FINAL DRAFT ENVIRONMENTAL IMPACT ASSESSMENT OF THE PROPOSED CEMENT GRINDING PLANT AT LOTS 3 & 4 MARCH PEN ROAD, SPANISH TOWN, ST. CATHERINE

Submitted to:

MAINLAND INTERNATIONAL LIMITED
8 March Pen Road
Spanish Town

MAY 2006

CL ENVIRONMENTAL
Taking Care of You and Your Environment.

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Submitted to:

MAINLAND INTERNATIONAL LIMITED
8 March Pen Road
Spanish Town

Submitted by:

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MAY 2006

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Portland cement is the basic ingredient in concrete. Locally as well as globally cement consumption has increased with global increase averaging 2.75% in the period 2000-2002. There are an estimated 1,447 integrated production facilities and a further 250 separate grinding installations world-wide.

The proposed Mainland cement grinding plant project involves the grinding and packaging of the overall cement production process to produce 150 tonnes per day of Portland cement in the initial stage. The second phase will involve the increase in production to approximately 340 tonnes of Portland cement. The process consists of the cement milling (clinker size reduction with additional materials) and cement packing and dispatch. Clinker will be transported to the proposed plant from either Kingston Wharves or from Port Esquivel by covered trucks. The clinker will be stored on hardstands on the ground and covered under polyethylene sheets. It will be transferred to silos where it will be held prior to milling. Limestone to be used in the process will be sourced and transported from Pauls Mountain quarry in St. Catherine, 12 km from the proposed site. Electronic weigh proportioners will introduce the clinker which with addition of other additives will result in cement. Cement milling will be performed by tube (ball) mills in an open circuit with external water sprays for cooling. All input raw materials of clinker, limestone and gypsum, will be completely used thus excluding waste which may be generated as a result of materials handling (spillages and as a result of dust) it is anticipated that there will be no waste from the overall general grinding and bagging process.

The proposed area of the Mainland cement processing plant is 7,975 square metres with an additional 5,870 square metres of land immediately adjacent to the cement processing plant to be filled and stabilized. On completion it is expected that site will be completely paved to accommodate the use of trucks and other heavy equipment with drainage to tie-in with the existing drainage under Spanish Town by-pass. No sediment traps (or oil-water separators) are proposed for the development.

Mainland proposes to utilize both a grey-water as well as black-water sewerage system for its proposed 54 workers. The grey-water system will consist of trap gully basins (for removing the primary solids) and a soak-away pit which will overflow to the black-water system. The black water system will consist of a septic tank and an Evapotranspiration (ET) bed of approximately 2384 m^2 with vegetation to be planted on the surface of the bed to enhance the transpiration process.

The yearly mean maximum temperature of 31.7°C and a yearly mean minimum temperature of 19.9°C expected at the proposed site are normal for an inland tropical site. Combined with a annual mean rainfall of 67 mm the RH data as reported from the Bernard Lodge station shows that a yearly mean of 19.3%; humidity may be expected at the proposed site indicating a dry arid conditions. The predominant easterly wind with average speeds of 1 and 3 m s^{-1}. These conditions are standard for the location within the island and require no mitigation strategies.

The site of interest is situated on the Rio Cobre alluvial fan, of indeterminate depth but is thought to be less than 30 m. Horizontal variation in soils across the site was minimal and soils were generally a mixture of Stiff Silty Clays overlying Dense Medium to Fine Silty Sands. Foundation type that reduces or mitigate the effects soil concerns were recommended and no major foundation deformation problems are envisaged across the site. Excavation, paved area and infrastructure recommendations are provided to facilitate adequate construction of drainage and absorption pits. The closest previous earthquake epicentre to the proposed site was approximately 1.3 km southwest of the site in question. This earthquake occurred 10 years ago in 1985 and measured 2.2 on the Richter scale at a depth of 0 metres. The site is therefore relatively safe for this type of construction.

Being an already cleared site there were no floral nor faunal characteristics which will be impacted by the development. The noise on the proposed property was relatively low (Figure 28). Average noise levels at all locations tested were below standards for residential areas, noise pollution impact in and around the March Pen area, will be minimised as the planting of trees and vegetation around the proposed cement grinding plant and the installation of the 4.5m concrete perimeter wall will act as a kind of noise barrier. Air quality values (maximum predicted PM_{10} concentrations plus the background concentration is 146 μg m^{-3} and this is below the 24 h average JNAAQS for PM_{10} (150 µg m^{-3}) also appear to be well within acceptable ranges thus no ambient air quality monitoring program is necessary.

Socioeconomic evaluation revealed the unemployment rate among the labour force in the parish in 1991 stood at approximately 53.2%, while unemployment within the study area, stood at approximately 52%. The project is expected to employ a total of 79 persons, twenty-five (25) during the site clearance and construction phase and fifty four (54) during operation therefore making a small but significant impact on unemployment in the area. Detailed mitigative strategies are outlined in the document for both the construction and operational phases of the project and an Environmental Management Plan is submitted. Clearly the many benefits far out weigh the issues and problems associated with the development and alternatives recommend the changes in design/ content to ensure an environmentally acceptable approach.

1.0 DESCRIPTION OF THE PROPOSED PROJECT

1.1 INTRODUCTION

Portland cement, the basic ingredient in concrete, was first produced and patented in 1824 by a British stonemason. Global cement consumption rose an average 2.75% in the period 2000-2002 and at the end of 2002 there were an estimated 1447 integrated production facilities and a further 250 separate grinding installations world-wide. Today around 1700 million tonnes of cement are used every year, with different types manufactured to meet various chemical and physical requirements. To produce these requires a clear understanding and careful control of the manufacturing processes.

1.2 THE MAINLAND GRINDING PROCESS

The proposed Mainland project (see Figure 1 for proposed site) involves the grinding and packaging of the overall cement production process (see Figure 2). The required raw materials will be clinker and gypsum and the plant will produce 150 tonnes per day of Portland cement. Clinker productions will be done offsite, and will not be apart of the day-to-day work operations at the proposed Mainland grinding and bagging facility. Externally produced clinker will be imported and transferred to the plant in covered trucks from Kingston Wharves or Port Esquivel. It will be stored on hardstands on the ground and covered under polyethylene sheets. At its maximum capacity an estimated 40 – 80,000 tonnes of clinker will be used annually (≈ 219 tonnes / day) and 22.5 tonnes per day of gypsum and 7.5 tonnes /day limestone. The process consists of two steps:

1. Cement milling (clinker size reduction with additional materials); and
2. Cement packing and dispatch.

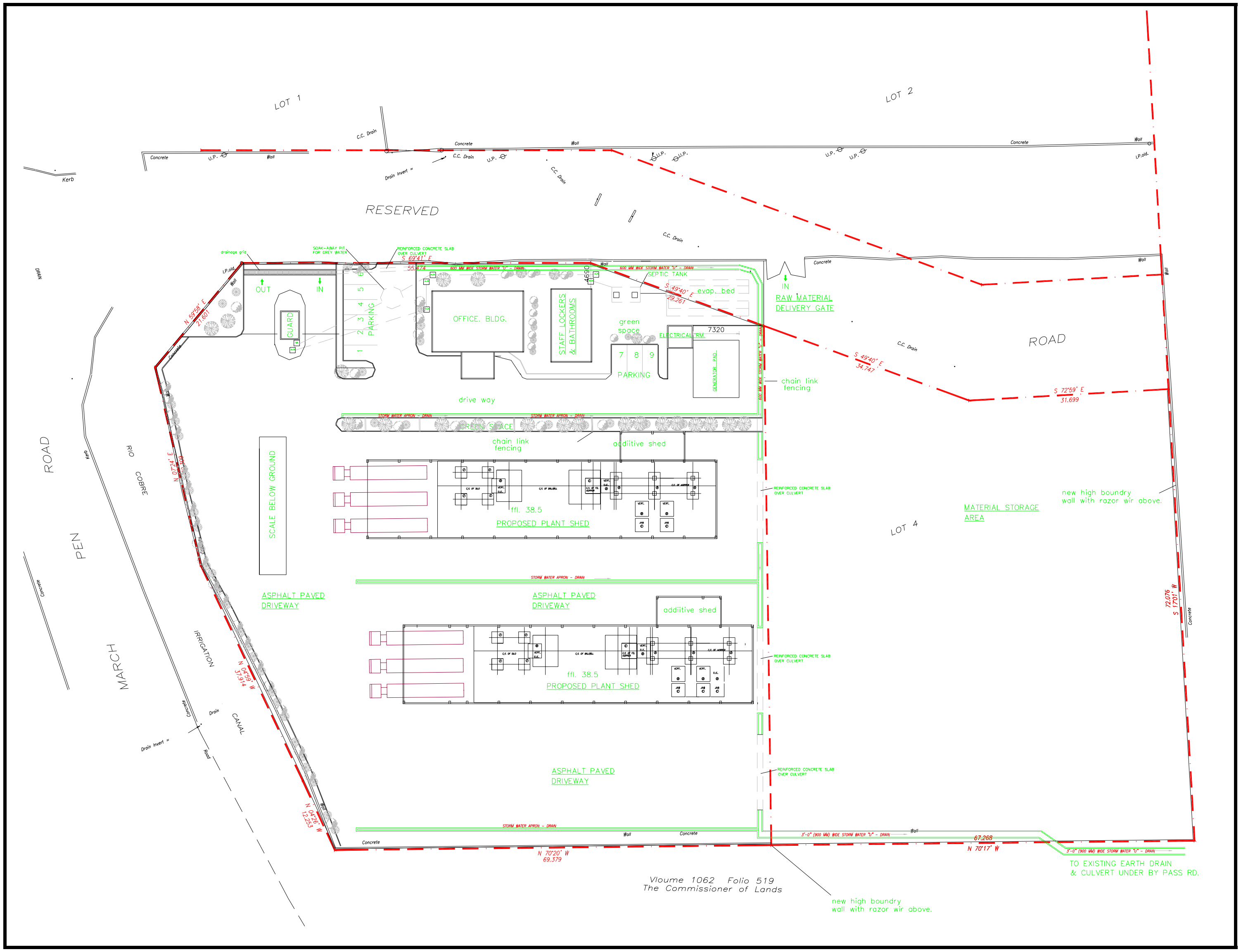
The major structures and equipment will be:

1. Jaw Crusher
2. Hopper
3. Elevator
4. Electronic Measuring & Control System

5. Discharge Hopper
6. Feed Hopper
7. Ratchet Feeder
8. Cement Mill
9. Elevator
10. Aeration / Storage Silo
11. Packing Machine
12. Pollution Control Device
13. Reverse Pulse Jet
14. Dust Collector unit
15. Cyclone

Figure 3 provides a flow chart of the process and Plate 1 shows a typical ball mill similar to the one to be used at the proposed plant.

Figure 1 Location map of the proposed Cement Grinding plant



(Adapted from Carl Chin & Associates – Designers & Architects)

Figure 2 Site plan layout of the proposed cement grinding plant

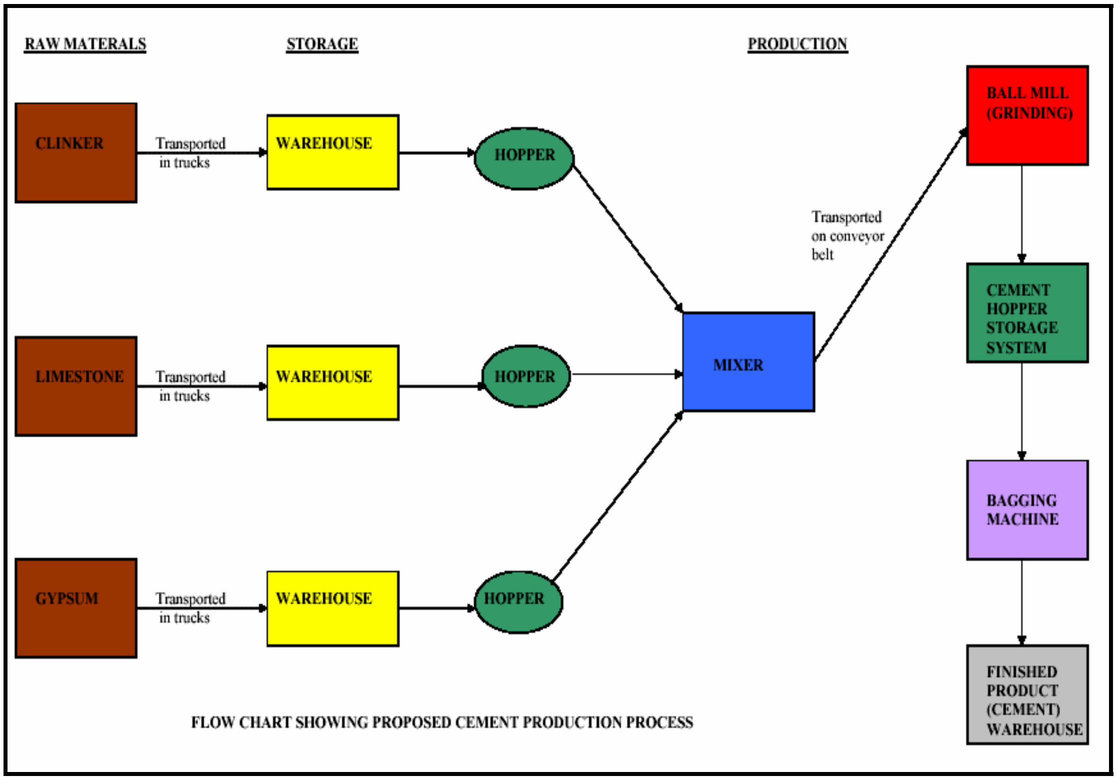


Figure 3 Flow chart showing proposed cement production process

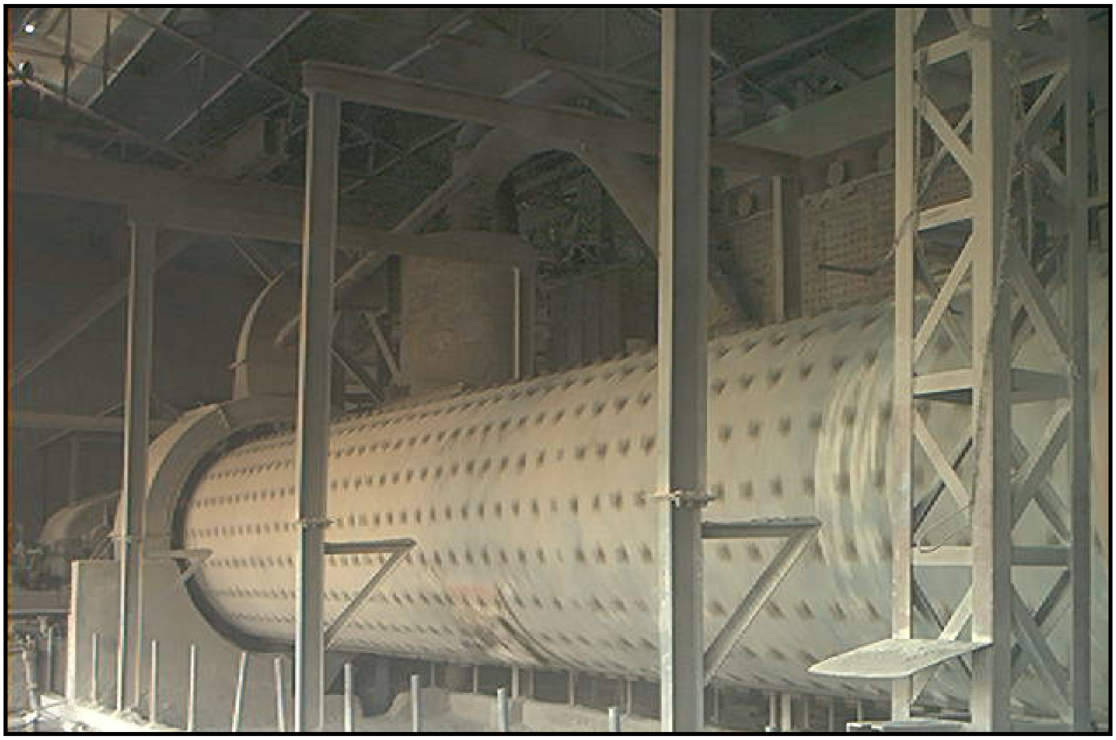


Plate 1 Typical ball mill used at cement grinding plants

The mass balance on this process indicates there is potentially no waste. Excluding waste which may be generated as a result of materials handling (spillages and as a result of dust) it is anticipated that there will be no waste from the overall general grinding and bagging process. All input raw materials of clinker, limestone and gypsum, will be used. The following basic equation summarises the mass balance of the proposed Mainland cement production process:

100 tonnes CLINKER + 15 tonnes Limestone +5 tonnes Gypsum = 120 Tonnes Cement.

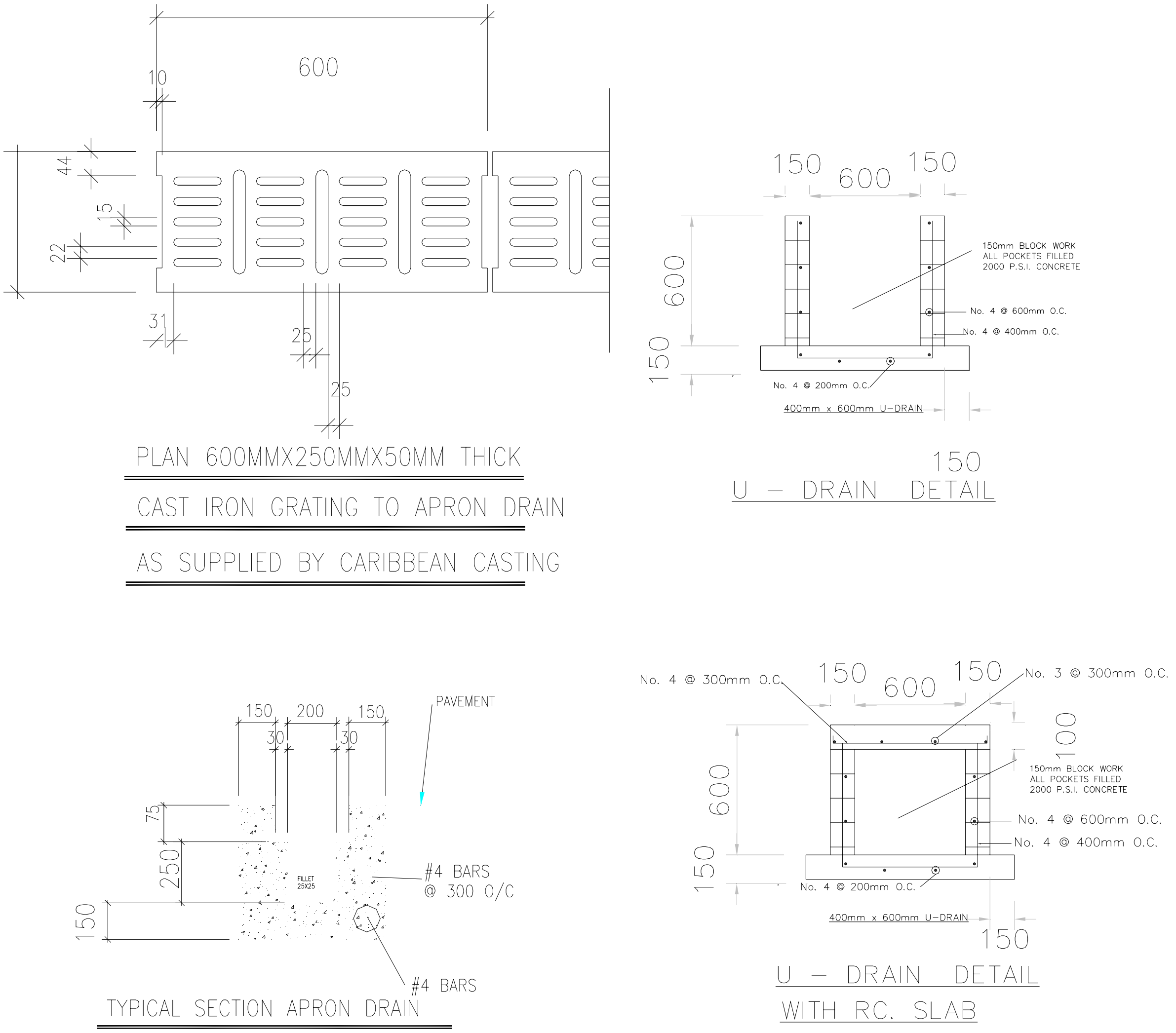
The major issues of an operation of this nature include:

1. Energy consumption
2. Generation of dust
3. Generation of heat
4. Generation of Noise
5. Occupational health and safety (i.e. heat stress, air quality (dust), noise)

1.3 PROPOSED DRAINAGE WORKS

The proposed area of the Mainland cement processing plant is 7,975 square metres. In addition it is also proposed that approximately 5,870 square metres of land immediately adjacent to the cement processing plant (to the east), be filled and stabilized.

On completion it is expected that site will be completely paved to accommodate the use of trucks and other heavy equipment, on a daily basis. Obvious (post-grading) drainage path directions will be from March Pen Road to the Spanish Town by-pass culvert. Proposed engineering drawings (see drainage cross-sections in Figure 4) indicate a set of 600mm perimeter drains, 200mm apron drains and a 900mm collection drain will be installed to tie-in with the existing drainage under Spanish Town by-pass. Drainage water will be collected within the site's perimeter and central apron drains and then discharge from the south side of the site into the latter drainage system, under the Town by-pass. No sediment traps (or oil-water separators) are proposed for the development.



PLAN 600MMX250MMX50MM THICK
CAST IRON GRATING TO APRON DRAIN
AS SUPPLIED BY CARIBBEAN CASTING

U – DRAIN DETAIL

TYPICAL SECTION APRON DRAIN

U – DRAIN DETAIL
WITH RC. SLAB

Figure 4 **Proposed drain cross-section**

1.4 PROPOSED WASTEWATER TREATMENT

Mainland proposes to utilize both a grey-water as well as black-water sewerage system. It is estimated that the cement processing plant will employ at most 54 workers and this is expected to result in a sewage flow rate of 2,400 litres per day (540 imp gal/day) (at a per worker sewage generation rate of 10 IGPD).

The grey-water system will handle flows from face basins only, whilst the black water system will handle the sewage flows from the toilets (Figure 5). The grey-water system will consist of trap gully basins (for removing the primary solids) and a soak-away pit. The soakaway pit will overflow to the black-water system.

The black water system will consist of a septic tank and an Evapotranspiration (ET) bed. Approximately 75 square metres of space is proposed for the ET bed.

An ET system is a feasible option in semi-arid climates and locations where the annual evaporation rate exceeds the annual rate of precipitation and wastewater applied. The ET System can eliminate all or most of the effluent from being discharged into an environment with limitations on nitrogen discharges on impervious soils. The main components are (i) a treatment unit (usually a septic tank) and (ii) an ET bed with wastewater distribution piping, a bed liner (unless the soils are determined to be impermeable), fill material, monitoring wells, overflow protection and a surface cover. Vegetation has to be planted on the surface of the bed to enhance the transpiration process.

The clarified effluent from the septic tank flows into the lower portion of a sealed ET bed that has a continuous impermeable liner (or dense impermeable sub-soils) and carefully selected sands. Capillary action in the fine sand causes the wastewater to rise to the surface and escape through evaporation as water vapour. In addition, vegetation transports the wastewater from the root zone to the leaves, where it is transpired as a relatively clean condensate. This design allows for complete wastewater evaporation and transpiration with no discharge to nearby soil.

