burner)	Regulatory exceedances, transboundary impacts, health risk	• Use low-NO_x burners and combustion control; monitor fuel quality (low sulphur	Plant Technical Manager; EO	Continuous; periodic monitoring quarterly	2,000,000

		fuels or alternative fuels with controls) • Stack emission monitoring (CEMS or periodic sampling) and ensure compliance with schedule in Air Quality Regulations (emission limits & permits) • Maintain combustion efficiency, periodic tuning.			
Wastewater / process effluent	Contamination of surface/groundwater, violation of discharge consents	• Implement the sedimentation /oil–water separator/ recycling system sized earlier • Duty to obtain effluent discharge license from NEMA • Regular effluent sampling (BOD, TSS, pH, oil & grease, heavy metals) and calibration of flow meters.	Plant Manager EO	Continuous operations; Sampling weekly/monthly	200,000
Waste (solid—slag, cement dust, packaging) & hazardous wastes	Landfill pressure, potential contamination; non-compliance with Waste Management Regs	• Waste hierarchy: avoid, reuse, recycle. Reuse cement kiln dust (CKD) in product blending or road sub-base where safe; • Segregate hazardous waste (used oils) and use licensed collectors.	Operations; Waste Contractor; EO	Continuous	600,000

		On-site recycling area, labelled skips, quarterly waste audits.			
Noise (plant operation, transport)	Nuisance to local communities; compliance with Noise Regs	- Noise mapping; install acoustic enclosures for high-noise units (compressors), maintain mufflers. - Schedule heavy deliveries to daytime - Maintain haul roads and speed limits - Community notification for any high-noise maintenance.	Plant Operations Manager CLO	Continuous	200,000
Occupational health & safety (OHS)	Injuries, respiratory disease, hearing loss, chemical exposures	- Comprehensive OHS Management System per OSHA 2007: work permits, confined space procedures, PPE (respirators, hearing protection), - training, - medical surveillance (baseline and periodic), - safety committee. - Respiratory protection program for dust exposure; - fit testing & PPE replacement schedule.	Plant HR & OHS Officer; EO	Continuous; training quarterly	600,000

Greenhouse gases (CO2 from fuel, electricity)	GHG emissions contribution; corporate sustainability concerns	• Energy efficiency program (waste heat recovery where feasible), • Fuel switch options, • Baseline GHG inventory and annual reporting. • Consider clinker substitution (pozzolana, fly ash) to lower clinker factor.	Plant Manager	Baseline at commissioning; annual reporting	600,000
Traffic & roads (increased heavy truck movements)	Road degradation, accidents, community impacts	• Agreement with county on haul routes • truck scheduling; weighbridge & tyre wash • Road maintenance fund contribution.	Operations; Logistics Manager Community	Continuous	1,200,000
Community health & social (dust, jobs, expectations)	Expectation gap, local employment disputes, health impacts	• Community investment plan (local recruitment 60% target), • Grievance & redress mechanism, • Regular stakeholder consultations, • Community health outreach.	CLO	Ongoing	1,000,000
Monitoring & compliance (permits, audits, reporting)	Risk of regulatory non-compliance and fines	• Maintain permit register (NEMA, WRA, County), • Annual independent environmental audit (EA),	Plant General Manager	Continuous; audits annually	450,000

		Quarterly self-monitoring and public disclosure of key indicators.			
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DECOMMISSIONING PHASE					
Environmental parameter	Impact	Mitigation measure	Responsible party	Time frame	Cost (Ksh.)
Land contamination / soils (residual hydrocarbons, heavy metals)	Long-term contamination of soils and groundwater	- Prepare Decommissioning Plan and Site Remediation Plan (soil sampling, delineation). - Remove all fuel tanks and contaminated soils; - Treat or dispose at licensed facility; - Backfill with clean material and cap where required.	Proponent NEMA	Prior to dismantling & after plant removal	3,100,000
Waste management; dismantled equipment, scrap, hazardous waste	Large volumes of waste; risk of illegal dumping	- Segregate recyclable scrap (sell where possible), - Hazardous wastes to licensed handlers,	Decommissioning Contractor	During decommissioning	2,000,000

		• Arrange transport & disposal licenses.			
Noise & dust during demolition	Community disturbance, worker exposure	• Dust suppression, water sprays during demolition • enclose demolition of dusty structures • schedule noisy work during daytime and notify community.	Decommissioning Contractor CLO	During demolition period	150,000
Water quality & runoff (exposed soils)	Increased turbidity and sediment runoff	• Install silt traps / temporary sedimentation ponds; • re-vegetate disturbed areas quickly • Maintain controls until stable.	Contractor; EO	During immediately and after demolition	300,000
Ecological restoration / landscaping	Loss of habitat; visual impacts	• Rehabilitate site: topsoil replacement • native species planting • Post-planting maintenance for 2 years.	proponent Environmental Specialist	After demolition (6–24 months)	600,000
Redevelopment / land use conversion	Potential contamination risk for new use	• Provide Remediation Certificate & “as left” condition report • restrict land use where residual contamination remains • Incorporate monitoring wells if necessary.	Proponent County Planning	Post-decommissioning	450,000

Worker safety during teardown	Injuries, falls, confined space hazards	• Implement demolition-specific safety plan, • PPE, • Medical support.	Decommissioning Contractor OHS Officer	During demolition	300,000
Monitoring & reporting (final audit)	Failure to meet regulatory closure/permit requirements	• Final environmental audit, • submit closure report to NEMA and County • Final stakeholder disclosure and sign-off.	Client; External Auditor; EO	Within 3 months of completion	350,000

CHAPTER EIGHT: CONCLUSIONS

This Project Report has been prepared to provide sufficient and relevant information on the proposed project to enable NEMA to establish whether activities of the project are likely to have significant adverse environmental impacts. Mitigation measures have been proposed for identified impacts in this report and an Environmental Management Plan (EMP) for the implementation of the proposed measures has been presented. The EMP presented in this report is a tool to be used by the Project Team during the construction, hand-over and operation periods.

To ensure implementation, mitigation measures should be reflected in the Conditions of Contract and Bills of Quantities. It is the responsibility of the Proponent to ensure these measures are incorporated into these two documents.

It is recommended that the available waste management systems must be monitored to ensure that they adequately handled.

In this respect the project can proceed on condition that the concerns are addressed the proposed mitigation measures are implemented and an ESIA license issued with the above conditions taken fully into account amongst any others.

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10. Kenya gazette supplement number 56. Environmental (Impact Assessment and Audit) Regulations, 2003. Government Printer, Nairobi.

11. Kenya Gazette Supplement Number 69. Environmental Management and Coordination (Waste Management) Regulations, 2006. Government Printer, Nairobi.
12. Kenya Gazette Supplement Number 74. Environmental Management and Coordination (Fossil Fuel Emissions Control) Regulations, 2006. Government Printer, Nairobi.
13. Occupational Safety and Health Act, 2007
14. Sessional Paper No. 1 of 1999. Government Printer, Nairobi.
15. County Integrated Development Plan For Kisumu County, 2018 -2023

Annexure

1. Proof of land ownership
2. Certificate of registration
3. KRA Pin
4. Summary of bill of quantities
5. Proof of Public Participation
6. Proposed plans/designs