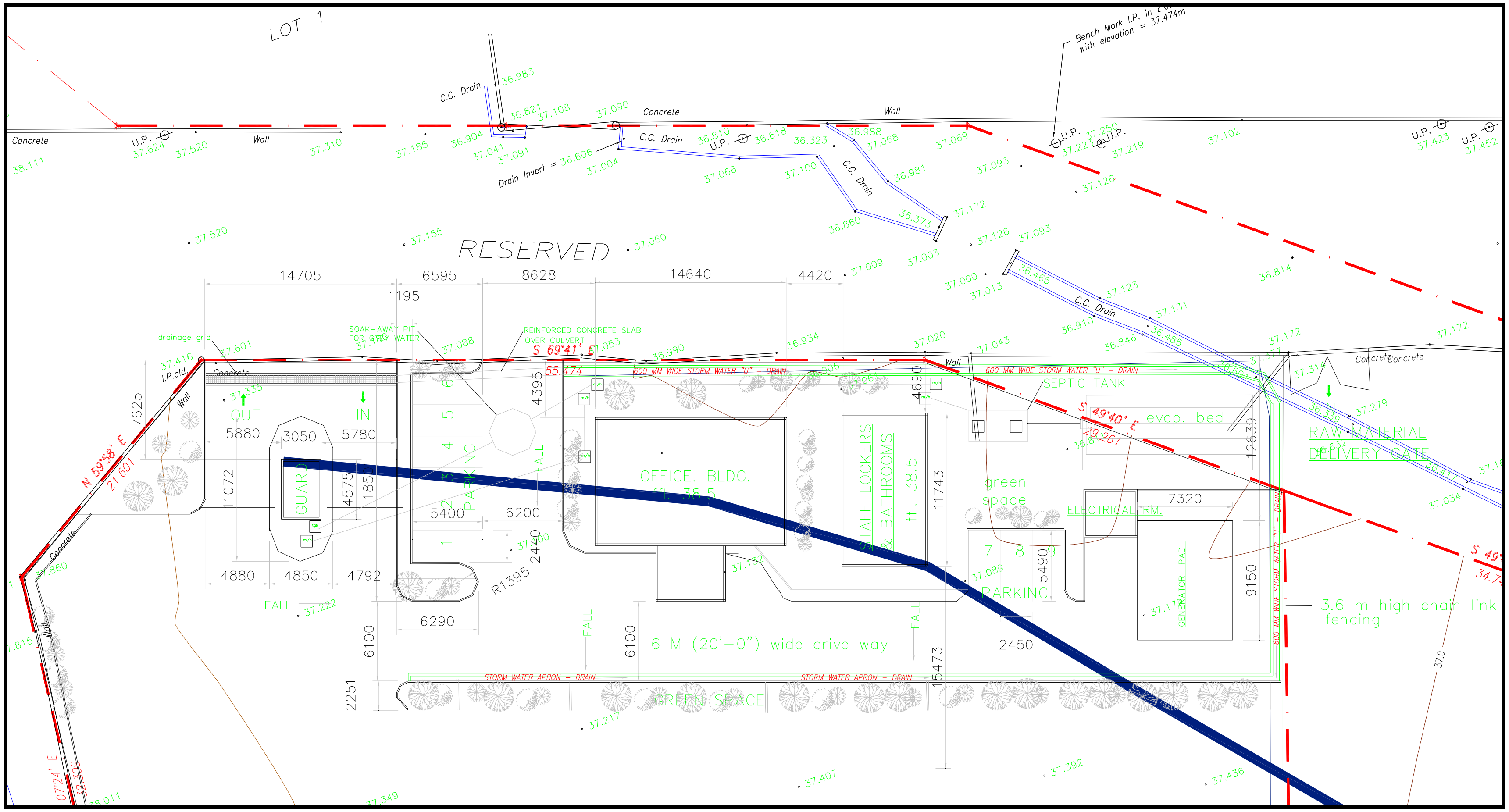


Figure 5 Layout of purposed sewage treatment system for site

1.5 CONSTRUCTION PHASE

It is anticipated that the construction of the proposed cement grinding plant will have a total duration period of approximately 6 to 8 months and that operations will commence one (1) month after completion. It should be noted here that the likely environmental impacts of this construction phase are identified in Section 7.1 of this report.

The proposed site is approximately 1.42 hectares (3.5 acres) in area. This land will be subsequently graded in preparation for the construction of the proposed facility. Of this area, approximately 0.4 ha (≈1 acre) will be used for storage of raw materials.

Following site preparation, 4.5m high reinforced concrete walls will be erected around the perimeter of the site.

The construction of a concrete base and steel portal frame structure will be carried out in order to be able to house the proposed plant. The construction of a staff admin building, lockers and bathroom, electrical room for plant equipment, car park and a guardhouse with bathroom will commence on completion of building of the base structures. In addition the installation of weighing scale will be done.

Storm water drains will be constructed. In addition, the paving of roads and landscaping of the site will be included in this construction phase.

1.6 OPERATION PHASE

The operational phase will be divided into two phases. The first phase will see the production of 150 tonnes of cement per day. The second phase, which is to be completed approximately ten months after the commission of the first phase will increase the cement production by 190 metric tonnes per day to 340 tonnes/ day. To achieve this clinker will be transported to the proposed plant from either Kingston Wharves or from Port Esquivel by covered trucks. It is anticipated that between 40,000 – 80,000 tonnes of clinker will be imported per year. This will be done in two shipments, with each shipment (20 – 40,000 tonnes) expected to be enough for six months production. Transportation of each shipment from the ports to the proposed site is expected to be done over a week.

Limestone to be used in the process will be sourced from Pauls Mountain quarry in St. Catherine, which is situated approximately 12 km from the proposed site. It is expected that approximately two covered trucks per day will be needed to transport limestone to the proposed plant.

The clinker will be transferred to silos where it will be held prior to milling. It will be withdrawn from storage and fed to the cement mill by electronic weigh proportioners with an addition of possibly other additives. The resulting product is cement, which is then conveyed to cement silo storage. The additives that will be added will control the setting properties of finely ground clinker.

Cement milling will be performed by tube (ball) mills in an open circuit. Milling generates heat and external water sprays may be required depending on the ambient temperature. The water sprays will operate in closed circuit and no water is wasted. All water is consumed and only very small addition is required for the water that evaporates. Total top up (add-up) water requirement per day would be approximately 100 litres (≈ 22 imp. gals.).

Cement milling produces particulate laden exhaust streams that will be controlled by Reverse Jet bag filters which will collect the particulate matter.

1.6.1 Product Handling and Storage

Cement will be transferred from the silos either directly into bulk road tankers or to a bag packing station to be bagged and stored for sale.

1.6.2 Employment

The Cement Grinding factory has great employment potential providing employment to approximately 54 full time persons split over two shifts (Table 1). Additionally, temporary workers will be employed.

Table 1 Breakdown of staff categories and numbers

A. Managerial & Engineering Staff	**Staff**
Mechanical Engineer	1
Chief Chemist	1
Electrical Supervisor	1
Plant Supervisors	3
Director	1

B. Production & Other Plant Operations	**Staff**
Mill Operator	4
General Workers	12
Maintenance	7
(Electrical/Mechanical) Packing & Forwarding (For packing machine)	8
Shift Chemist	4
Pay Loader operators	4
C. Administration	**Staff**
Clerical Staff	2
Accounts	1
Sales	1
Security / Watch man	4
Total	**54**

1.7 STUDY TEAM

Dr. Dale Webber - Ecologist

Carlton Campbell, M. Phil. – Socio economics/Noise Assessment

Professor Edward Robinson – Geology

Christopher Burgess, M.Sc., P.E. – Hydrology (CEAC Solutions Ltd.)

David Narinesingh, M.Sc. (PhD pending) – EIA Specialist

Denise Forest, MSc, MBA – Environmental Management Systems Specialist/Process

Karen McIntyre, B.Sc. – Environmental Scientist

Dr. Claude Davis – Air Quality Modelling (Claude Davis & Associates)

2.0 APPROVED TERMS OF REFERENCE

2.1 PROJECT IMPLEMENTATION

Collaborating with project's design, installation and management teams, to ensure that the design criteria are implemented in the most environmentally sound manner possible.

A full description of all the elements of the project and its existing setting during the site clearance, construction and operational phases will be prepared. The elements to be analysed will include the infrastructural arrangements of the project, including the access, transportation, plans for power and water supply, location, employment; general layout (size, capacity, etc.); areas slated for development, construction methodology (earthworks, bunds, etc.), site management, operation and maintenance activities; project life span, solid waste disposal, and operational aspects of the proposed project. This will be done using plans, maps and graphic aids as appropriate. Attention will be given to issues of air quality, energy consumption, raw material supply, and waste generation and management.

During this task, all features of the project, which could impact on the environment, will be identified. Recommendations will be made as necessary for mitigative measures to be implemented. Special attention will be given to the sensitive elements of the project.

Deliverable: Analysis and assessment of designs to ensure environmental soundness, sustainability and regulatory compliance.

2.2 SITE SURVEYING:

A survey of the proposed development site will be conducted. The survey will include a photo-inventory of the physical and biological features of the site and its environs. The areas will be viewed with respect to their suitability for the proposed facility.

Deliverable: Site survey and resource assessment with accompanying recommendations.

2.3 FIELD ASSESSMENTS

These will be conducted on the physical, biological and socio-economic aspects of the site and associated environs to determine the potential impacts, if any, of the proposed project. The study will include, but necessarily be limited to:

A). **Physical**: Physical environment: terrestrial; topography; geology; soils; climate and meteorology; ambient noise; hydrology; drainage and storm water runoff. The natural hazard vulnerability of the site will also be considered, particularly with respect to potential earthquakes, hurricanes and flooding.

B). **Biological:** Species composition of any floral and faunal communities, presence of rare, endangered and/or endemic species, migratory species, species of commercial importance, community structure and health and species with potential to become vectors or nuisances will be documented.

C). **Socio-economic:** Description of the Demography, Regional setting, Location Assessment, Land use, Social Services, Emergency Response and Cultural/Historical characteristics. Additionally, the physical carrying capacity of the local infrastructure and public service will be investigated and the possible attitudes of the local people to the development will be gauged.

Deliverable: Assessments of the physical, biological and general socio-economic conditions associated with the site.

2.4 ANALYSIS OF ALTERNATIVES

This will include the no action alternative, the identification of (possible) alternative site locations, and alternatives to the project design. These alternatives to the development as proposed will be discussed in light of their merits and drawbacks, and assessed against the physical, ecological and socio-economic parameters of the site. The rationale for the identified alternatives will be examined and the preferred alternative substantiated. Where necessary, appropriate recommendations will be made for enhancing the features of the project.

Deliverable: Alternatives to the development will be evaluated and the best possible development option will be presented.

2.5 LEGISLATION AND REGULATORY CONSIDERATIONS

All pertinent Government policies, environmental laws, regulations and standards governing land use control, environmental quality, health and safety, sewage effluent discharge, protection of sensitive areas, and protection of endangered species will be identified. Local plans and policies e.g. Parish Council will also be taken into consideration.

Deliverable: The legislation relevant to the development will be summarized and presented in the Draft and Final Reports.

2.6 IDENTIFICATION OF MAJOR ENVIRONMENTAL IMPACTS

An analysis of the elements of the proposed project and their interaction with environmental parameters and setting will be conducted to identify the potential and cumulative impacts of the project. Long-term and short-term impacts, construction and post-construction phase impacts, positive and negative impacts, and direct and indirect impacts will be discussed.

Special attention will be given to the following:

- Air quality – including the development of an emissions inventory of the proposed plant and preparation of atmospheric dispersion simulation to determine the changes in air quality caused by the project.
- Vegetation clearance and placement of buildings and services installation.
- Modification of existing drainage patterns and surface runoff during construction and post construction phases.
- Raw material transport and storage
- Solid waste management during construction and post-construction phases.
- Environmental health within the plant and in surrounding areas
- Traffic movement - include the conduct of a traffic impact analysis (evaluating the impact of the project on road safety and traffic congestion

- Employment and effects on existing users of the adjacent areas; community involvement and public perceptions of the project.
- Potential impacts of the development on adjacent property owners.
- Natural hazard vulnerability

Deliverable: Potential environmental impacts (both positive and negative) likely to result from the development.

2.7 MITIGATION OF MAJOR NEGATIVE ENVIRONMENTAL IMPACTS

For each potential impact identified, recommendations will be made for their avoidance, minimization or mitigation and the cost associated with each mitigative measure. The responsible or likely responsible party will also be identified.

Deliverable: Recommendations for the avoidance, minimization and mitigation of the identified major environmental impacts.

2.8 ENVIRONMENTAL MONITORING

An environmental monitoring and management plan will be developed for the sensitive elements of the environment that may require monitoring during the construction and operation of the facility. Recommendations will be made on the institutional arrangements that will be necessary to ensure effective monitoring and management.

Deliverable: A detailed management and monitoring programme will be developed to reduce the effects of the negative environmental impacts identified.

2.9 CLIENT REPRESENTATION

The Consultants will maintain regular contact with both the Client and the National Environmental Planning Agency (NEPA) to ensure that all queries and/or concerns are addressed in a timely manner".and environmentally sound manner. Additionally, the Consultants undertake to represent the Client at meetings with NEPA and other relevant Government bodies as necessary.

Deliverable: The Consultant will represent the Client at the NEPA and all relevant Government bodies to ensure that regulatory compliance is maintained.

2.10 PUBLIC PRESENTATION

The National Environmental Planning Agency (NEPA) may require that a Public Presentation be conducted. C.L. Environmental is prepared to arrange and deliver such a presentation.

2.11 REPORT

A report will be prepared which will focus on the findings, conclusions and recommended actions. The environmental assessment report will be organized according to the outline below.

- Executive Summary
- Introduction
- Description of Proposed Project
- Policy, Legal and Administrative Framework
- Description of the Existing Environment
- Significant Environmental Impacts and Impact Mitigation Measures
- Cumulative Impacts
- Consideration of Alternatives
- Environmental Management and Monitoring Plan

3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 BACKGROUND

An Environmental Impact Assessment (EIA) is "*a structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the development process. This information consists, basically, of predictions of how the environment is expected to change if certain alternative actions are implemented and advice on how best to manage environmental changes if one alternative is selected and implemented*" (Bisset, 1996).

The basis of EIAs has been summarised as follows[1]:

1 *Beyond preparation of technical reports, EIA is a means to a larger end - the protection and improvement of the environmental quality of life.*

2 *It is a procedure to discover and evaluate the effects of activities on the environment - natural and social. It is not a single specific analytic method or technique, but uses many approaches as appropriate to the problem.*

3 *It is not a science but uses many sciences in an integrated inter-disciplinary manner, evaluating relationships as they occur in the real world.*

4 *It should not be treated as an appendage, or add-on, to a project, but regarded as an integral part of project planning. Its costs should be calculated as a part of adequate planning and not regarded as something extra.*

5 *EIA does not 'make' decisions, but its findings should be considered in policy - and decision-making and should be reflected in final choices. Thus it should be part of decision-making processes.*

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[1] Wood, C., "Environmental Impact Assessment: A Comparative Review" p. 2. (from Caldwell, 1989, p.9)

6 *The findings of EIA should focus on the important or critical issues, explaining why they are important and estimating probabilities in language that affords a basis for policy decisions.*

3.2 RELEVENT AGENCIES AND LAWS OF THE GOVERNMENT OF JAMAICA

3.2.1 St. Catherine Parish Council

The St. Catherine Parish Council has portfolio responsibility for the provision of public services such as public health, fire protection, street cleaning and maintenance of recreational areas such as parks and play fields. The parish council's portfolio of solid waste collection and management of public markets was taken over by Metropolitan Parks and Markets. The government has however; more recently established the National Solid Waste Management Agency, which will be given overall responsibility of managing national solid waste.

It must be noted that one of the Parish Council's key responsibility is development control. This very important function serves to not just guide development but to shape and influence the pattern of development in any parish and or region. As a direct result development proposals have to be sent to the local parish council for development approval.

3.2.2 National Water Commission

The National Water Commission's chief portfolio responsibility in the land development process is to provide potable water and sewage services. Each proposal to develop land needs information and advice from the NWC as to whether or not the agency will be able to provide potable water. The issue of sewage is also important especially in the instances where central sewage plants are being used. The NWC is also the responsible body to comment and advice (approve or disprove) sewage proposals put forward by the project proponents.

3.2.3 The Solid Waste Management Authority

The new Solid Waste Management Authority Act (2001) subsumes the Litter Act and seeks to control the disposal of refuse in undesignated areas, as well as the delegation of garbage collection.

This Act seeks to control the disposal of refuse in undesignated areas, to include public places as described under Section 2 (c) of the Act, which includes public gardens, parks or open spaces, or 'any place of general resort to which the public have, or are permitted to have access with or without payment of any fees'…. Or 'any other place in the open air to which the public has right of access without payment of any fees'. As such, disposal of refuse in the area during any phase of the development would constitute an offence under this Act.

3.2.4 Water Resources Authority

The Water Resources Authority was established to ensure the proper use of surface and ground water. This agency comments on proposed methods of sewage solutions in so much as it affects ground water contamination.

3.2.5 Environmental Health Unit (Ministry of Health)

The Environmental Health Unit of the Ministry of Health also comments proposed the methods of sewage disposal facilities. The agency is concerned about environmental degradation and human health, and ensures that sewage proposals are not designed to impact negatively on any of the two. (i.e. the environment and human health).

3.2.6 National Works Agency (NWA)

The National Works Agency focuses on the designs of drains and road network (layout).

3.2.7 National Environment and Planning Agency (NEPA)

This Executive agency is an amalgamation of three agencies, the Town Planning Department, The Land Development and Utilization Commission and the Natural Resources Conservation Authority. The National Environment and Planning Agency seeks to ensure that proposed developments do not have adverse negative impacts on the environment. To ensure this, proposed developments are submitted to NEPA for a permit and or license to develop.

The agency's mission is to ensure protection of the environment and orderly development locally and nationally.

The Natural Resources Conservation Authority Act (1991)

The Natural Resources Conservation Act was enacted in 1991, and created the then Government environmental agency, the Natural Resources Conservation Authority.

Under this Act, the NRCA was mandated to effectively manage the physical and natural resources of Jamaica so as to ensure their conservation, protection and proper use; promote public awareness on Jamaica's ecological systems and their importance to the social and economic life of Jamaica; manage national parks, marine parks, protected areas, public recreational facilities; and advise the Minister on general policies relevant to the management, development, conservation and care of the environment.

The Town and Country Planning Act (1948)

This Act was enacted in 1948. There have been substantial amendments to the Act in 1999 to provide for effective enforcement of development controls. The major objectives of this Act are to control the orderly development of lands comprised within the established development orders (now outdated), protecting amenities, and conserving and developing the resources of the area as prescribed.

This Act also provides for the making of Tree Preservation Orders whereby a local authority may seek to preserve trees or woodlands in their area and prohibit the lopping or wilful destruction of trees or securing the replanting of trees.

Water Resources Act (1995)

The Water Resources Authority Act was established in 1995 to regulate and manage the abstraction and allocation of water Resources. The Act also governs the preservation of water quality and the conservation of such resources. The Authority is required to gather data on the quantity and quality of water in above ground and underground resources.

The Public Health Act (1974)

The Public Health Act falls under the ambit of the Ministry of Health. Provisions are also made under this Act for the functions of the Environmental Health Unit of the Ministry of Health. The Environmental Health Unit functions through the Public Health Act to monitor and control pollution from point sources. The Central Health Committee would administer action against any breaches of this Act.

The Clean Air Act, 1964

This act refers to premises on which there are industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke or fumes or gases or dust in the air.

An inspector may enter any affected premise to examine, make enquiries, make tests and take samples of any substance, smoke, fumes, gas or dust as he or she considers necessary or proper for the performance of his/her duties.

Factories Act, 1968

The Act empowers the Minister of Labour to register factories, inspect and regulate their operations. The regulations were updated in 1968 to provide for the following:

i. The safe means of approach or access to, and exit from, any factory, or machinery;
ii. The fencing and covering of all dangerous places or machines;
iii. Life-saving and first aid appliances;
iv. Safety in connection with all operations carried on in a factory;
v. Safety in connection with the use of cranes, winches, pulley-blocks and of all engines, machinery, mechanical gear and contrivances generally whatsoever;
vi. The periodic inspection, testing and classification, according to age, type or condition, of boilers;
vii. The duties and responsibilities assignable to any person generally, and in particular to employers, owners, and managers in charge of factories, in connection with any one or more of such regulations;
viii. The proper ventilation of any factory, having regard to the nature of the process carried on therein;
ix. The sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory.

3.2.8 The Solid Waste Management Authority

The new Solid Waste Management Authority Act (2001) subsumes the Litter Act and seeks to control the disposal of refuse in undesignated areas, as well as the delegation of garbage collection.

This Act seeks to control the disposal of refuse in undesignated areas, to include public places as described under Section 2 (c) of the Act, which includes public gardens, parks or open spaces, or 'any place of general resort to which the public have, or are permitted to have access with or without payment of any fees'…. Or 'any other place in the open air to which the public has right of access without payment of any fees'. As such, disposal of refuse in the area during any phase of the development would constitute an offence under this Act.

3.3 JAMAICAN ENVIRONMENTAL REQUIREMENTS

EIAs are not only recommended in project design, but also required by Jamaican legislature. The following is a review of Jamaican *Environmental* policy and law that are relevant to the Mainland Cement Grinding Development design, construction and operation.

3.3.1 National Environment and Planning Agency (NEPA)

NEPA is Jamaica's Regulatory Planning and Environmental Agency and represents a merger of the Natural Resources Conservation Authority (NRCA), the Town Planning Department (TPD) and the Land Development and Utilisation Commission (LDUC).

3.3.2 Town and Country Planning Authority (TCPA)

The Town and Country Planning Act, as amended (1999) establishes the Town and Country Planning Authority, which is responsible for land use zoning and planning regulations as described in their local Development Orders. In particular for subdivisions, the Act is responsible, through the Development Orders, for:

a) regulating the type of development to be carried out and the size and form of plots;

b) requiring the reservation of land for any of the public services referred to in Part V or for any other purposes referred to in this Schedule for which land may be reserved;

c) prescribing the character and type of public services or otter works which shall be undertaken and completed by the applicant for subdivision as a condition of the grant of authority to subdivide;

d) *co-ordinating subdivision of contiguous properties in order to give effect to the scheme of development of such properties.*

The relevant local planning authority for the project is the St. Catherine Parish Council. The Cement Grinding Plant Development concept plans will need to be submitted to the Parish Council for approval.

3.3.3 Natural Resources Conservation Authority (NRCA) Act

The NRCA Act is Jamaica's umbrella environmental law. The purpose of the Act is to provide for the management, conservation and protection of the natural resources of Jamaica.

The Act has established the Natural Resources Conservation Authority (NRCA), which has a number of powers including, inter alia:-

- *issuing of permits to persons responsible for undertaking any construction, enterprise or development of a prescribed category in a prescribed area*
- *issuing licences for the discharge of trade or sewage effluent*
- *requesting an Environmental Impact Assessment (EIA) from an applicant for a permit or the person responsible for undertaking any construction, enterprise or development*
- *revocation or suspension of permits.*

The Act binds the crown and therefore takes precedence over the authority of other state in environmental matters.

3.3.4 NRCA's EIA Process

Under Section 9 of the NRCA Act, the proposed Mainland Cement Grinding Plant will require a Permit for construction and may, under Section 10 of the Act, require an EIA.

1. *The NRCA permit procedure is initiated by the submission of the Project Information Form (PIF) to the Authority. The PIF screening form is reviewed to determine whether and EIA is required and to begin determining areas of environmental significance, especially in waste discharge.*

2. *Based on the plans for the development, an EIA is expected to be required for the Mainland Cement Grinding Plant Development. The consultants will liaise with the NRCA to determine the scope of the EIA through proposed Terms of Reference (TORs). The TORs are proposed by the consultant using NRCA guidelines and are approved by the NRCA.*

3. *The EIA is then prepared by a multi-disciplinary team of professionals. The NRCA requires that the EIA include the following:*

    - *A description of the present environment, i.e. physical, biological and social environment. This includes, for example, consideration of economic situations, cultural heritage and ecological preservation.*

    - *A description of the significant impacts the environmental professionals expect the development to have on the environment, compared to the environment that would remain if there were no development. This will include indirect and cumulative impacts.*

    - *An analysis of alternatives that were considered in order to consider means of minimising or eliminating the impacts identified above.*

- *An Environmental Management Plan, which includes a Monitoring & Hazard Management Plan and an Auditing schedule.*

4 The NRCA guidance on EIAs states that this process "should involve some level of stakeholder consultation in either focus groups or using structured questionnaires." A draft EIA is submitted to the developer to solicit the proponents' input into the description of the project (to check for accuracy of statements, and to enter into realistic discussions on the analysis of alternatives, as well as to inform the proponents of any other relevant legislation with which they must comply).

5 Eight copies of the finalised draft are then submitted to NRCA, two to the client, and the consultant keeps one (11 in all are produced). The NRCA distributes these to various other public sector institutions who sit on the Technical Committee (e.g. Water Resources Authority, Environmental Control Division of the Ministry of Health etc.) for their comments. Typically this depends on the nature of the project.

6 As deemed necessary by the NRCA, Public Meetings are then held, following the deposition of the Draft EIA at Parish Libraries (by the NRCA). A verbatim report of the public meetings is required, as well as a summary report of the main stakeholder responses which emerged.

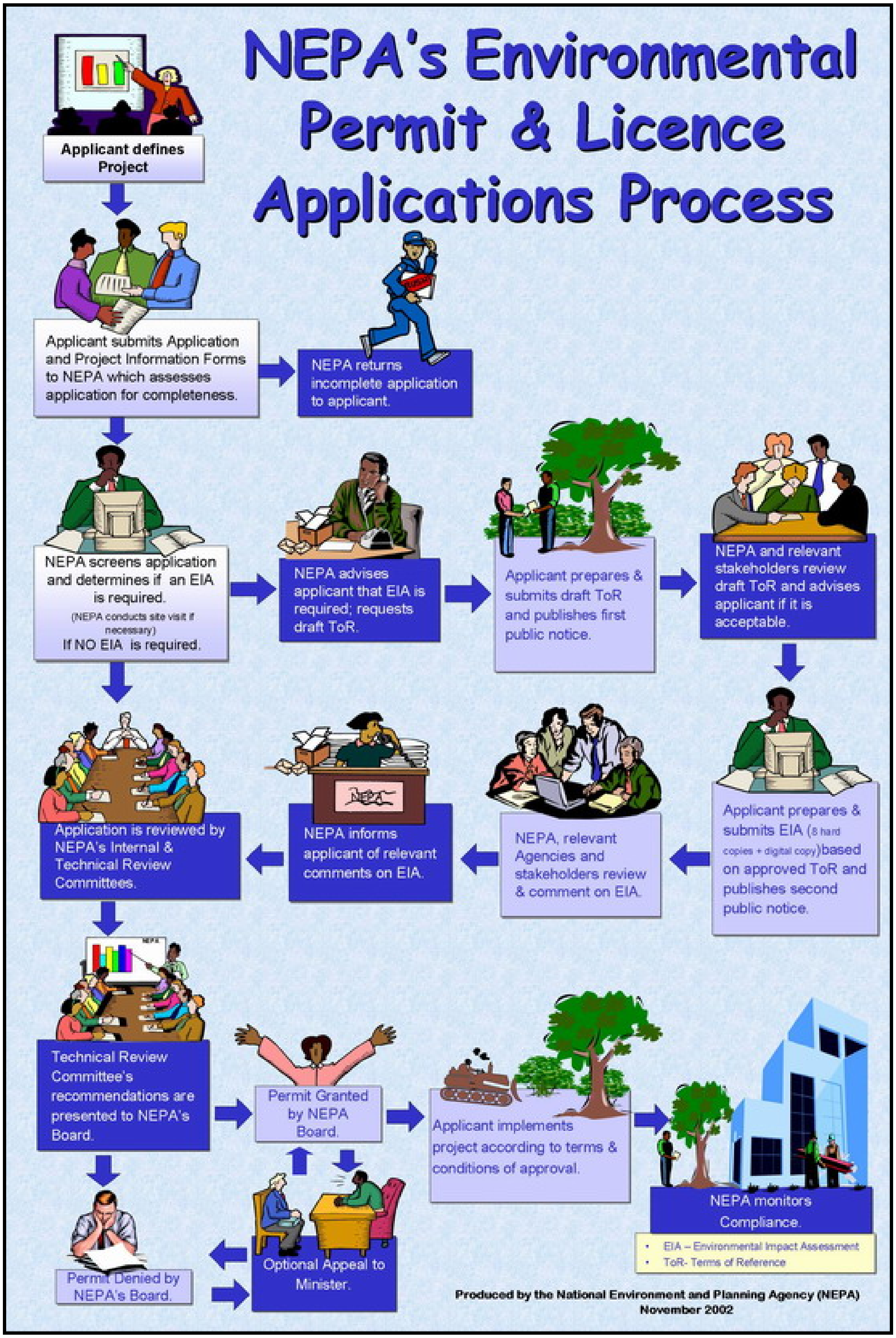
7 The comments of the NRCA, the other GOJ interests and the public are compiled and submitted in writing to the consultant not only for finalisation of the report but for incorporation into the development's design.

8 The NRCA then reviews this report again, and if further clarifications are needed, these are again requested. Once the NRCA is satisfied, the EIA is submitted to the Technical Committee of the NRCA Board for final approval. If the EIA is not approved, the proponents may appeal to the Minister of Land and the Environment.

In recent times, the dynamic NEPA EIA process (Figure 6) has been requiring written confirmation of the feasibility of infrastructure access from companies providing amenities and utility services to the proposed development, including the National Water Commission, the

National Solid Waste Management Authority and the Jamaica Public Service. Negotiations with these agencies will be important to this development where water supply and electricity access is concerned.

Further information on NEPA and EIAs is available from the NEPA website (*www.nepa.gov.jm*). In particular, documents providing guidance on EIA preparation and public participation in EIAs are available at the site.



NEPA's Environmental Permit & Licence Applications Process

Applicant defines Project

Applicant submits Application and Project Information Forms to NEPA which assesses application for completeness.

NEPA returns incomplete application to applicant.

NEPA screens application and determines if an EIA is required.

(NEPA conducts site visit if necessary)

If NO EIA is required.

NEPA advises applicant that EIA is required; requests draft ToR.

Applicant prepares & submits draft ToR and publishes first public notice.

NEPA and relevant stakeholders review draft ToR and advises applicant if it is acceptable.

Applicant prepares & submits EIA (8 hard copies + digital copy)based on approved ToR and publishes second public notice.

NEPA, relevant Agencies and stakeholders review & comment on EIA.

NEPA informs applicant of relevant comments on EIA.

Application is reviewed by NEPA's Internal & Technical Review Committees.

Technical Review Committee's recommendations are presented to NEPA's Board.

Permit Granted by NEPA Board.

Applicant implements project according to terms & conditions of approval.

NEPA monitors Compliance.

- EIA – Environmental Impact Assessment
- ToR- Terms of Reference

Permit Denied by NEPA's Board.

Optional Appeal to Minister.

Produced by the National Environment and Planning Agency (NEPA) November 2002

Figure 6 Diagram showing the NEPA Environmental Permit and Licence Application Process

4.0 DESCRIPTION OF THE PHYSICAL ENVIRONMENT

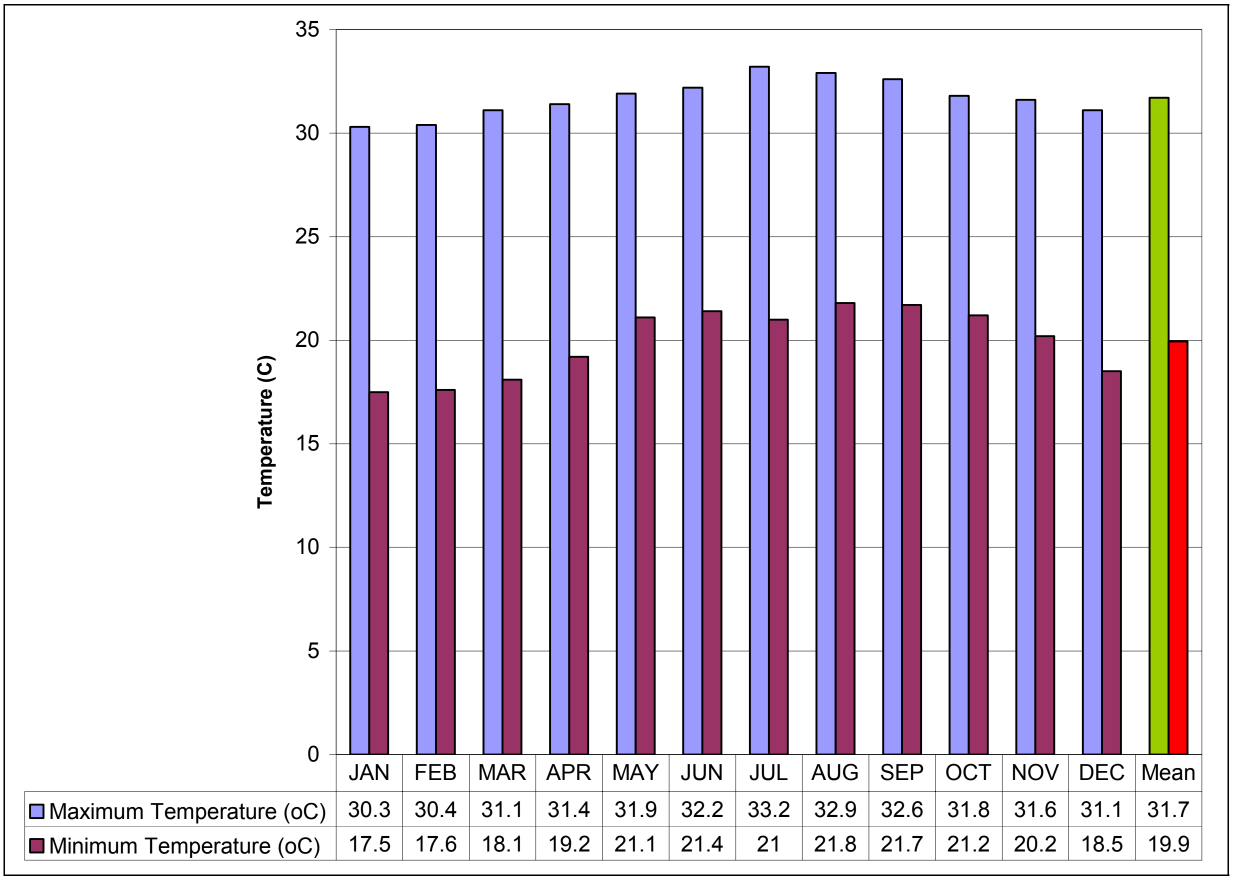
4.1 METEOROLOGY

4.1.1 Temperature

Maximum and minimum 30-year mean temperature data were available for Bernard Lodge (St. Catherine), the closest metrological station to the proposed site. As illustrated in Figure 7, maximum recorded temperatures for Bernard Lodge ranged between 30.3 and 33.2°C throughout the year, with the peak of 33.2°C occurring in July. The lowest maximum temperatures of 30.3 and 30.4°C are experienced during the first two months of the year.

Minimum temperatures displayed a similar pattern with the lowest minimum temperatures of 17.5 and 17.6°C being recorded for January and February respectively. Minimum temperatures reached a peak of 21.8°C during the month of August.

Essentially, the temperature data suggested that the typical winter months (December, January through to March) were generally cooler than May through to November. Since the proposed site is situated in close proximity to the recording station, and is located in a similar geographical setting, the temperature patterns described herein are representative of the proposed site. A yearly mean maximum temperature of 31.7°C and a yearly mean minimum temperature of 19.9°C can therefore be expected to occur at the proposed site.



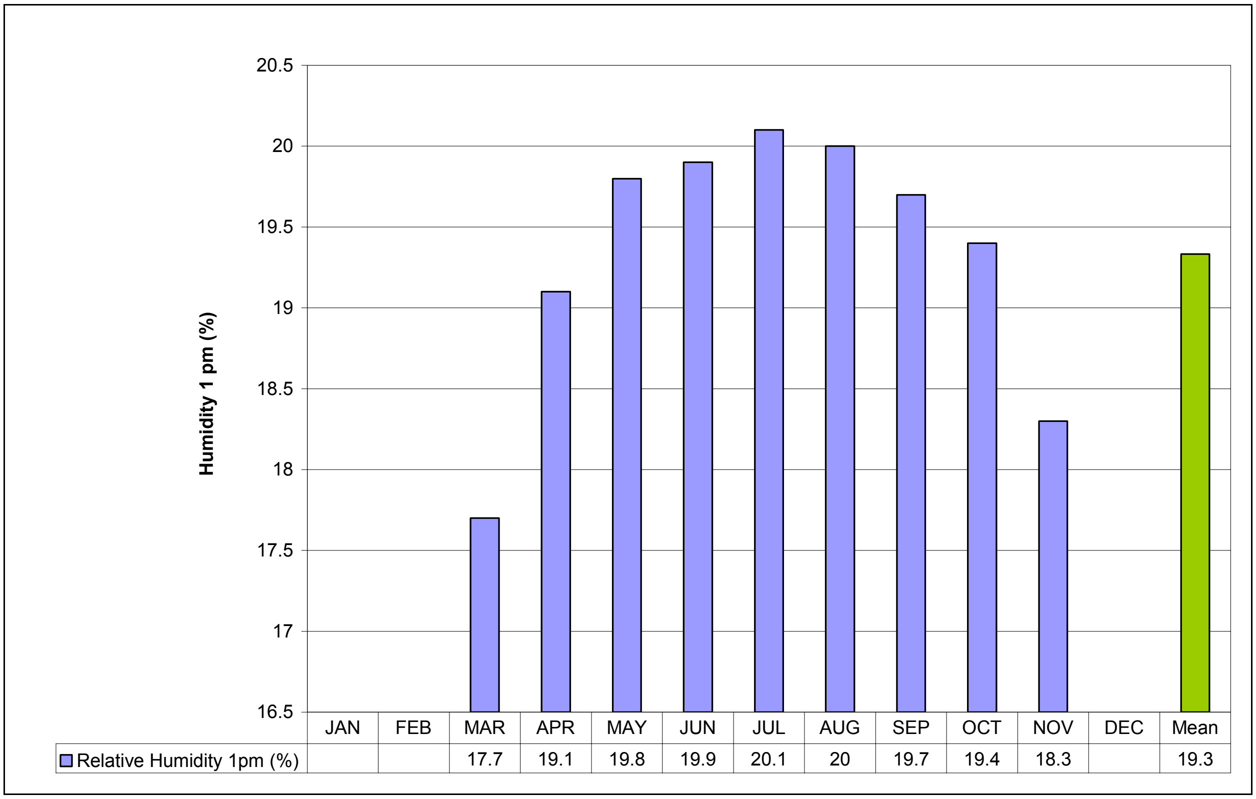
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean
Maximum Temperature (oC)	30.3	30.4	31.1	31.4	31.9	32.2	33.2	32.9	32.6	31.8	31.6	31.1	31.7
Minimum Temperature (oC)	17.5	17.6	18.1	19.2	21.1	21.4	21	21.8	21.7	21.2	20.2	18.5	19.9

Figure 7 Maximum and minimum 30-year mean monthly temperatures for Bernard Lodge, St. Catherine

4.1.2 Humidity

The 30-year mean relative humidity (RH) data obtained from the Bernard Lodge station is shown below in Figure 8. A peak of 20.1% RH was observed during mid-year in the month of July, whilst a minimum value of 17.7% occurred in March. The months of April through to October had RH values between 19.1 and 20.1%, whilst November and March had lower values of 18.3 and 17.7% respectively. As seen in the Figure 8, there were no data available for three months, specifically December, January and February. It is likely that on average, these months experienced similar RH values of those seen to occur during November and March, between 17.5 and 18.5% RH.

The RH data available for Bernard Lodge resulted in a yearly mean of 19.3%; humidity values of this magnitude may be expected at the proposed site.

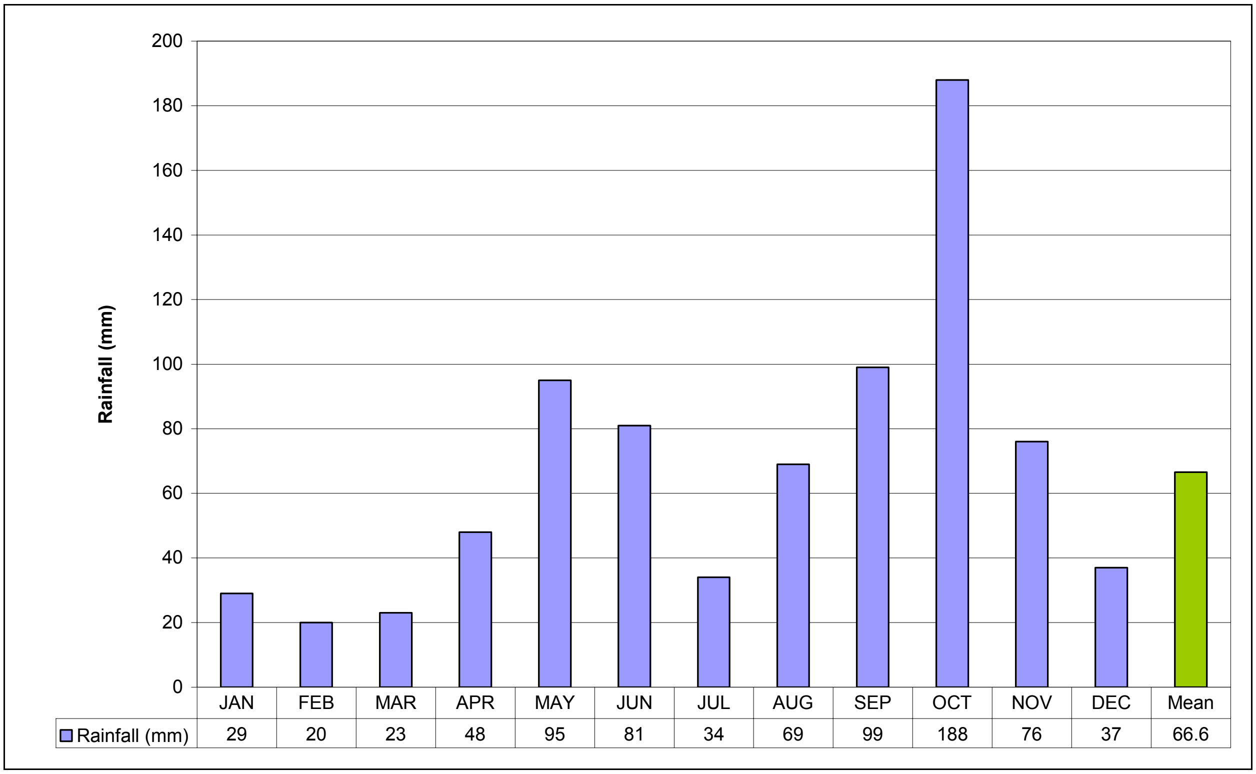


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean
▨ Relative Humidity 1pm (%)			17.7	19.1	19.8	19.9	20.1	20	19.7	19.4	18.3		19.3

Figure 8 **Monthly mean relative humidity for Bernard Lodge, St. Catherine (30-year mean)**

4.1.3 Rainfall and Evaporation

The Bernard Lodge rainfall data clearly indicated October as the rainiest month of the year with 188 mm of rainfall. As seen in Figure 9, for the remainder of the year, monthly rainfall amounts ranged between 20 and 99 mm. A mean of approximately 67 mm of rainfall may be expected on a yearly basis at the proposed location.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean
■ Rainfall (mm)	29	20	23	48	95	81	34	69	99	188	76	37	66.6

Figure 9 **Monthly mean rainfall for Bernard Lodge, St. Catherine (30-year mean)**

Inspection of the meteorological data for Bernard’s Lodge (which is approximately 5 kilometers from the site) indicate that for the majority of the time of the year the area is considerably arid. However, September and October are traditionally wet months (Figure 10).

	Month											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Monthly evaporation rate (mm/month)	115	120	167	168	180	195	211	180	156	143	114	124
Monthly precipitation rate (mm/month)	-38	-46	-38	-66	-140	-104	-74	-92	-196	-273	-74	-43
Net Evoporation rate (mm/month)	77	74	129	102	40	91	137	88	(40)	(130)	40	81

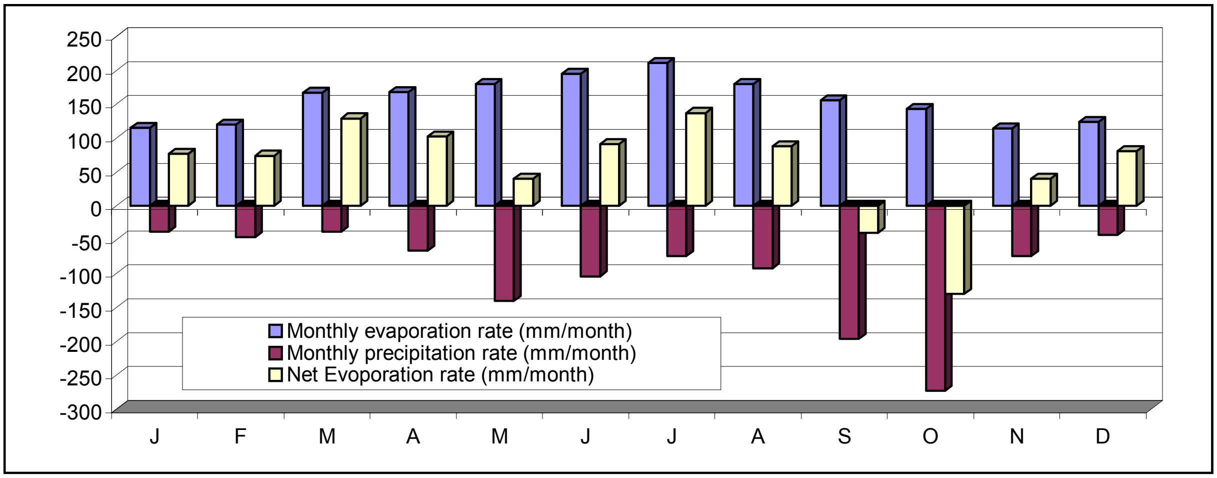
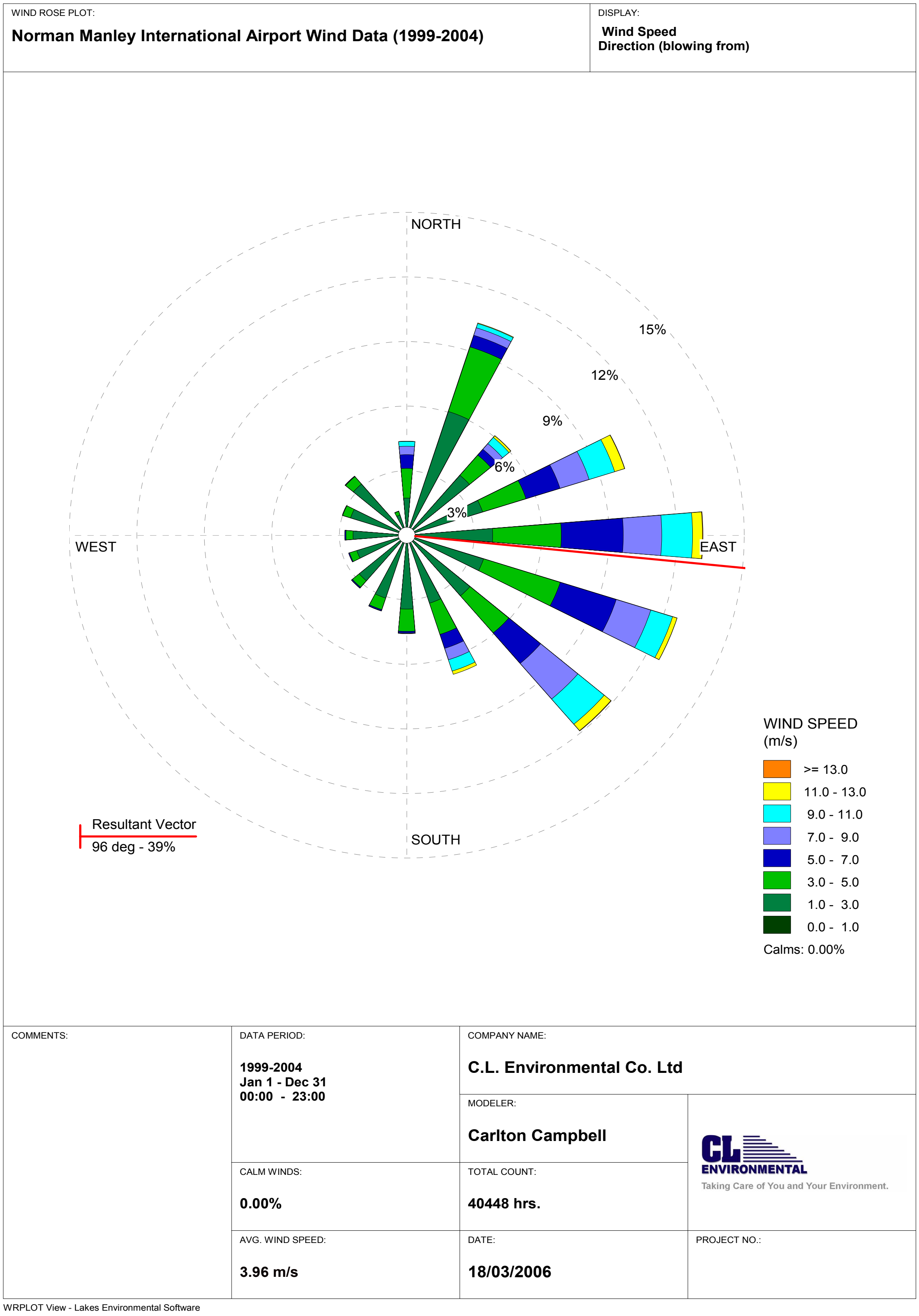


Figure 10 **Historical meteorological data for Bernard's Lodge (1951 to 1980)**

4.1.4 Wind

Figure 11 and Figure 12 represents the surface wind recorded at the Norman Manley International Airport (NMIA) station from 1999 to 2004. This was the closest station for which wind data were available. The results showed that the majority of the wind came from an easterly direction and for approximately 47% of the time wind speeds were between 1 and 3 m/s.



WIND ROSE PLOT:

Norman Manley International Airport Wind Data (1999-2004)

DISPLAY:

Wind Speed
Direction (blowing from)

COMMENTS:

DATA PERIOD:

1999-2004
Jan 1 - Dec 31
00:00 - 23:00

COMPANY NAME:

C.L. Environmental Co. Ltd

MODELER:

Carlton Campbell

CL ENVIRONMENTAL
Taking Care of You and Your Environment.

CALM WINDS:

0.00%

TOTAL COUNT:

40448 hrs.

AVG. WIND SPEED:

3.96 m/s

DATE:

18/03/2006

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Figure 11 Wind rose for Norman Manley International Airport wind data (1999-2004)

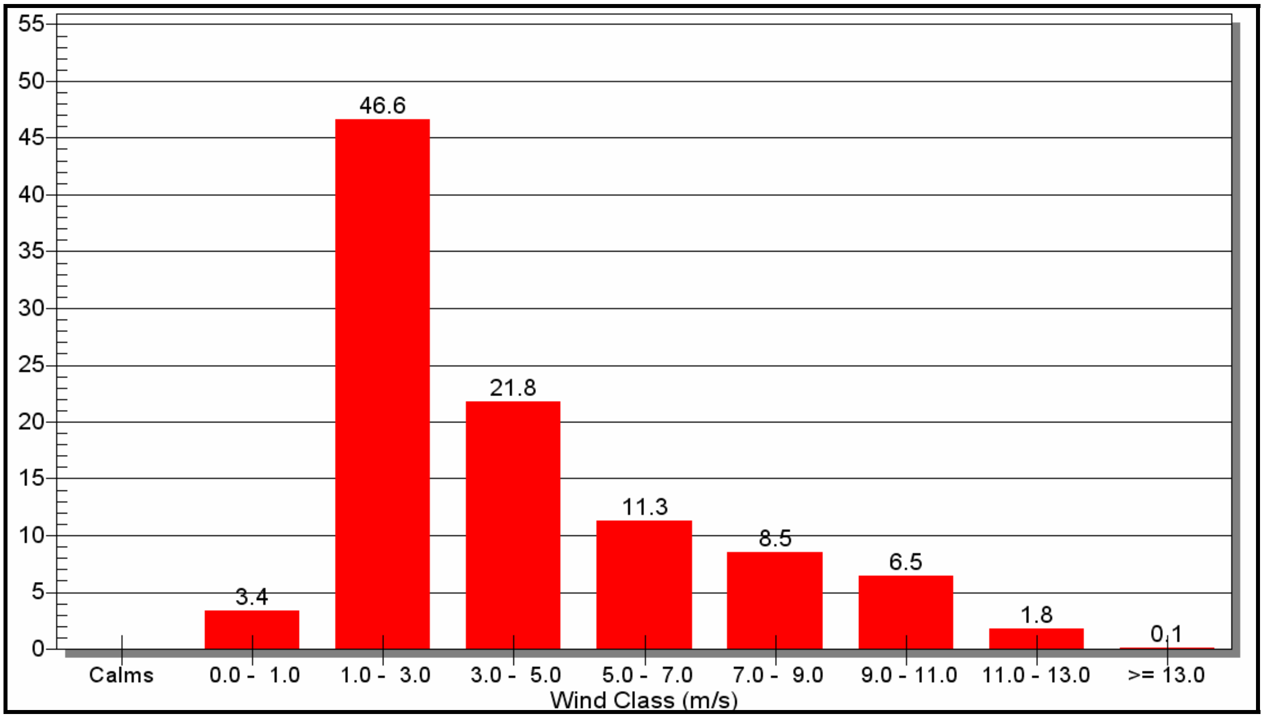


Figure 12 **Frequency distribution graph for Norman Manley International Airport wind data (1999-2004**

4.2 NATURAL HAZARD VULNERABILITY

4.2.1 Earthquakes

Jamaica is located near the edge of the Caribbean tectonic plate and is therefore subjected to seismic activity and earthquakes. The earthquake risk zonation map for Jamaica (Figure 13), covering the period 1879 - 1978, showed that the project site is situated in an area susceptible to earthquakes, where 6-15 events of intensity VI or greater (Modified Mercalli scale) have occurred over the last century.

Figure 14 depicts the locations of earthquake epicentres that occurred between 1978 and 2002. The closest earthquake epicentre to the proposed site is approximately 1.3 km southwest of the site in question. This earthquake occurred 10 years ago in 1985 and measured 2.2 on the Richter scale at a depth of 0 metres.

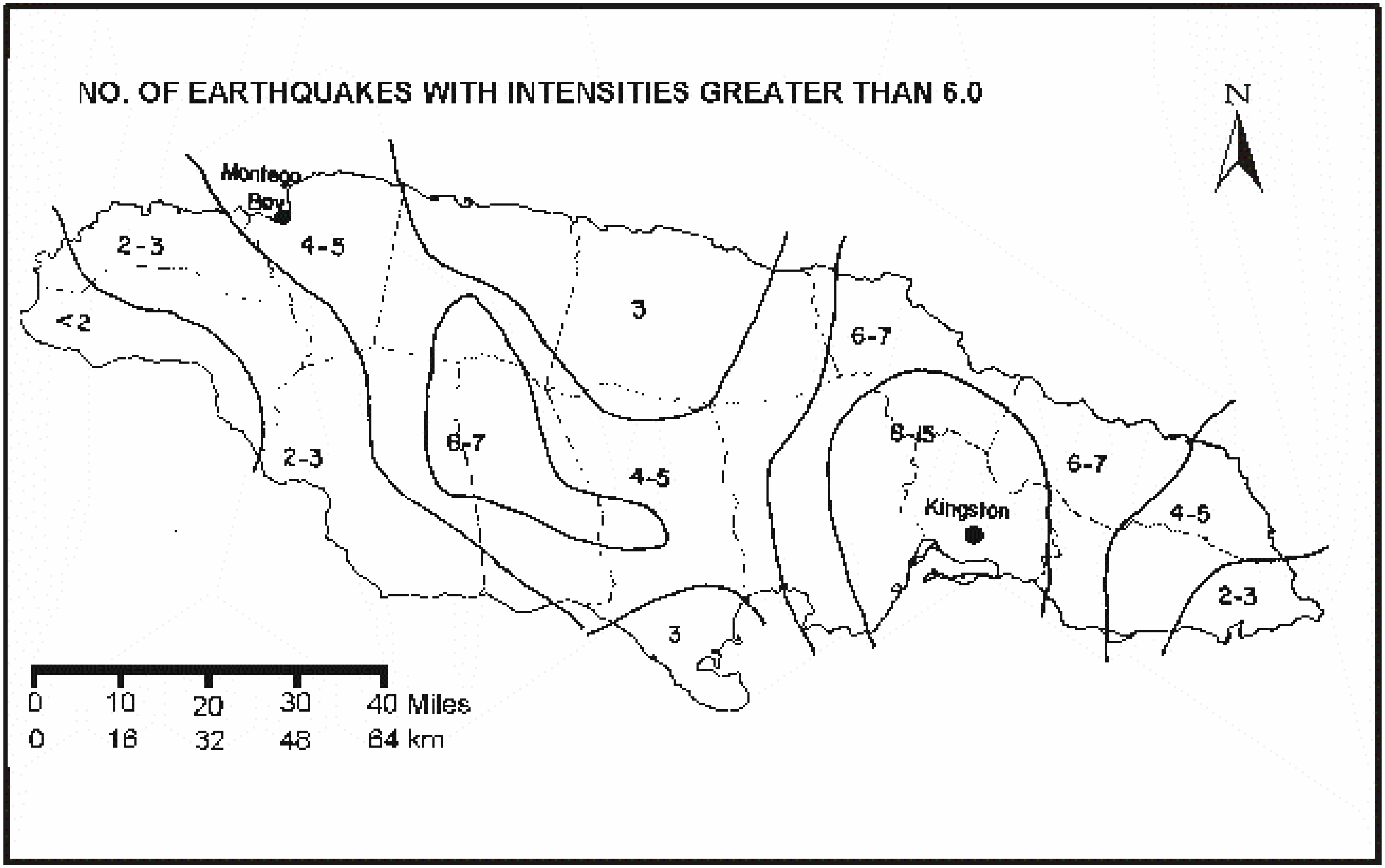


Figure 13 **Map of earthquake events greater than intensity VI (Modified Mercalli scale), occurring in Jamaica between 1879 and 1978**

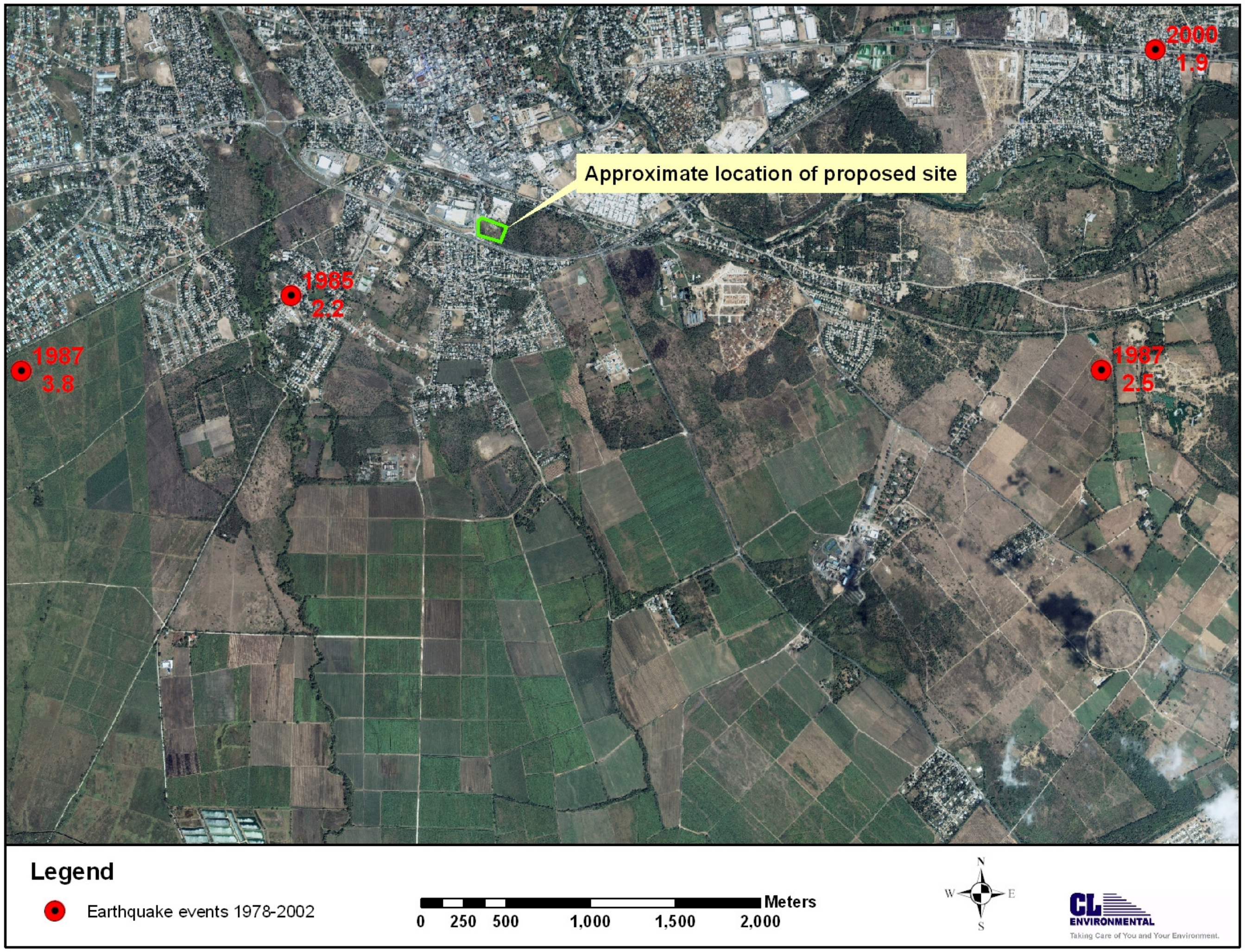


Figure 14 Earthquake epicentre locations in close proximity to the proposed site for 1978-2002, showing year of earthquake occurrence and magnitude on Richter scale

4.2.2 Hurricanes

Jamaica also lies within the Caribbean hurricane belt and has been directly affected by several hurricanes over the last century (Figure 15). Hurricanes that pass within 100 kilometres of the island have caused considerable damage although the eye has not passed directly over the island. Natural disasters associated with hurricanes include flooding and damage due to gale force winds.

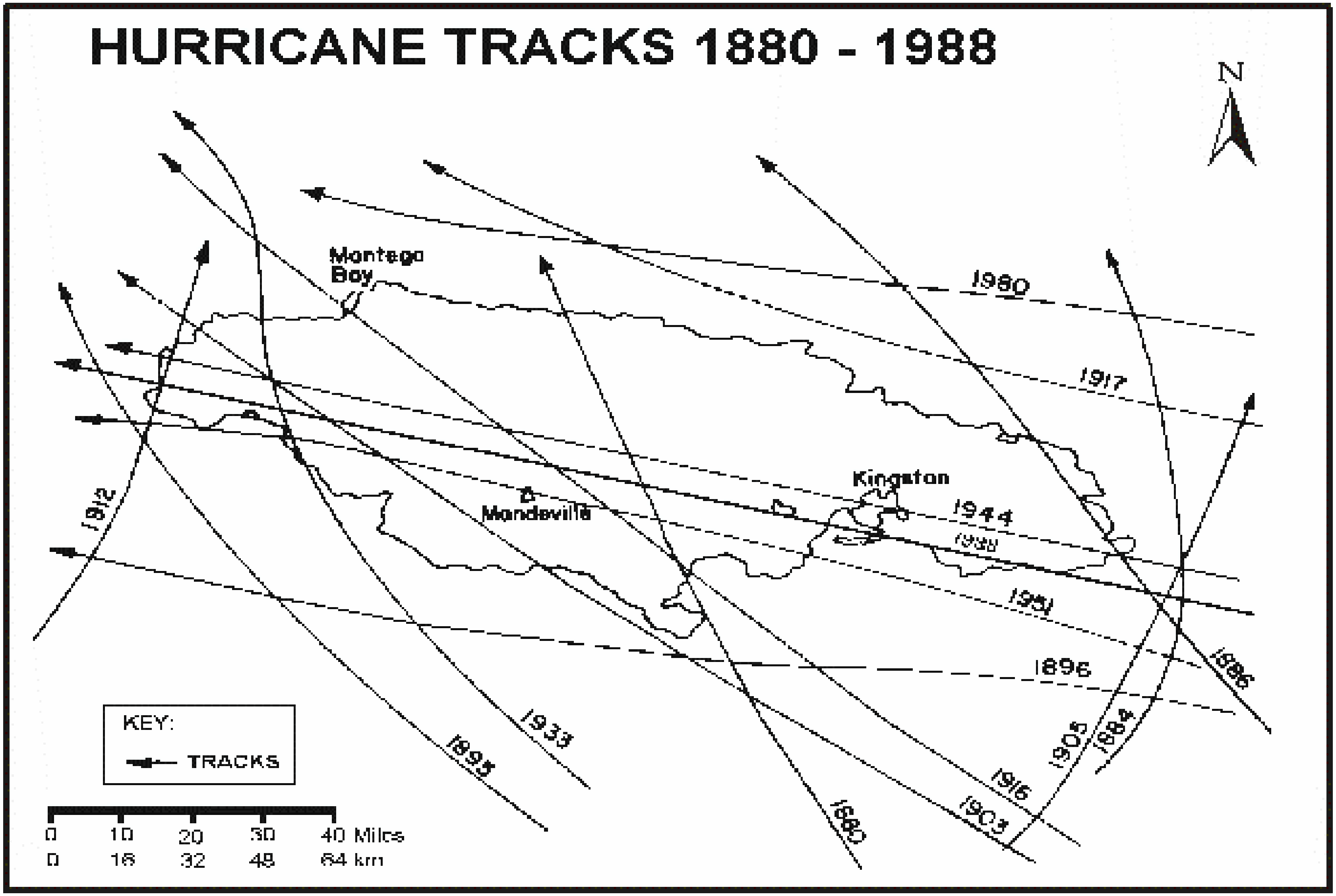


Figure 15 Tracks of hurricanes (1880 - 1988) directly affecting Jamaica

4.3 GEOLOGY

The site of interest is situated on the Rio Cobre alluvial fan, formed by the Rio Cobre over the past two to three million years carrying sediment from the island's interior. The fan sediments in this region are of Pleistocene age, the Holocene part of the deposits (last 11,000 years) being incised into the older parts of the fan and more or less confined to the present course of the Rio Cobre. The thickness of the more or less unconsolidated sediments of the fan in this area has not been ascertained, but is thought to be less than 30 m. The bedrock below is assumed to be limestone of the White Limestone Group. Drainage is via small seasonal streams and gullies, such as Town Gully, that drain in a southerly direction down the slope of the fan.

4.4 SOILS

4.4.1 Background

NHL Engineering Limited was contracted in order to undertake a soil investigation for the parcel of land on which the proposed cement facility is to be located. The methodologies utilised for this investigation and the resulting findings are summarised within this section.

4.4.2 Database

4.4.2.1 Proposed Programme

It was proposed to drill a total of five (5) boreholes, distributed across the site as shown in Figure 16. The borings were to be taken to a maximum depth of 10.7m unless N_{55} values dictated that further investigation was necessary.

The boreholes were to be used to recover representative samples of the soil for examination by the soils engineer for carrying out of a laboratory testing programme. It was envisaged that no more elaborate testing than the conventional Classification and Index Test would be required.

4.4.2.2 Anticipated Design Approach

The following concerns are based on the geographical location of the site and intuitive deduction of the typical soil type characteristics expected to be found at this location:

i) Unconsolidated high plastic clays and silts overlying random pockets of loose to compact sands resulting in

   a) Swell/shrinkage problems

   b) Total and differential settlement problems.

ii) Relatively High water level conditions, (within 6m to 10m of existing ground levels).

iii) The possibility of foundation on liquefiable soil materials

Given the above site concerns, the likely mode of failure for shallow foundation placed on the site is seismic induced shear failure or deformation related failure. It therefore appears that a foundation type that reduces or mitigate the effects of these possibilities will be suitable for this site.

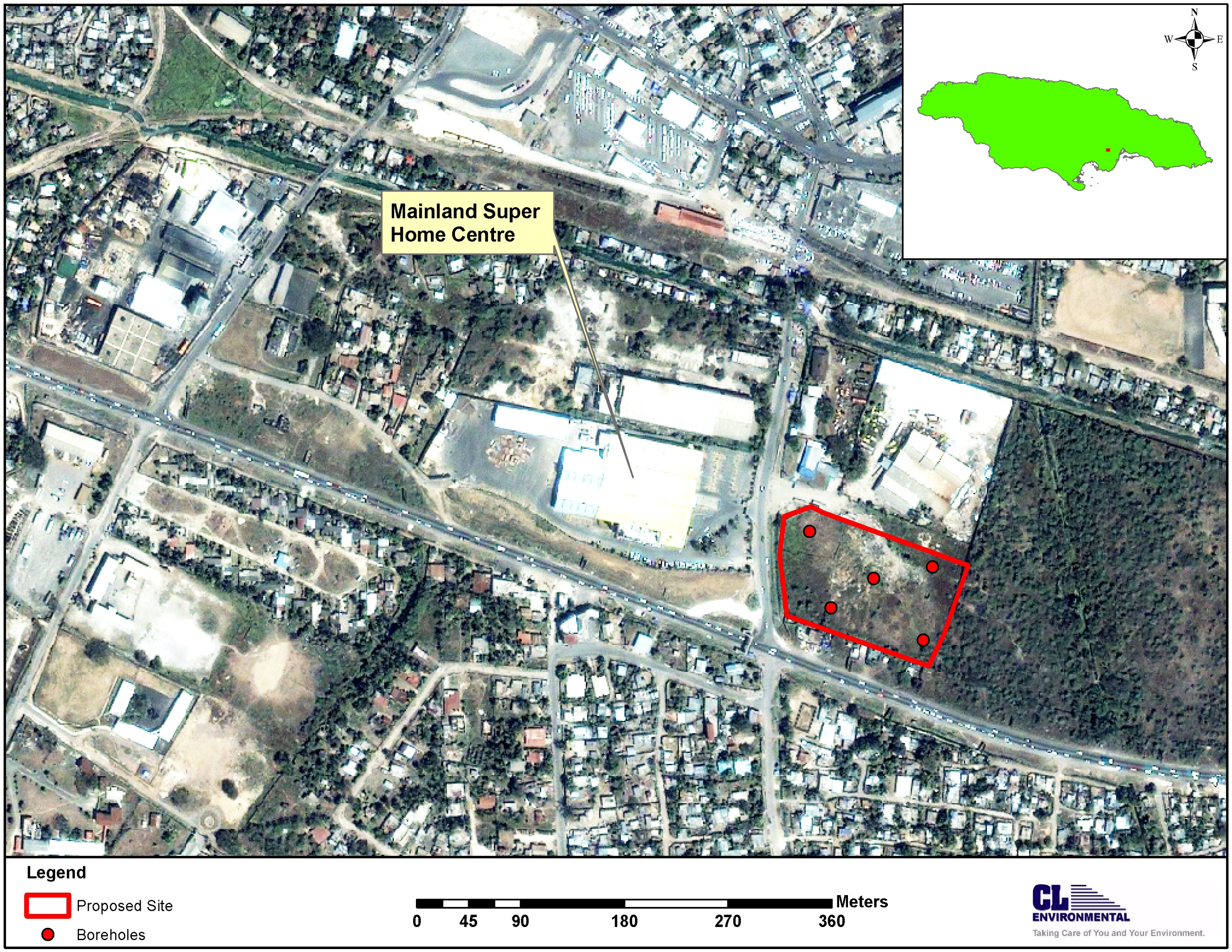


Figure 16 **Location of boreholes used for soil investigations**

4.4.2.3 Soil Boring & Sampling

Methodology

The borings made by NHL Drillers were done using a truck mounted CME Drill Rig, with a 160 mm hollow stem auger string. Sampling was done with a Split Spoon in accordance with Standard Penetration Testing specifications, using a Cathead Hammer (N_{55} values). In general, sediment samples were taken at 0.76 metre intervals of depth to the first 3 metres and thereafter at 1.5 metre interval to the maximum depth. See Appendix 1 for the office logs of the boreholes.

Results

The results indicated that the horizontal variation across the site was minimal. The soils penetrated were generally a mixture of Stiff Silty Clays overlying Dense Medium to Fine Silty Sands. Borehole Number 1 shows a layer of dumped material (biodegradable soils) within the upper 1m of soils (Figure17).

With regards to the in situ condition of the soils investigated, it was observed that the soils generally had N_{55} values in the dense/stiff range. No natural groundwater observation was made within the depth explored; however, wet samples were encountered in Borehole number 1 at about 6m during the time of the drilling operation. This water is presumed to have originated from the adjacent gully path/drain running along the site boundary by infiltration.

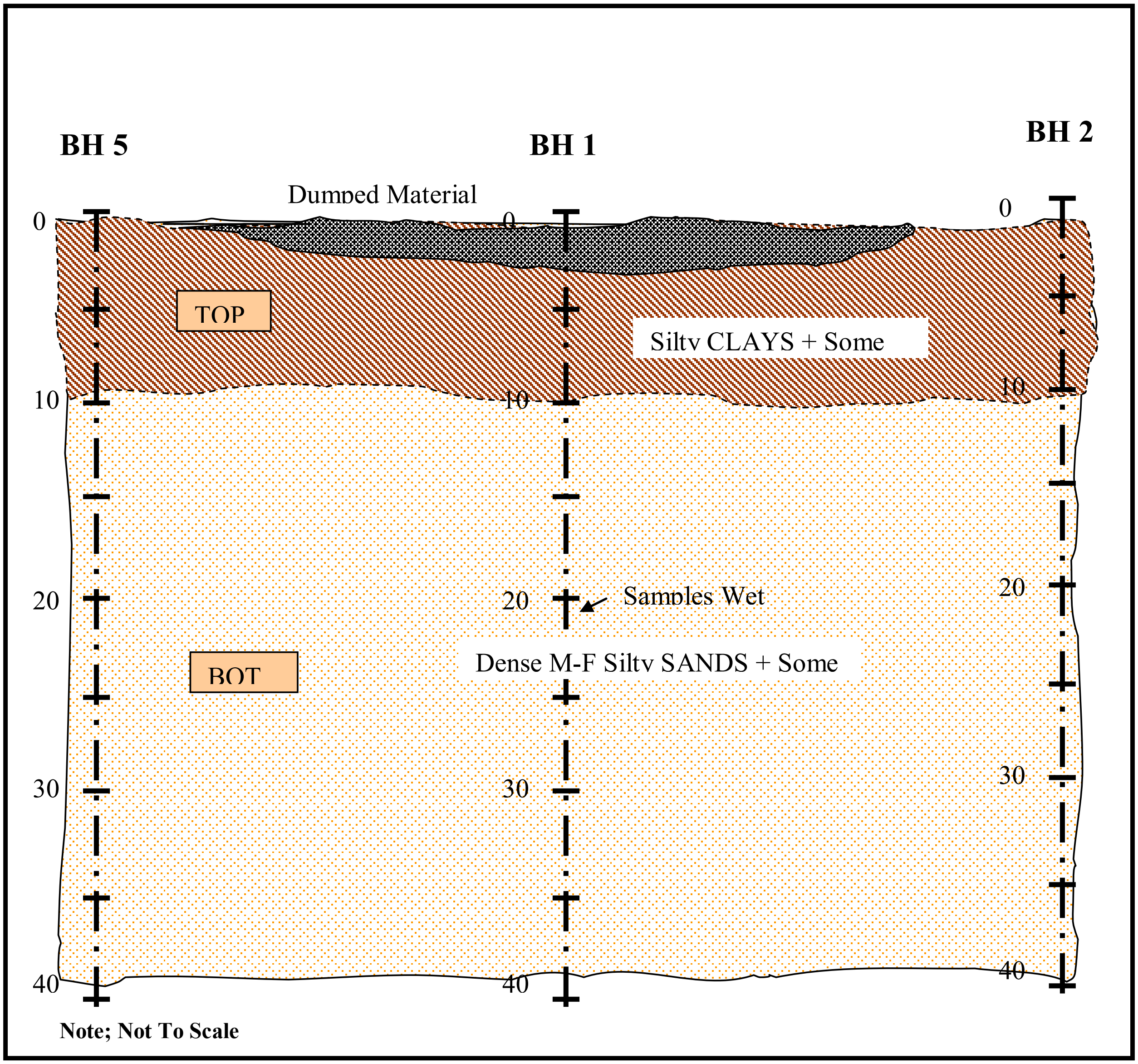


Figure 17 Deduced profile showing primary horizontal soil variability

4.4.3 Laboratory Test Results

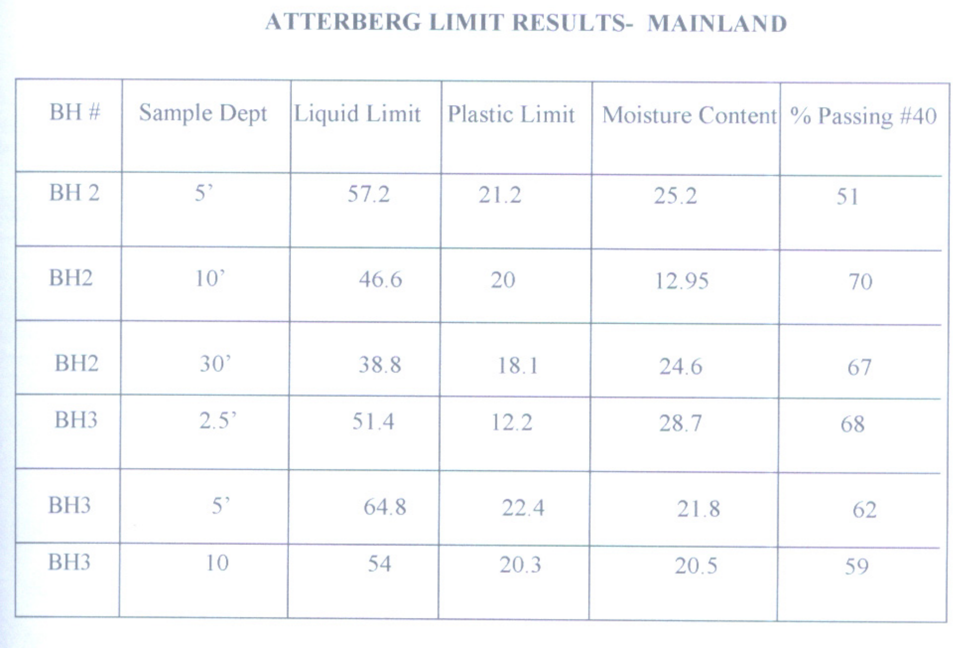
Twenty (20) samples were selected for testing: twelve (12) predominantly Plastic (Index tests) and eight (8) for grain size distribution testing. The chosen samples are, to the best of the engineer's judgment, representative of the samples recovered from the boreholes.

4.4.3.1 Classification & Index Testing:

Soil Plasticity:

Table 2 gives a listing of the Atterberg Limits for the samples tested. Of those samples tested, all had very significant coarse grained contents (ret. USS sieve #40). The results indicate that the soils classified as Inorganic Clays of medium to high Plasticity; the Liquid Limits ranged between 38.9% and 77.0%; the Plastic Limits between 11.2% and 25.0%; and the Moisture Contents between 12.5% and 28.7%. Based on these results, it is expected that the majority of these soils will exhibit high swell/shrinkage behaviour and moderate to high compressibility. Given also their frequency of occurrence within the upper depths explored, it is expected that they will have a significant impact on the design of the foundations and infrastructural elements (roads, drains etc.).

Table 2 Atterberg Limit Results



ATTERBERG LIMIT RESULTS- MAINLAND

BH #	Sample Dept	Liquid Limit	Plastic Limit	Moisture Content	% Passing #40
BH 2	5'	57.2	21.2	25.2	51
BH2	10'	46.6	20	12.95	70
BH2	30'	38.8	18.1	24.6	67
BH3	2.5'	51.4	12.2	28.7	68
BH3	5'	64.8	22.4	21.8	62
BH3	10	54	20.3	20.5	59

Grain size Distribution:

Figure 18 shows the grain size distribution of the samples tested. The analysis indicates that the samples have gradation that falls essentially into two groups. The groups can be described as follows:

- Group A - the Medium to Fine Sands + Some Silts/Clays
- Group B - the Fine Sandy Clays/Silts

Group B is generally limited to the upper 3m and Group A below the 3.0m depth.

USSIEVE	BH1@10'	BH1@35'	BH2@20'	BH3@15'	BH4@15	BH4@25'	BH5@15'	BH5@25'		
20	100	100	100	100	100	100	100	100		
14	72.7	100	100	100	100	100	100	100		
9	68.3	100	100	100	100	100	100	100		
5	67.1	100	99.9	100	100	99.6	100	98.8		
2	62.4	84.5	96.7	98.5	94.9	97.5	96.9	76.2		
0.8	58.1	58.3	67.1	95.3	62.1	91.6	84.1	62.7		
0.4	51.8	34.4	45.5	75.8	26	80.8	50.4	41.1		
0.08	49.8	27.8	41.5	65.5	16.6	78	39.8	26.2		

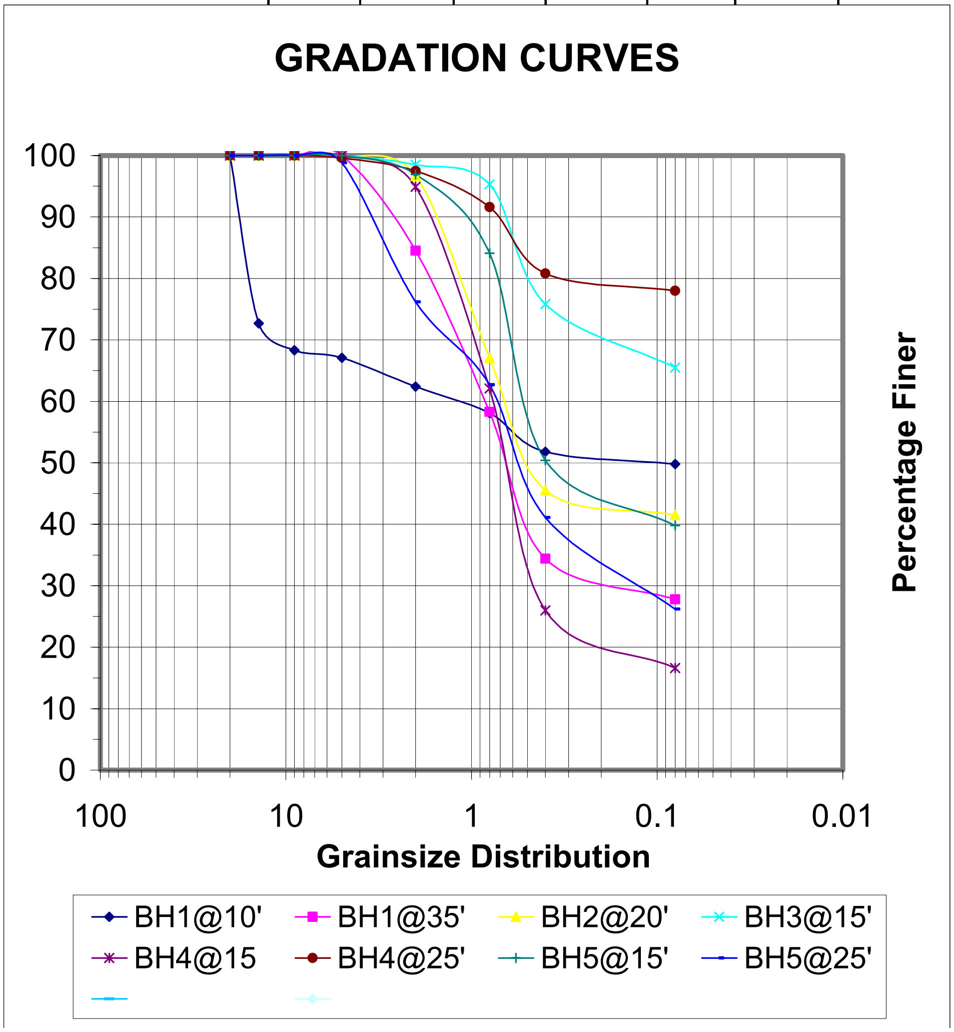


Figure 18 Grain Size Analysis Results

4.4.4 Geotechnical Discussion

4.4.4.1 Presumptive Soil Profile

The Presumptive profile shown in Figure 17 is an extrapolation of the borehole information along with an understanding of the deposition history of the soils in the area. The profile boundaries shown are presumptive and should be viewed only as approximate representations of the in situ soil condition on site.

The following soil types are presumed to be applicable for evaluating engineering behavior and construction concerns:-

A) TOP 1
  - Stiff CLAYS/SILTS + Some Fine Sands
  - Depth Range 0 – 3 metres
  - Average $N_{55} = 20$
  - All Boreholes

B) BOT 1
  - Dense Silty M-F SANDS + Some Clays
  - Depth Range 3.0+ metres
  - Average $N_{55} = 40$
  - All Boreholes

4.4.4.2 Depth and Type of Foundations

Based on the above information, no major foundation deformation problems are envisaged across the site.

The grain size distribution results suggest that the soils tested are not classical liquefaction cases and are unlikely to liquefy with the advent of an earthquake below Magnitude VII given their high relative densities and Fines Content.

The site is low-lying and therefore susceptible to flooding under moderate rainfall intensities. The established levels for the structure should therefore ensure that the site is properly drained.

The use of conventional Shallow Foundations is recommended on this site with some restrictions. The restriction involves the possible use of a Steel framed structure for the proposed construction; this structure is more susceptible to hurricane forces and the possibility of foundation uplifting during extreme wind conditions. A foundation that mitigates the effects of;

a) Uplift forces (Steel framed structure)
b) Differential deformation (reinforce concrete structure) and
c) Facilitates proper structure and site drainage is recommended.

The above requirement can be satisfied economically by the use of one of the following solutions:

i) To account for "a" above increase depth of isolated footing to at least 1.5m below finish floor level. This will increase shear resistance between soil and concrete, passive resistance and self weight of soil on footing. Note finished floor level should be increased by at least 0.75m using a compact granular fill (marl) prior to excavating for pad footing. This will increase flood protection and improve site drainage.
ii) As in (i) above, however, using a stiffened raft foundation above the compact granular fill.
iii) To account for "b" & "c" above use isolated footing within a layer of compacted granular fill; the base of the footing should have a minimum of 0.5m of fill below and above the footing.
iv) As in (iii) above, however using a stiffened raft foundation above compact granular fill.

Note; the recommendations above assume the excavation and disposal of the dumped material from the site.

4.4.4.3 Vertical Deformation considerations:

The effects of soil deformation under steady load conditions should be for the most part, of little structural consequence to the building if the above recommendations are adopted. Poor detailing and bad construction practice could however result in the formation of cracks (structural and or non-structural cracks) in the walls of the building.

The following is the result of our settlement analysis inclusive of loading assumptions:

- Total foundation pressure per column assuming 3 stories; estimated at 4455 psf. (Column spacing 15'; footing size 5'x5')

- The calculated long term settlement assuming the design profile deduced from the field and laboratory information is approximately 4.92" (125.04mm**).** This obviously can be lowered by reducing the presumed column spacings (or increasing the footing sizes) which effectively reduces the foundation pressures per column.
- In the vicinity of Borehole Number 3 (refer to report), columns spanning towards the other locations may experience differential settlements in the order of magnitude of 2.8**".**
- The severity of these findings should be assessed by the design engineers based on their designed settlement criteria. Differential settlements greater than 1" are however, generally taken as significant to the integrity of structural elements.

4.4.4.4 Other Considerations:

1) Infrastructural Considerations:

It is unsure whether sewer disposal is to be localized on site. The soils generally encountered in the upper strata are plastic and exhibit percolation rates below those generally recommended for absorption pit usage. If pits are taken below 3.5m however percolation rates deduced should be in the order of magnitude of 0.015cm/s. Typically absorption pits constructed in this soil environment usually require less maintenance. Tile fields are also a possible, however, land space requirements should be considered prior to decision making.

2) Paved Area Considerations:

The problem to overcome here is the penetration resistance of the subgrade material. Because of the anticipated truck loadings, the high water table and the relatively low CBR values (approx. 10%) of the upper soils, it is recommended that the base course be comprised of a layer of crush stone or river shingle to facilitate pore pressure release during moist conditions, and that the base course be comprised of crushed crystalline marl aggregate or be cement stabilized if the marl proctor is below 132 lb/ft3 (20.7 KN/m3). The long- term benefits to be had from this additional expenditure will far surpass the cost to maintain the roads periodically.

3) Excavation Considerations:

Although the soils on site are high to moderately plastic, the walls of open trenches will be at risk of failure during moist conditions if they were constructed vertically. It is our recommendation that excavations be constructed with walls at a slope of 1:2.5 (hor. to vert.).

These excavations should not be loaded following construction with heavy equipment and/or overburden from excavate.

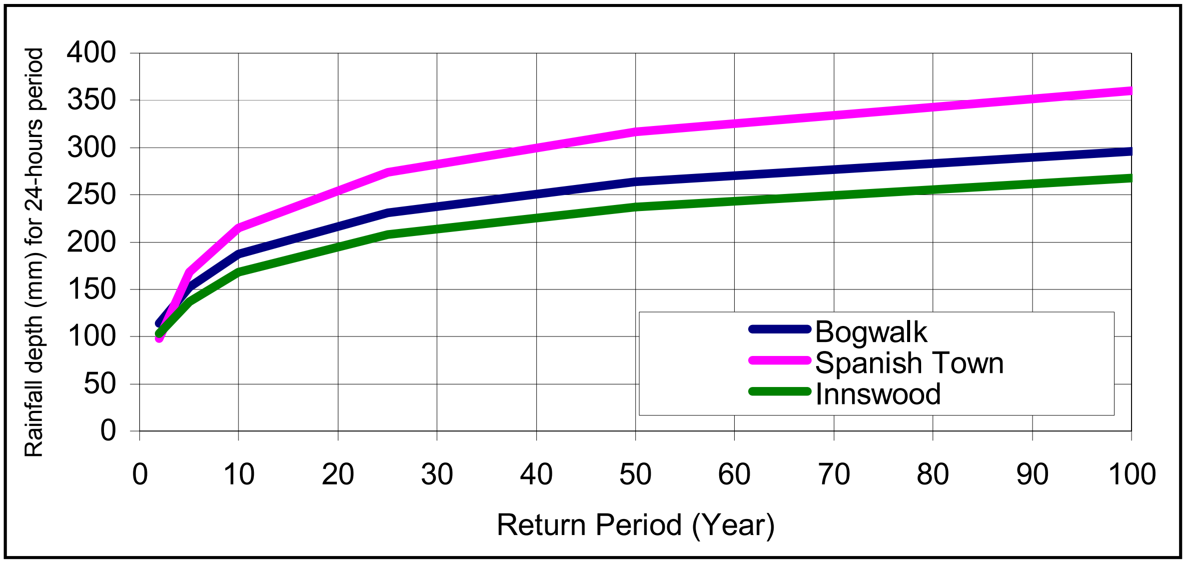
4.5 DRAINAGE AND HYDROLOGY

There are a number of drainage features within the study area. These include the Rio Cobre River which is located north east of the study area, irrigation canals, gullies and other drains, most of which are earthen. The proposed site is generally flat.

The meteorological data for the catchment was obtained from the Meteorological Office of Jamaica. Gauges were located for the Spanish town area and the 1 in 2 year return period 24 hour rainfall was recorded and used as input for the hydrological analysis. From Table 3, the estimated 2 –year Return Period rainfall depth is 98 mm in a 24 hour period.

Table 3 **Location of rain gauges, from the Meteorological Service of Jamaica**

	Rainfall Depth (24 hours) in millimetres					
Gauge	**2**	**5**	**10**	**25**	**50**	**100**
Bogwalk	114	152	187	231	264	296
Spanish Town	98	168	215	274	317	360
Innswood	103	137	168	208	237	268



The runoff from the 2-year Return Period Event was estimated to be 0.187 cubic metres per second using the SCS Method (Table 4).

Table 4 Pre-project drainage calculations

Input Parameters	**All site**	**Units**
Catchment	2	
Area	13,845	m2
Main stream length, L	212	m
Distance from outlet to centroid, Lc	106	m
Lower elevation	36.15	m
Upper elevation	38.11	m
Slope	0.9%	
Ct	1.50	
Cp	0.17	
Runoff Coefficient, C	95.0%	
Curve Number, CN	89	
Box Channel		
Length of main channel	212	m
Slope	0.93%	
Mannings Coefficient	0.013	
Width	**0.9**	m
Depth	**0.6**	m
Depth + freeboard	0.86	m
R	0.3	m
P	2.1	m
A	0.54	m2
Velocity	3.0	m/s
Flow	1.62	m3/sec
Tt	0.04	hours
Hydrology		
Time entry	0.083	hours
Rainfall-24 hours (1 in 50 year return period)	98	mm/24hours
Output		
Time of Concentration		
Tc-Australian	0.1	hours
Tc-FAA	0.1	hours
User switch (Box = 1, V = 2, Pipe = 3)	1	
Tc-Manning	0.12	hours
Tc-used	0.12	hours
Maximum potential retention, S	31.4	
Rainfall intensity for tc	8.80	
Effective Runoff (SCS)	**0.187**	**m3/s**
Effective Runoff (Rational)	**0.178**	**m3/s**

4.6 TERRESTRIAL VEGETATION AND FAUNAL STUDY

4.6.1 Flora

The site visit to the proposed location of the cement grinding plant revealed that the land was clear and here were no vegetation. Therefore there are no impacts expected as it relates to vegetation during the site preparation, construction and operation of the proposed project.

4.6.2 Avifauna

With the absence of vegetation on the proposed site there were no avifaunal or other faunal species on the proposed site. Additionally, most of the area in vicinity to the proposed plant is already commercial/industrial nature therefore, it is not expected that it would support a thriving avifaunal community.

The potential for negative impacts on the faunal community is negligible to non-existent.

4.7 NOISE

4.7.1 Methodology

Baseline noise measurement was taken at four (4) locations between 9:00 and 11:30 am using a Quest SoundPro DLX sound level meter (Figure 19). These locations are listed in Table 5. The sound level meter was calibrated with a Quest QC - 10 sound calibrator. A windscreen (sponge) was placed over the microphone to prevent measurement errors due to noise caused by wind blowing across the microphone.

A baseline noise surface map was generated using the average noise levels measured at the four stations and was generated using ArcGIS 9.0 Spatial Analyst using an analyst mask of the boundary walls of the proposed site and a tension spline interpolation method (Figure 19).

Table 5 Noise station locations in JAD 2001

STATION #	EASTINGS	NORTHINGS
N 1	648629.989	754960.546
N 2	648554.906	754930.949
N 3	648595.003	754815.917
N 4	648667.252	754818.800

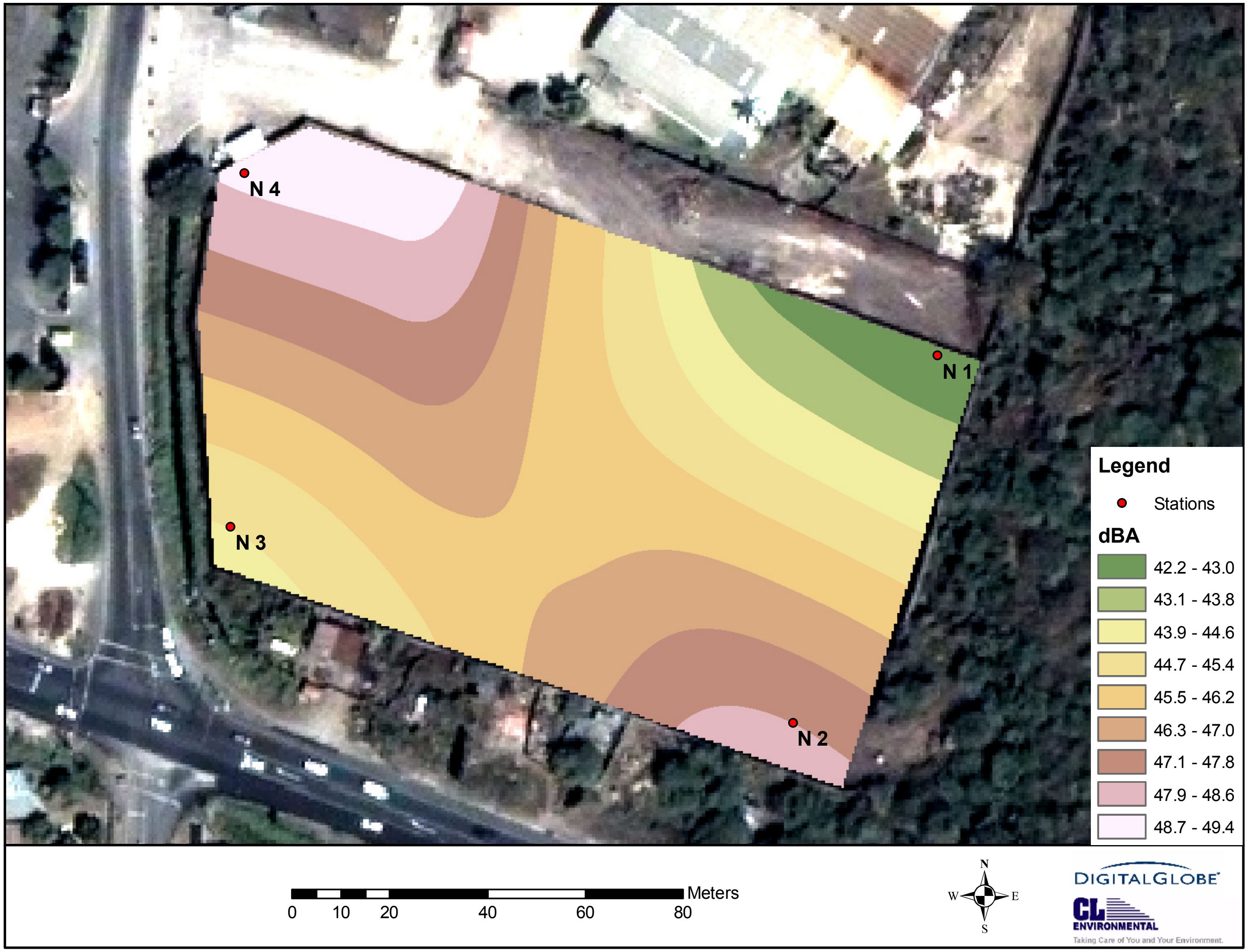


Figure 19 **Locations of noise stations and the predicted average baseline noise (dBA) map within the proposed property**

4.7.2 Results

Station N 1

Average noise level at this station during the assessment was 42.3 dBA. Most (25.3%) of the noise measured at this station was within the 38 dBA band (Table 6) and the lowest level recorded during the sampling period was 37.3 dBA and the highest 48.1 dBA (Figure 20). Octave band analysis indicated that noise is centred around the low frequency range of 16 Hz (octave frequency range 11 – 22 Hz) (Figure 21).

Table 6 Statistics Table for Station N 1

dB	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	%
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	0.0	0.0	0.0	0.2	1.5	1.1	1.5	1.0	2.7	3.1	11.0
38	2.9	3.6	1.7	1.7	4.7	2.7	2.3	1.3	2.4	2.1	25.3
39	0.9	0.7	0.6	0.4	0.3	0.3	0.3	0.6	0.2	0.4	4.7
40	0.3	0.3	0.1	0.4	0.5	1.0	0.8	0.6	0.8	0.8	5.5
41	1.1	0.6	0.5	0.5	0.6	0.3	0.3	0.3	0.6	1.2	6.0
42	0.9	0.4	0.6	0.5	0.8	0.6	0.2	0.7	1.0	0.5	6.2
43	0.5	0.8	0.1	0.4	0.5	1.2	0.5	1.0	0.5	1.3	6.8
44	2.3	1.4	1.0	2.3	2.6	1.4	0.5	0.6	0.5	1.4	14.1
45	1.3	2.1	1.7	1.4	1.2	2.1	1.1	1.0	1.1	0.5	13.5
46	0.5	1.2	0.2	1.0	0.4	0.2	0.3	0.3	0.3	0.2	4.5
47	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.1	1.6
48	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

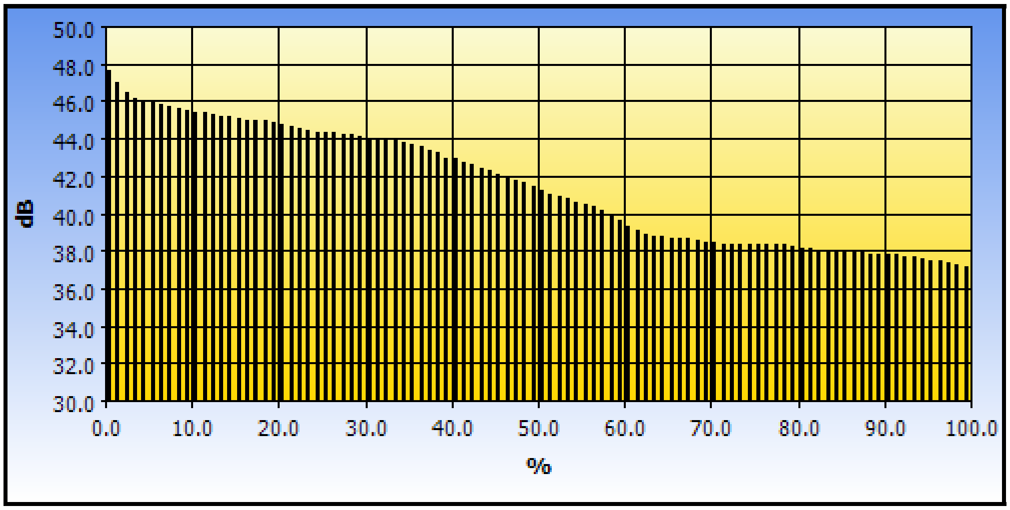


Figure 20 Exceedance chart for Station N 1

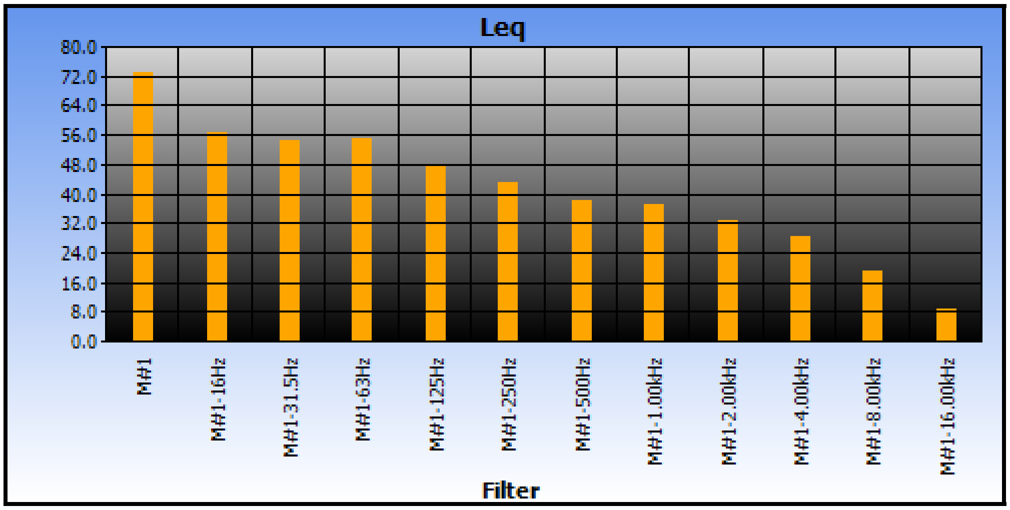


Figure 21 Spectral filter chart for Station N 1

Station N 2

Average noise level at this station was 47.8 dBA. The statistics for the noise measurements at station N 2 indicates that most (22.5%) of the noise was within the 46 dBA band (Table 7) with the lowest noise level recorded being 41.5 dBA and the highest being 55.4 dBA (Figure 22). Octave band analysis indicated that noise is centred around the low frequency range of 16 Hz (octave frequency range 11 – 22 Hz) (Figure 23).

Table 7 Statistics Table for Station N 2

dB	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	%
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.2	2.0	0.5	3.7
42	0.2	0.9	0.8	0.3	0.7	0.7	0.4	0.3	0.8	1.7	6.9
43	1.5	0.9	0.3	2.2	1.9	0.5	0.4	0.4	0.6	1.0	9.7
44	0.7	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.2	3.4
45	0.3	0.5	0.2	0.3	0.8	0.2	1.5	1.4	2.0	2.9	10.2
46	2.6	4.1	0.6	2.1	1.6	1.1	2.7	3.9	2.1	1.6	22.5
47	1.8	2.2	1.5	1.9	1.5	1.3	0.7	0.6	0.5	1.1	13.2
48	1.4	1.2	0.7	0.8	0.5	0.7	0.6	0.7	0.7	0.5	8.0
49	0.5	0.4	0.2	1.4	0.5	0.6	0.5	0.2	0.2	0.2	4.6
50	0.2	0.1	0.2	0.2	0.7	0.4	0.4	0.4	0.7	0.8	4.2
51	1.2	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.7	1.0	5.4
52	0.8	0.5	0.1	0.1	0.1	0.2	0.2	0.1	0.4	0.5	3.0
53	0.5	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.9
54	0.1	0.1	0.2	0.1	0.1	0.1	0.3	0.5	0.3	0.2	2.0
55	0.2	0.3	0.2	0.3	0.4	0.0	0.0	0.0	0.0	0.0	1.3
56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

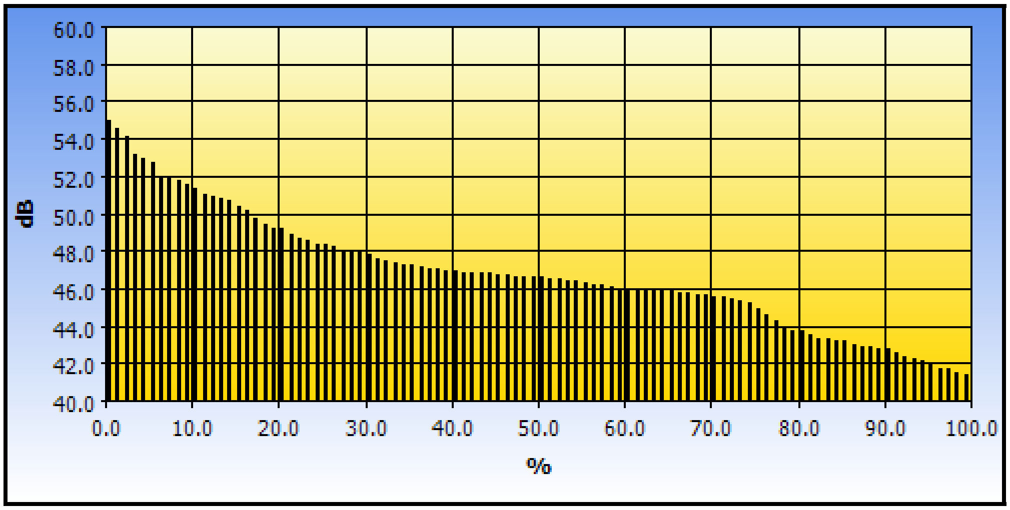


Figure 22 Exceedance chart for Station N 2

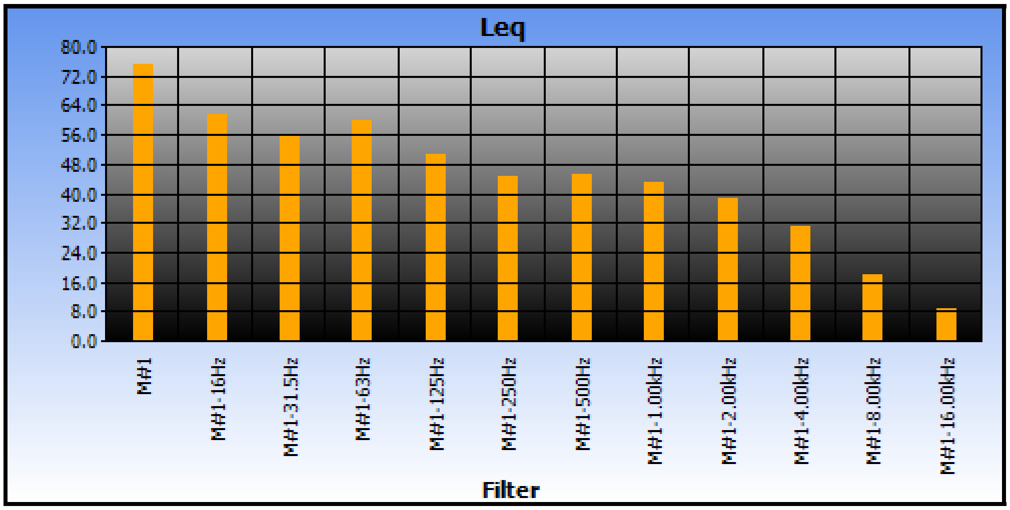


Figure 23 Spectral filter chart for Station N 2

Station N 3

Average noise level was 44.6 dBA. The majority (24.8%) of the noise measured was within the 45 dBA range (Table 8), with the lowest level recorded being 41.4 dBA and the highest at 47.7 dBA (Figure 24). Octave band analysis indicated that noise is centred around the low frequency range of 63 Hz (octave frequency range 44 - 88 Hz) (Figure 25).

Table 8 Statistics Table for Station N 3

dB	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	%
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.0	0.0	0.0	0.0	0.1	0.8	0.5	1.6	1.3	0.6	5.0
42	0.8	1.2	1.0	1.3	2.5	1.8	2.0	0.6	1.0	1.9	14.2
43	1.4	1.2	0.3	0.8	1.8	1.9	3.3	2.2	3.1	1.9	18.0
44	2.3	3.6	2.8	2.3	1.8	1.0	1.0	1.8	2.3	3.3	22.2
45	3.0	3.3	3.2	3.6	2.0	1.6	2.3	2.3	2.4	1.1	24.8
46	1.6	2.3	0.9	1.2	1.6	1.3	0.9	1.0	0.8	0.5	12.2
47	0.6	0.4	0.4	0.5	0.4	0.5	0.4	0.5	0.0	0.0	3.6
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

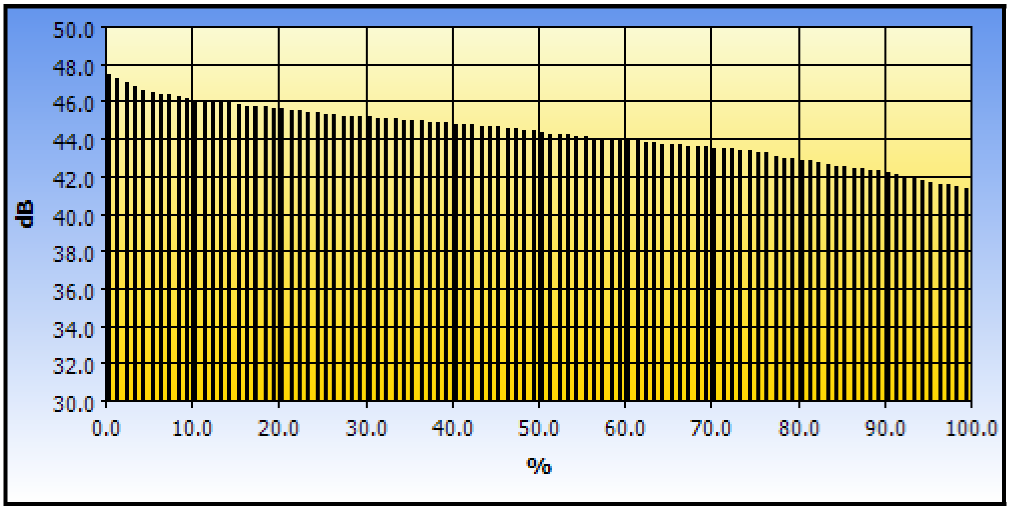


Figure 24 **Exceedance chart for Station N 3**

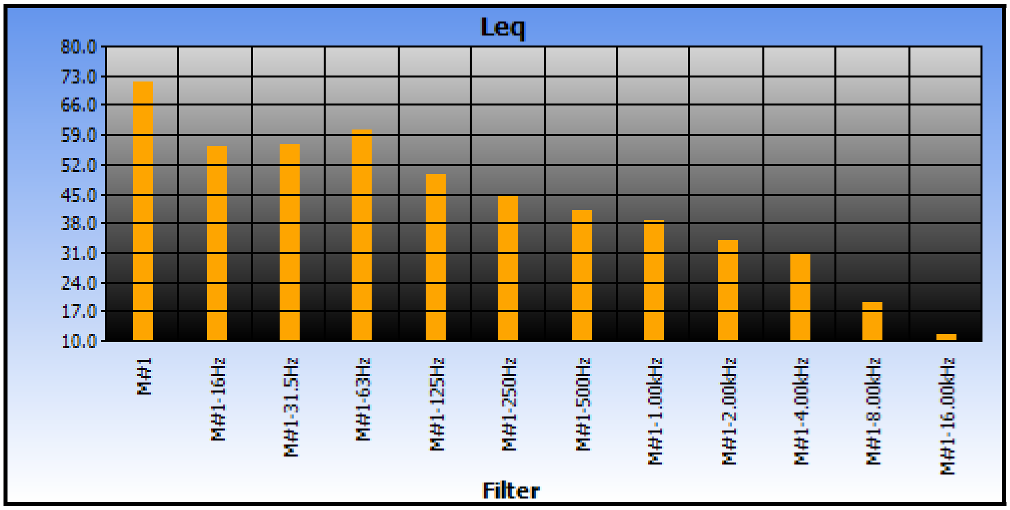


Figure 25 **Spectral filter chart for Station N 3**

Station N 4

Average noise level was 48.8 dBA. The majority (31.3%) of the noise measured was within the 46 dBA band (Table 9), with the lowest level recorded being 44.5 dBA and the highest at 53.8 dBA (Figure 26). Octave band analysis indicated that noise is centred around the low frequency range of 63 Hz (octave frequency range 44 - 88 Hz) (Figure 27).

Table 9 **Statistics Table for Station N 4**

dB	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	%
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

dB	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	%
44	0.0	0.0	0.0	0.0	0.0	1.5	0.8	0.6	0.5	0.7	4.1
45	1.6	1.5	0.3	0.6	0.8	0.4	0.4	0.4	1.3	1.3	8.6
46	0.8	2.2	1.5	3.2	1.9	5.1	6.8	5.7	2.3	1.8	31.3
47	1.6	2.2	1.5	1.6	1.0	0.3	0.3	0.3	0.7	0.3	9.7
48	0.2	0.2	0.5	1.0	0.6	0.7	0.6	0.6	0.5	0.6	5.6
49	1.2	1.1	1.0	1.0	0.8	0.8	0.8	0.9	0.5	1.1	9.3
50	1.0	1.0	1.9	1.8	0.7	0.3	0.7	1.0	1.1	1.0	10.5
51	1.2	1.1	0.9	0.8	1.4	1.4	1.2	0.9	1.9	1.8	12.5
52	1.4	0.4	0.3	0.3	0.5	0.5	0.5	0.7	1.3	0.5	6.4
53	0.5	0.2	0.2	0.1	0.2	0.1	0.2	0.3	0.2	0.0	2.0
54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

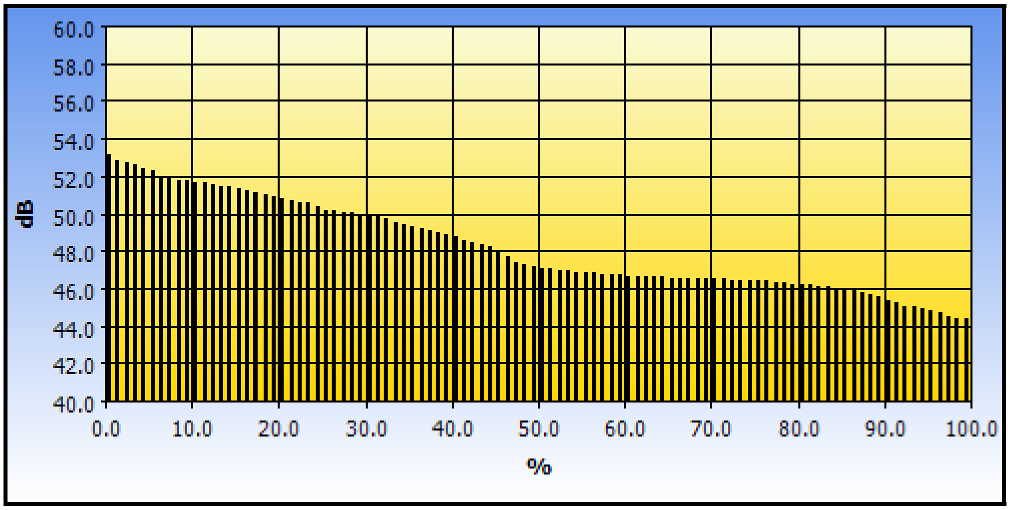


Figure 26 **Exceedance chart for Station N 4**

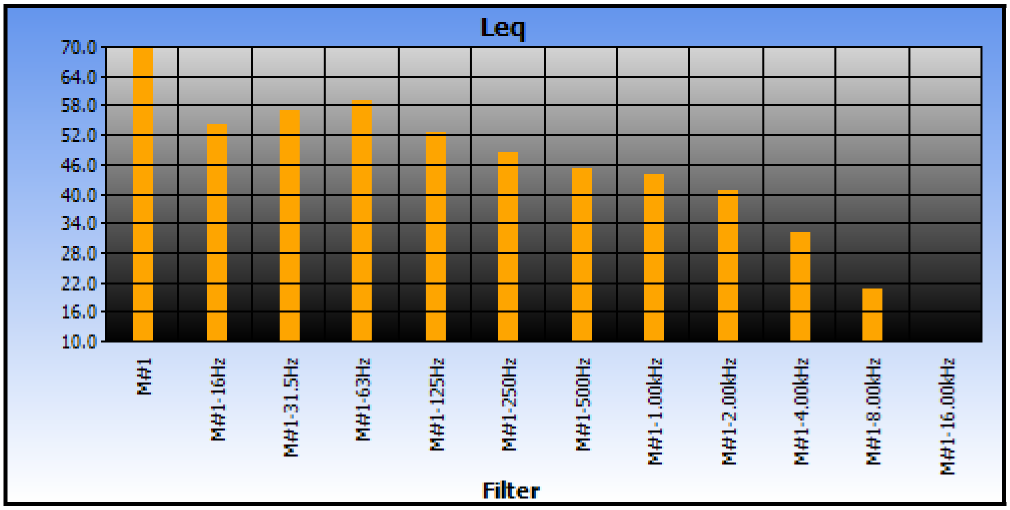


Figure 27 Spectral filter chart for Station N 4

The results of the noise level assessment indicated that the noise on the proposed property was relatively low (Figure 28). Average noise levels at all locations were below the World Health Organization guidelines of 55 dBA (serious annoyance) and the NEPA daytime guidelines (65 dBA) for residential areas.

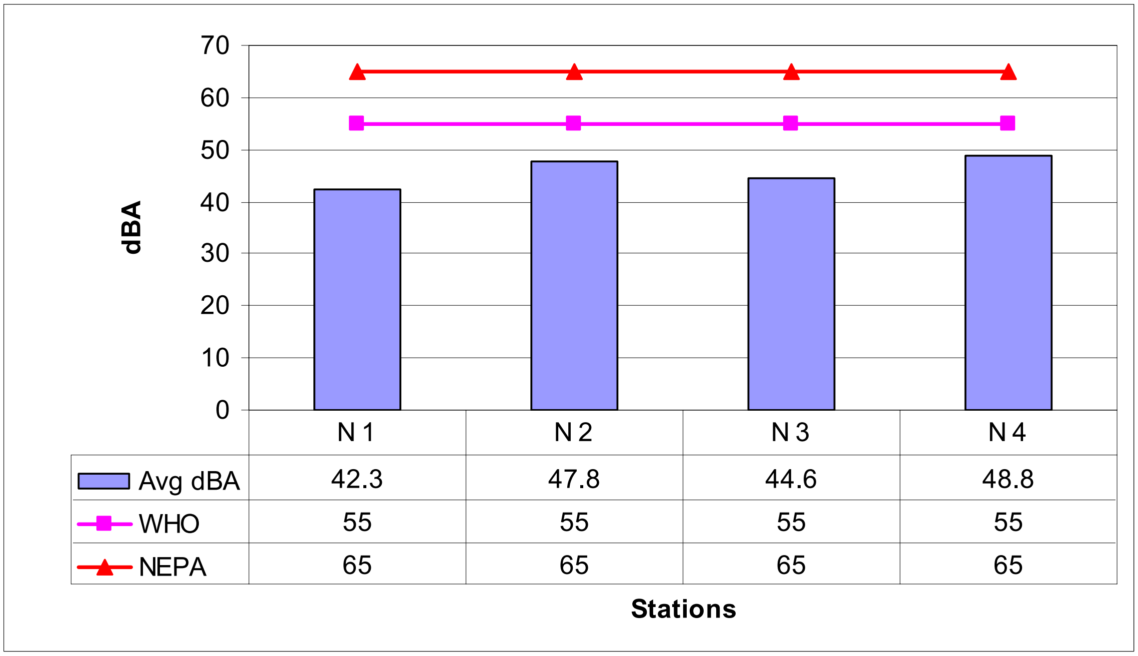


Figure 28 Average noise level readings in dBA

Noise will be generated from the grinding mills, operational machines such as front end loaders and trucks both for delivery of raw materials and for the transportation of finished products.

The proposed development is not expected to have a major negative impact as it relates to noise pollution in and around the March Pen area, as the planned planting of trees and vegetation around the proposed cement grinding plant and the installation of the 4.5m concrete perimeter wall will act as a kind of noise barrier, thereby resulting in attenuation of noise waves.

4.8 AIR QUALITY

4.8.1 Ambient Air Quality

There are limited measurements of ambient particulate matter concentrations in the Spanish Town area. The only available data are from measurements made at four locations over a two (2) week period in 1997 by the Environmental Control Division (ECD)[2]. The mean PM10 concentrations ranged from 33 to 95 µg m-3 and the maximum concentrations ranged from 55 to 182 µg m-3. Other measurements of TSP made at Bodles had a mean of 18 µg m-3 and a maximum of 40 µg m-3[3].

4.8.2 Dispersion Modeling

4.8.2.1 Sources and Pollutants

The potential air quality impacts of the facility were based on an estimate of the air emissions and the modelling of their dispersion in the atmosphere. The only pollutant of importance that is released from the facility is particulate matter. Power for the processes is supplied by electricity and the use of electric motors. The use of standby generators is assumed to be negligible.

4.8.2.2 Methods Used to Estimate Emissions

Emissions estimates are based on the emission factors for PM_{10} derived from the relevant sections of the US EPA publication AP42 (Section 11.6 - Cement Manufacture, Section 11.12 - Concrete Batching, Section 11.19.2 - Crushed Stone Processing, Section 13.2.4 – Aggregate Handling and Storage Piles and Section 13.2.1 – Fugitive Sources: Paved Roads). A PM_{10} emission factor clinker grinding with emission control was not available so the emission factor for PM was used. This will result in a conservative (higher) estimate since the mass of PM

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[2] ECD (1998). Baseline Study to Ascertain Linkage Between Respiratory Tract Diseases and Air Quality in the Kingston Metropolitan & Spanish Town Areas.

[3] Davis, M., Grant, C., Ho-Yorck-Krui, G., Johnson, A., Lalor, G.C., Robotham, H. and Vutchkov, M. (1996). Suspended particulates in the Jamaican atmosphere, Environmental Geochemistry and Health (18)

would be greater than for PM_{10}. The relevant processes, whether or not there are emission controls and the emission factors are given in Table 10.

Emission factors for PM_{10} for the storage of cement in silos were not available and so that for cement unloading to elevated silos in a concrete batch plant was used instead since this is precisely what is contemplated at the plant.

Emissions can also arise from the movement of vehicles delivering raw materials and transporting the final product (as well as other plant vehicles) over roadways within the plant. Emission factors for these processes are given by Equation 1:

$$E = k\left(\frac{sL}{2}\right)^{0.65}\left(\frac{W}{3}\right)^{1.5} - C \quad \text{..........} 1$$

Where: E = particulate emission factor (estimated as PM30 which is a surrogate for TSP);

k = particle size multiplier for particle size range (k = 24 for metric units g/VKt);

sL = road surface silt loading (grams per square meter) (g/m^2);

W = average weight (assumed to be 22.5, 12.5 and 2.2 tonnes respectively for raw material trucks, cement trucks and office vehicles) of the vehicles traveling the road; and

C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear (0.2119).

Trucks of 30 tonne capacity for delivery of raw materials and of 10 tonne capacity to receive product and travelling at a speed of 16.1 km/h (10 mph) inside the plant for a total round trip distance of 0.35 km, and a value of 0.6 g/m2 for the road surface silt loading, sL, were assumed. There are 9 parking spaces provided for office staff and the vehicles (assumed to be motor cars) using these spaces travel a very short distance (~40 m) that is common to the track traffic. Because of this the contributions from motor car traffic was negligible and therefore ignored.

Dust emissions can also occur during the loading of material onto storage piles, disturbances of the piles by strong wind currents, loadout from the pile and the movement of trucks and loading equipment in the storage pile. The quantity of these dust emissions depends on the volume of material passing through the storage cycle and on the age of the pile, moisture content and proportion of aggregate fines (AP42 Section 13.2.4). The emission factor (kg/tonne of material transferred) is given by Equation 2:

$$E = k\frac{(U/2.2)^{1.3}}{(M/2)^{1.4}} \quad \dots\dots\dots 2$$

Where: E = (kg/megagram [Mg]);

k = 0.0016;

U = mean wind speed; and

M = moisture content. (0.7% for limestone; 5% for gypsum and 0.5% for clinker)

The raw materials in the storage piles are clinker, gypsum and limestone. Clinker and gypsum will be stored under polyethylene sheets, so the emissions from the storage piles for these materials will be much smaller than estimated from Equation 2.

Similarly, the loading, crushing and transfer of the raw materials to the cement mill (Finish Grinding Mill Feed Belt – 30500627 and Finish Grinding Mill Weigh Hopper - 30500628) take place inside the building and releases to the atmosphere will be considerably less than those estimated by the emission factors for these processes. The crushing operations for gypsum, clinker and limestone were assumed to be tertiary crushing since the final products have sizes less than 25 mm hence the SCC for Crushed Stone Processing (SCC 3050030) was used. Similarly, since the transfer and loading operations from the crusher were uncontrolled, the emission factors for Crushed Stone Processing conveyor transfer points (SCC 30500306) were used.

The clinker grinding mills and the storage silos will be fitted with pollution control devices (pulse jet and reverse pulse jet dust collectors (fabric filters) which are vented to the atmosphere.

Table 10 Source Classification Codes (SCCs) and Emission Factors for the Proposed Cement Plant

SCC	SCC6_DESC	SCC8_DESC	POLLUTANT	CONTROL1	Emission Factor (EF)	EF Unit
	Aggregate handling & storage piles	Developed from equation in AP42 Section 13.2.4	PM_{10} (Limestone)	UNCONTROLLED	2.02E-02	kg/tonne
	Aggregate handling & storage piles	Developed from equation in AP42 Section 13.2.4	PM_{10} (Gypsum)	UNCONTROLLED	1.29E-03	kg/tonne
	Aggregate handling & storage piles	Developed from equation in AP42 Section 13.2.4	PM_{10} (Clinker)	UNCONTROLLED	3.24E-02	kg/tonne
30502003	Stone Quarrying - Processing	Tertiary crushing/screening	PM10, primary	UNCONTROLLED	8.70E-03	Lb/Tons Material Throughput
30502006	Stone Quarrying - Processing	Misc Operations: Screen / Convey / Handling	PM10, primary	UNCONTROLLED	1.10E-03	Lb/Tons Material Throughput
30500617	Cement Manufacturing (Dry Process)	Clinker Grinding	PM, filterable	FABRIC FILTER	8.00E-03	Lb/Tons Material Processed
30501107	Concrete Batching	Cement Unloading to Elevated Storage Silo	PM10, filterable	FABRIC FILTER	3.40E-04	Lb/Tons Material Processed
30500619	Cement Manufacturing	Cement Load Out	PM10, filterable	UNCONTROLLED	2.00E-01	Lb/Tons Cement Produced
	Vehicular traffic on property	Limestone	PM10	UNCONTROLLED	310.20	g/VKMT
	Vehicular traffic on property	Gypsum	PM10	UNCONTROLLED	310.20	g/VKMT
	Vehicular traffic on property	Clinker	PM10	UNCONTROLLED	310.20	g/VKMT
	Vehicular traffic on property	Cement	PM10	UNCONTROLLED	112.44	g/VKMT
	Vehicular traffic on property	Office	PM10	UNCONTROLLED	9.22	g/VKMT

4.8.2.3 Emissions Estimates

The sources and the estimated hourly emissions from each type of source are summarised in Table 11. The data show that there are four point sources that arise from the vents from the dust collectors on the cement storage silos (2 storage silos) and one on each of the two cement mills. Other emissions are from area sources - from the limestone storage pile and the movement of vehicles over the roadway in the plant and the unloading of clinker, limestone and gypsum from trucks.

Since the crushers and transfer points and weighing stations for clinker, gypsum and limestone are contained inside the building their emissions to the atmosphere are not included in the modelling. Control of these emissions is feasible and will be addressed in the section on air quality mitigation.

The plant was assumed to operate for 8 hours/day and 330 days/year. Emission rates were estimated for the plant operating at its maximum capacity of 150 tonne/day (t/d) cement based on using 120 t/d clinker, 22.5 t/d gypsum and 7.5 t/d limestone. Also included in Table 11 are the total emissions from all of the sources and the total for the entire facility.

Of the 9 sources listed in Table 11, four (4) are inside the buildings. The amounts that escape to the atmosphere are estimated at 0.9 tonnes/y. The total annual particulate emissions are considerably less than 25 tonnes which is the threshold above which facilities must apply for an air quality discharge licence (NRCA, Draft Air Quality Regulations). Therefore the proposed cement plant need not apply for a licence. Estimates of the air quality impacts of the releases can be made using the US EPA SCREEN3 dispersion model.

4.8.2.4 Dispersion Modelling

The modelling was performed for each of the following sources:

2 point sources (1) The combination of the two exhausts from the baghouses on the silos (Source ID 6) into one equivalent source vented to the side of the building [modelled as a volume source]; (2) Vents on the cement mills' dust collectors (Source ID 7) [as an equivalent point source].

3 area sources (1) Emissions from the uncovered limestone storage pile were modelled; since the clinker and gypsum piles are covered their emissions will be negligible and so they were not modelled. (2) Vehicular traffic for the delivery of raw materials (Source IDs 9, 10 & 11); (3) Vehicles used to collect cement and the office traffic (Source IDs 12 & 13).

SCREEN3 will model only one source at a time, for a site with multiple sources. A conservative approach is to add the maximum concentrations even though the locations of the maxima may not coincide. Since the site is located in an urban area and in flat terrain, model runs were performed using the urban option and for flat terrain. The model inputs are summarised in Table 12.

Because the model outputs are given as 1 h average concentrations and the Jamaican National Ambient Air Quality Standard (JNAAQS) for PM_{10} is expressed as a 24h average, the model outputs were multiplied by 0.4 which is the recommended factor to convert a 1 h average concentration in simple terrain to the equivalent 24 h average (Screen 3 User Guide).

Model results for the maximum predicted concentrations for point and area sources are shown in Table 13. Details are provided in Appendix 2. The maximum predicted concentrations all occur very close to the fence line (which was 20m or 40 m from the mid point of the sources). The sum of these concentrations is 134µg m^{-3} plus the recommended background concentration (12 µg m^{-3})[4] which is below the JNAAQS for PM_{10} which is 150 µg m^{-3}.

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[4] Davis, C. (1999). Natural Resources Conservation Authority, Ambient Air Quality Guideline Document. Report prepared for the Natural Resources Conservation Authority, August 1999

Table 11 Emissions for the Air Emission Sources at the Proposed Cement Plant

Source ID	SCC Code	Description	Emission Factor (EF)	EF Unit	Emission (g/h)							Total Emissions
					Clinker	Limestone	Gypsum	Cement	Total	Type	Number of sources	g/h
1		Developed from equation in AP42 Section 13.2.4	2.02E-02	kg/tonne	-	17.14	-	-	17.14	Area	1	17.1
2		Developed from equation in AP42 Section 13.2.4	4.34E-03	kg/tonne	-	-	1.23	-	1.23	Area	1	1.2
3		Developed from equation in AP42 Section 13.2.4	3.24E-02	kg/tonne	146.46	-	-	-	146.46	Area	1	146.5
4	30502003	Tertiary crushing/screening	8.70E-03	Lb/Tons Material Throughput	65.25	12.23	4.08	-	81.56	Area (Inside)	2	163.1
5	30502006	Misc Operations: Screen / Convey / Handling	1.10E-03	Lb/Tons Material Throughput	8.25	1.55	0.52	-	10.31	Area (Inside)	8	82.5
6	30500617	Clinker Grinding	8.00E-03	Lb/Tons Material Processed	-	-	-	75.00	75.00	Point	2	150.0
7	30501107	Cement Unloading to Elevated Storage Silo	3.40E-04	Lb/Tons Material Processed	-	-	-	3.19	3.19	Point	2	6.4
8	30500619	Cement Load Out	2.00E-01	Lb/Tons Cement Produced	-	-	-	1,875.00	1,875.00	Area (Inside)	2	3750.0
9		Limestone delivery trucks	3.10E+02	g/VKMT					2.63	Area	1	2.6
10		Gypsum delivery trucks	3.10E+02	g/VKMT					0.88	Area	1	0.9
11		Clinker delivery trucks	3.10E+02	g/VKMT					14.02	Area	1	14.0
12		Cement pick up trucks	1.12E+02	g/VKMT					7.62	Area	1	7.6

Table 12 Model Input Parameters for Air Emission Sources at the Proposed Cement Plant

	Emission Rate (g/s)	Euivalent diameter (m)	Flow Rate (m^3/h)	Height (m)	Exit Temperature (°K)	Emission Rate ($gm^{-2}s^{-1}$)	Equivalent Length (m)	Equivalent Width (m)	Area (m^2)	Min distances (m)
Point Sources										
Cement Mill Baghouses	4.17E-02	0.8	6400	2	300		12.95			60
Cement Silos	1.77E-03	2	3228	12	300					60
Area Sources										
Materials Handling and storage piles (limestone)	4.76E-03			1		9.52E-05	10	5	50	40
Vehicular traffic (Raw Materials)	4.87E-03			1		3.86E-06	70	18	1260	40
Vehicular traffic (Cement pickup and office)	2.25E-03			1		4.16E-06	60	9	540	20

Building Information	(m)
Building Height	9.144
Min horizontal building size	12.6
Max horizontal building size	55.7

Table 13 Summary of Maximum Predicted PM_{10} Concentrations the Proposed Cement Plant

	Max Predicted 1 h Avg Conc	Max Predicted 24 h Avg Conc (μg m^{-3})	Distance (m)	Max Dir (Degrees)
Point Sources				
Cement Mill Baghouses	100.8	40.3	71	
Cement Silos	8.52	3.4	46	
Area Sources				
Materials Handling and storage piles (limestone)	98.23	39.3	40	
Vehicular traffic (Raw Materials)	67.86	27.1	42	11
Vehicular traffic (Cement pickup and office)	59.2	23.7	35	0
Total		133.8		

4.8.2.5 Conclusions

The sum of the maximum predicted PM_{10} concentrations plus the background concentration is 146 µg m^{-3} and this is below the 24 h average JNAAQS for PM_{10} (150 µg m^{-3}). These estimates are considered conservative since the predicted component concentrations would not occur at the same location (distance from the plant's fence line). In view of this, no ambient air quality monitoring program is necessary.

Emissions inside the building may be controlled by adding any necessary hoods to the vicinity of the transfer points and venting the exhaust to one of the existing dust collectors.

5.0 SOCIAL BASELINE

5.1 INTRODUCTION

The Social Impact Area (SIA) for this study was assumed to be two kilometres (2km) for the proposed cement grinding plant (Figure 29).

5.2 METHODOLOGY

Windscreen surveys were conducted in the communities to verify and update the information on the maps, in addition to using current satellite imagery. Current socio-economic data was obtained from the 2001 population census and forty-five (45) structured questionnaires within the March Pen area (see Appendix 3 for questionnaire).

Population was calculated using the formula [$i_2 = i_1 (1 + p)^x$]; where i_1 = initial population, i_2 = final population, p = actual growth rate and x = number of years. The growth rate for the study area was determined from the 1991 to 2001 intercensal period.

Water consumption was calculated based on the assumption that water usage is 136.38 litres/capita/day (30 imp. gals.).

Domestic garbage generation was calculated at 1 kg/capita/day (National Solid Waste Management Authority).

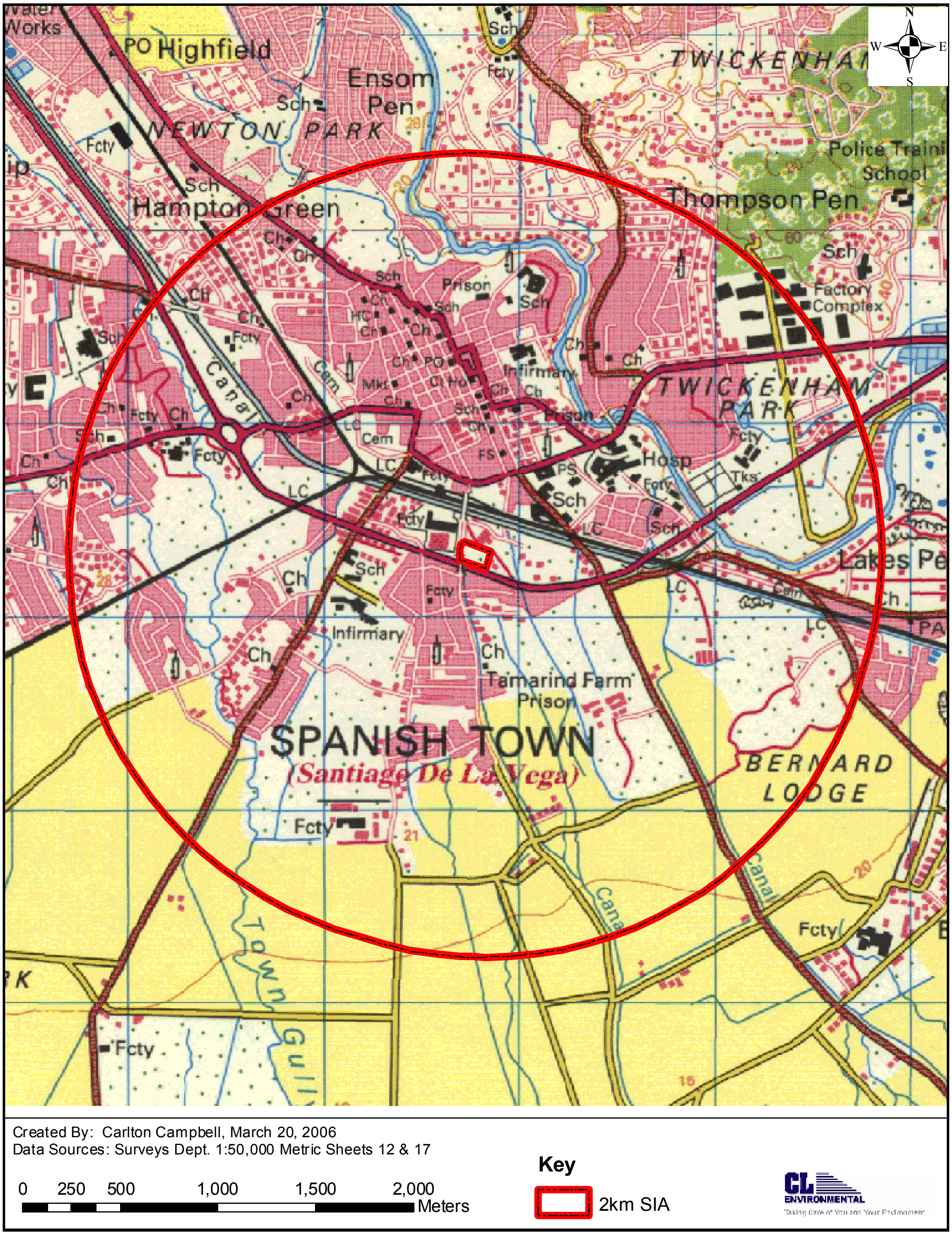


Figure 29 Map showing the 2 km SIA

5.3 DEMOGRAPHY

5.3.1 Population

The population of St. Catherine in 2001 was 482,265 persons (STATIN 2001). The population within the SIA (referred to as study area from here onward) of the proposed cement grinding plant site was approximately 43,430 persons in 2001, which represents approximately 9 % of the population of St. Catherine. Of this population, approximately 49.9% were males.

If the current growth trend in the study area continues (2.3% pa - based on the last intercensal change), then the population at this time within the study area is estimated to be 48,660 persons and is projected to grow to 85,913 persons over the next twenty five (25) years (2031).

An illustration of the population distribution in the study area based on the built environment is depicted in Figure 30.

The sex ratio (males per 100 females) within the parish in 2001 was 94.4, while in the study area it was 99.5. This means that within the study area (local) there were more males than females when compared to the regional context (parish).

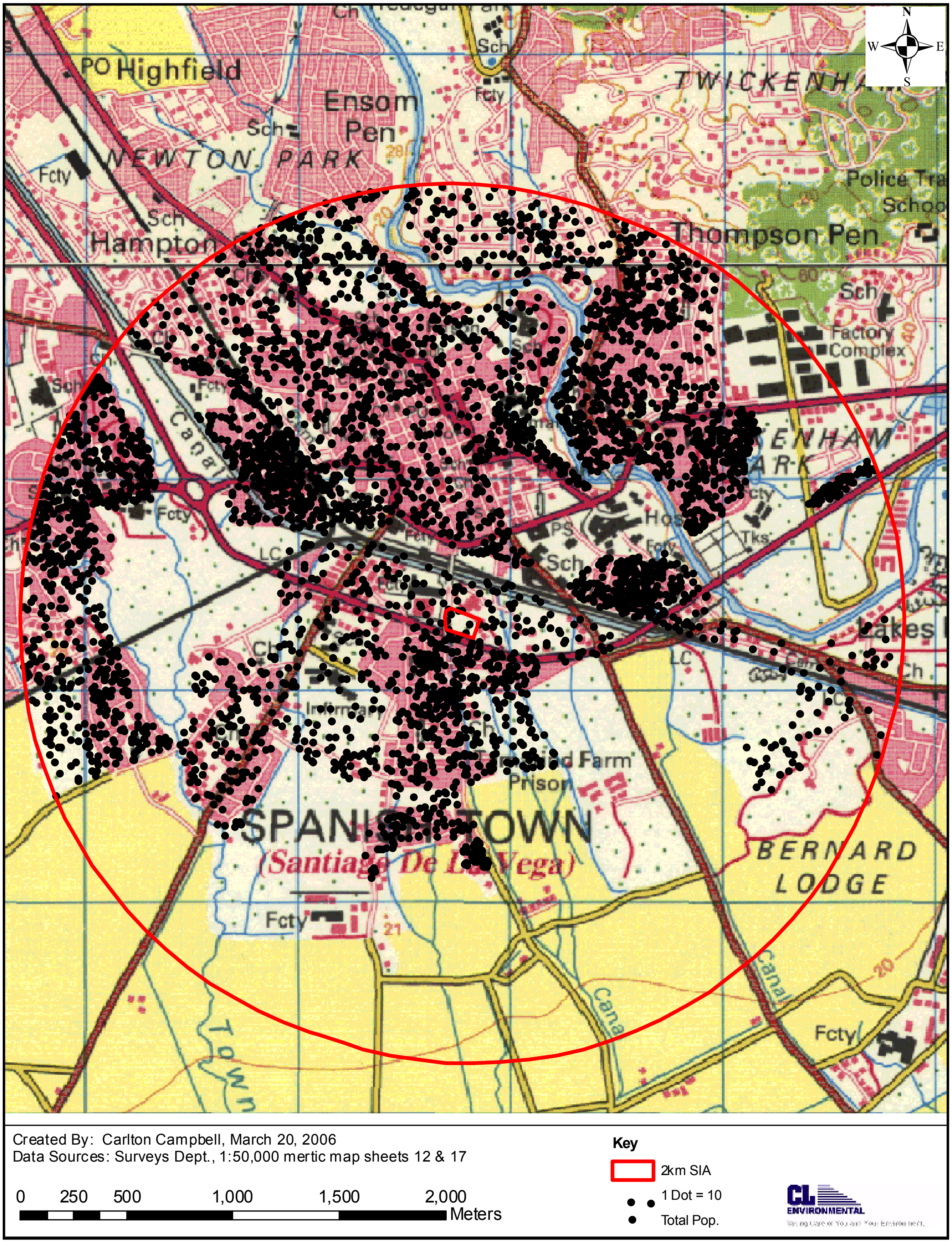
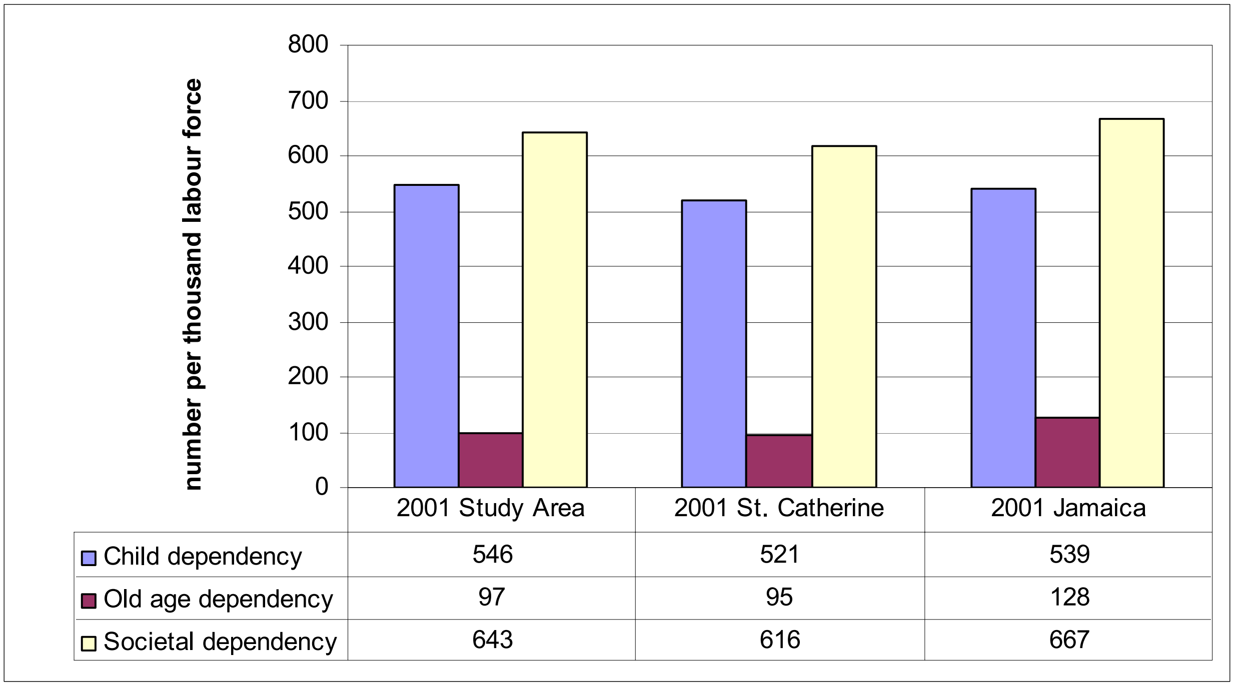


Figure 30 Illustration of population distribution in the study area based on the built environment

The child, old age and societal dependency ratios within the parish of St. Catherine in 2001 were 521, 95 and 616 per 1000 persons of labour force age respectively. The child, old age and societal dependency ratios for the study area were 546, 97 and 643 per 1000 persons of labour force age respectively. This indicates that there is an overall slight increase in dependency on the working population in the study area by the young in the population (0-14 years) and old (65 years and over) when compared with the parish.

A comparison of the dependency ratios in 2001 revealed that the national dependency ratios were higher than both the parish and the study area dependency ratios except for the child dependency ratio in the study area (Figure 31).



	2001 Study Area	2001 St. Catherine	2001 Jamaica
🟦 Child dependency	546	521	539
🟥 Old age dependency	97	95	128
🟨 Societal dependency	643	616	667

Figure 31 Dependency Ratios

The data suggests that there was a higher dependency on the working population by children in the study area for support and a slightly higher dependency by old agers when compared with the dependency ratio of the parish.

5.3.2 Population Density

It is estimated that the land area within the study area is 1,309 hectares. The average population density of the study area is approximately 33 persons per hectare (PPH). The average population density within the area is low (Figure 32), however, there are sections (settlements) within the area, which exceeds the average. The areas with the darker regions correspond to areas of population concentration. Areas that showed concentration spots included Tawes Pen, southern parts of March Pen Road, Twickenham Park and community between hospital and Spanish Town bypass.

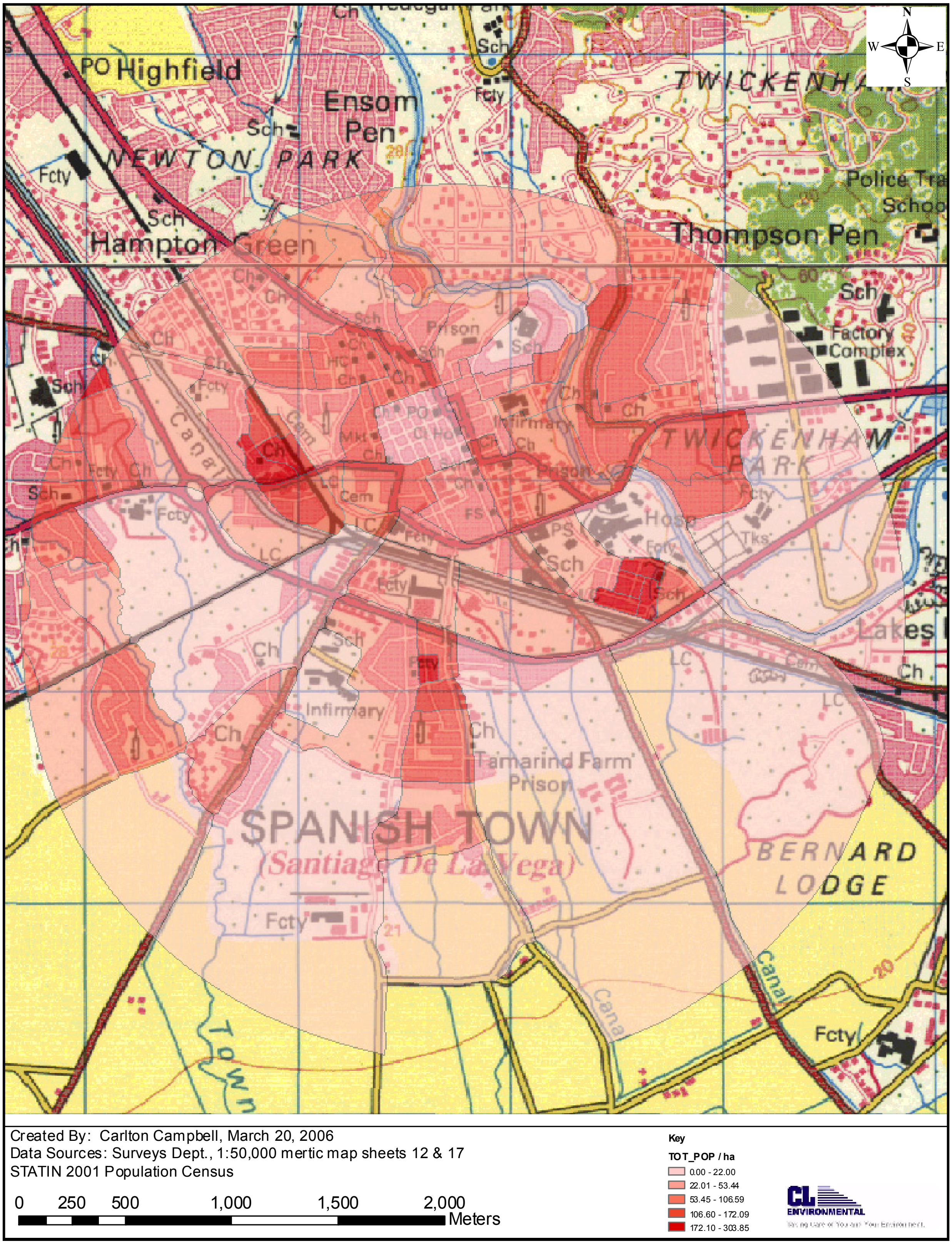


Figure 32 Population densities with the Study Area

The parish shows a young but aging population (Table 14). This is evidenced by the shift in the percentage of the population from younger age groups (0-14 years) to the middle to upper age ranges (15-44, 45 and over years). This is further supported by the fact that the percentage of the population in the 65 and over age group generally increased.

Table 14 Percentage composition of the population of the parish of St. Catherine over a thirty year period and the Study Area in 2001

AGE GROUP	1970	1982	1991	2001	STUDY AREA
0-4	16.6	12.7	11.6	10.7	11.4
5-14	31.1	27.6	23.5	21.5	21.8
15-29	20	29	30.5	26.9	28.2
30-44	13.3	15.2	17.6	21.7	20.7
45-64	13.6	9.7	11.3	13.3	12
65 & Over	5.4	5	5.5	5.9	5.9

(Source: STATIN 2001 Census data)

A comparison of the study area within the parish in 2001 showed that the distribution of the population age categories in the study area was similar to the parish.

Further investigation of the parish characteristics showed that there was a general decline (trend) in the percentage of the population in the 0-4 years category over the last thirty years, an increase in the 15-44 years and generally, a decline of the population in the 45-64 and 65 and over years categories.

5.4 EMPLOYMENT AND INCOME

The unemployment rate among the labour force in the parish in 1991 stood at approximately 53.2%, while unemployment within the study area, stood at approximately 52%. The 2001 data for the parish indicated that employment rates rose 48.9% of the total working population of 326,507 persons. Of this total, 57.6% were male. It is expected that the employment situation would be similar in the study area.

The project is expected to employ a total of 79 persons, twenty-five (25) during the site clearance and construction phase and fifty four (54) during operation.

5.5 EDUCATION

Educational attainment of persons within the study area when compared with the parish statistics showed that the population within the study area had a similar educational attainment when compared to the parish statistics. The exception to this is seen in the 'University', 'Other Tertiary' and 'Not Stated' categories, where the study area showed lower percentages in the previous two categories (Table 15). It shows that the majority of the persons within the study area have attained a secondary education.

Table 15 Comparison of categories as a percentage of educational attainment by the population in the Parish and the Study Area in 2001

Educational attainment	Parish	Study area
Pre-Primary	4.7	5.2
Primary	28.5	28
Secondary	49.3	51.4
University	3.7	1.9
Other Tertiary	7.7	5.2
Other	3.4	3.7
Not Stated	2.1	3.8
None	0.7	0.8

(Source: STATIN 2001 Census data)

5.6 LAND USE

Land use in the study area is mainly commercial, agricultural, residential, educational and recreational. The built environment dominates (≈60%) the land use of the study area. Sugarcane cultivation occurs approximately 31.5 km southeast of the proposed site at the Bernard Lodge Sugar Factory. Fish farming (aquaculture) occurs approximately 800m south east of the proposed development site. Cattle, pig and goat rearing are also done. Commercially, the study area has bars, shops and shopping centres. There are numerous existing and housing developments located in the study area. There are numerous educational facilities located in the study area; the most notable is the GC Foster College which is situated approximately 3km northwest of the SIA. Recreationally, there are parks and play fields and a mini stadium at the Spanish Town Prison Oval.

The area of and within proximity to the proposed site may be considered a industrial / commercial area, with industries such as the Industrial Chemical Company (ICC) and commercial facilities such as the Mainland Super Store.

Other land use practices within or in proximity to the study area include;

i. Improper solid waste disposal
ii. Charcoal burning
iii. Cemeteries
iv. Post Office
v. Churches
vi. Market
vii. Prisons
viii. Irrigation canal

The total area of the proposed site is approximately 1.4 hectares (≈3.5 acres) and the land is currently clear.

5.6.1 Housing

For the purposes of this study the definition of housing unit, dwelling and household are those used in the conduction of the population census conducted by the Statistical Institute of Jamaica. This definition states that a "housing unit is a building or buildings used for living purposes at the time of the census. A dwelling is any building or separate and independent part of a building in which a person or group of persons lived at the time of the census". The essential features of a dwelling unit are both "separateness and independence". Occupiers of a dwelling unit must have free access to the street by their own separate and independent entrance(s) without having to pass through the living quarters of another household. Private dwellings are those in which private households reside. Examples are single houses, flats, apartments and part of commercial buildings and boarding houses catering for less than six boarders.

In 2001, there were approximately 98,523 housing units, 128,974 private dwellings and 134,377 households in St. Catherine. The average number of dwelling in each housing unit was 1.3 and the average household to each dwelling was 1.04. The parish had an average household size of approximately 3.58 persons/household. When compared to the national levels, the average number of dwelling in each housing unit (1.2) and the average household size (3.48) were higher in the parish. However, the average household to each dwelling (1.25) was lower in the parish.

Approximately seventy eight percent (78.5 %) of the housing units in St. Catherine in 2001 were of the separate detached type, 19.9% of the attached type, 0.5% part of a commercial building and 0.1% improvised housing, 0.1% other and 0.9% not stated.

Approximately 67% of the households in St. Catherine occupied between 1 and 3 rooms, 28% between 4 and 6 rooms and 5% occupied 7 and over rooms. Most of the households (37.1%) in St. Catherine used two (2) rooms for sleeping (Table 16).

Table 16 Breakdown of rooms used by households for sleeping as a percentage

LOCATION	1	2	3	4	5	NOT STATED
PARISH	32.6	37.1	20.1	6.2	3.3	0.6
STUDY AREA	42.8	33.2	15.3	5.0	3.0	0.7

(Source: STATIN 2001 Census data)

In 2001, there were approximately 9,006 housing units, 11,541 private dwellings and 12,195 households in the study area. The average dwelling in each housing unit was 1.3 and the average household to each dwelling was 1.06. The average household size was 3.99 persons/household. While the average household to each dwelling and the average dwelling in each housing unit was similar to the parish statistics, the average household size was higher than the parish average.

Separate housing accounted for 85.8% of the housing units in the study area in 2001. Twelve percent (12%) was attached housing and 0.5% part of a commercial building, 0.1% improvised housing, 1.6% did not state and approximately 0.02% had other type of housing.

In 2001, approximately seventy six percent (76%) of the households in the study area occupied between 1 and 3 rooms, 19.9% between 4 and 6 rooms, 2.1% occupying 7 and over rooms and 2.0% did not state.

Most of the households (42.8%) in the study area occupied one (1) room for sleeping. Approximately thirty three percent (≈ 33.2%) occupied two rooms, 15.3% three rooms, 5% four rooms, 32% occupying over five rooms and 0.7% did not report how many rooms they used for sleeping. The data suggest that there is a propensity for over crowding in the study area as evidenced by the higher household sizes and the higher households to dwellings when compared to the parish statistics.

5.6.2 Tenure

Table 17 is a comparison of household tenure for the parish and the study area.

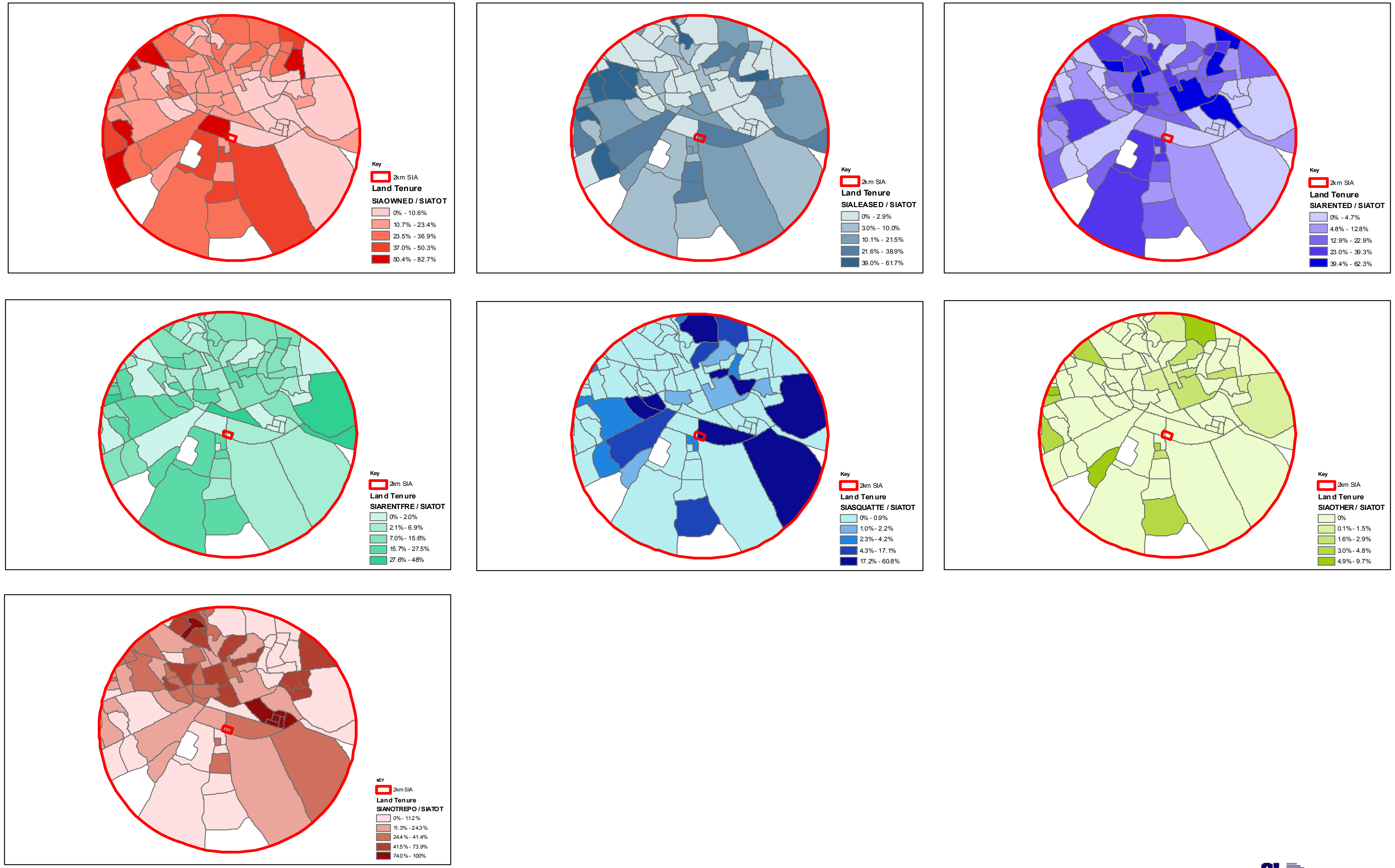
Table 17 Percentage household tenure for the parish and the study area

CATEGORY	ST. CATHERINE (%)	STUDY AREA (%)
Owned	29.6	23.8
Leased	7.3	14
Rented	9.6	16
Rent Free	11.6	11.8
Squatted	2.5	7.2
Other	0.7	0.8
Not Stated	38.7	26.4

Source STATIN 2001 Census data

In 2001, there were a lower percentage of households within the study area than the parish that had owned where they lived. There was a concomitant increase in those leasing, renting living rent free and squatting, all of which were higher than the Parish statistics. The data would suggest that a relatively higher percent of households within the study area when compared to the Parish were in a formal living and stable living arrangement. Figure 33 depicts the type of land tenure per household within the study area.

Mainland International owns the property on which the proposed development is to take place.



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Source: STATIN 2001 Census Data

Figure 33 Type of land tenure per household within the study area

5.6.3 Infrastructure

5.6.3.1 Electricity

Approximately 89.3% of the households in 2001 used electricity in the parish of St. Catherine. The use of kerosene was the next major source of lighting in households in the parish accounting for approximately 8.1%. Approximately two percent (2.2%) of the households did not report what means they used for lighting, while less than one percent (0.4%) of the households in the parish had other means of lighting.

In the study area in 2001, approximately 91.9% of the households used electricity and 4.8% used kerosene for lighting. Less than one percent of the households each used other means (0.6%) and 2.7% had not reported the type of lighting used in their households. There were a greater percentage of households within the study area using electricity than in the parish (St. Catherine). The percentage of households using kerosene in the study area was dramatically lower when compared with the parish.

Power supply to the proposed development will be sourced from the Jamaica Public Service Co. Ltd. It is anticipated that approximately 400 to 500 kWh of electricity will be needed. Additionally, a standby generator will be installed with a fuel storage steel tank above ground, of approximately 27,276 litres (≈ 6,000 imp. gal.) of diesel oil.

It is not anticipated that there will be any problems as it relates to the supply of electricity to the proposed development.

5.6.3.2 Telephone/Telecommunications

The parish of St. Catherine and the study area are served with landlines provided by Cable and Wireless Jamaica Limited. Wireless communication (cellular) is provided by Cable and Wireless, Digicel Jamaica Limited and Oceanic Digital Jamaica Limited.

It is not anticipated that there will be any problems as it relates to the provision of telephone service to the proposed development.

5.6.3.3 Water Supply

Approximately 79% of the households in the parish in 2001 received water from the National Water Commission (NWC). Approximately 9% were supplied by private means, 4.9% from springs and rivers, 4.8% had other means of receiving their water supply and 2.5% did not report the source of their water supply (Table 18).

In 2001, the percentage of households receiving water from the NWC in the study area was higher (≈ 88.4%) than that obtained in the parish. Approximately five percent (5.4%), of the households received water from private means, 3.3% had other means of water supply, 2.9% did not report the means of their water supply and none received water from a spring or river.

Notably, the percentages of the household having water piped into their dwelling was lower than that of the parish, with a higher percentage of households in the study area having water piped into their yard or to a stand pipe when compared to the parish (Table 18).

Table 18 Water supply by categories as a percentage of total households for the parish and the study area (2001)

	CATEGORY	ST. CATHERINE (%)	STUDY AREA (%)
Public Source	Piped in Dwelling	55.6	47.2
	Piped in Yard	18	35.6
	Stand Pipe	2.7	3.2
	Catchment	2.2	2.4
Private Source	Into Dwelling	4.1	4.4
	Catchment	5.2	1.0
	Spring/River	4.9	0
	Other	4.8	3.3
	Not Reported	2.5	2.9

(Source: STATIN Population Census 2001)

Water demand for the proposed development is estimated to be 7,465 litres per day (1,642 imp. gpd). This is broken down into 100 litre as top up water for the operation and 7,365 litres for the day to day domestic use, such as toilet facilities, drinking and washing purposes. Water will be obtained from the NWC.

5.6.3.4 Sewerage Disposal

A higher percentage of households in the study area compared to those within the parish used pit latrines to dispose of their sewage. A lower percentage of households in the study area used water closets. There was, however, an increase in the households not reporting the method of sewage disposal they use and those without an established means when compared to the parish statistics (Table 19). Figure 34 shows the percentage of households in each enumeration districts by the toilet facilities they use for the collection, treatment and disposal of their sewage.

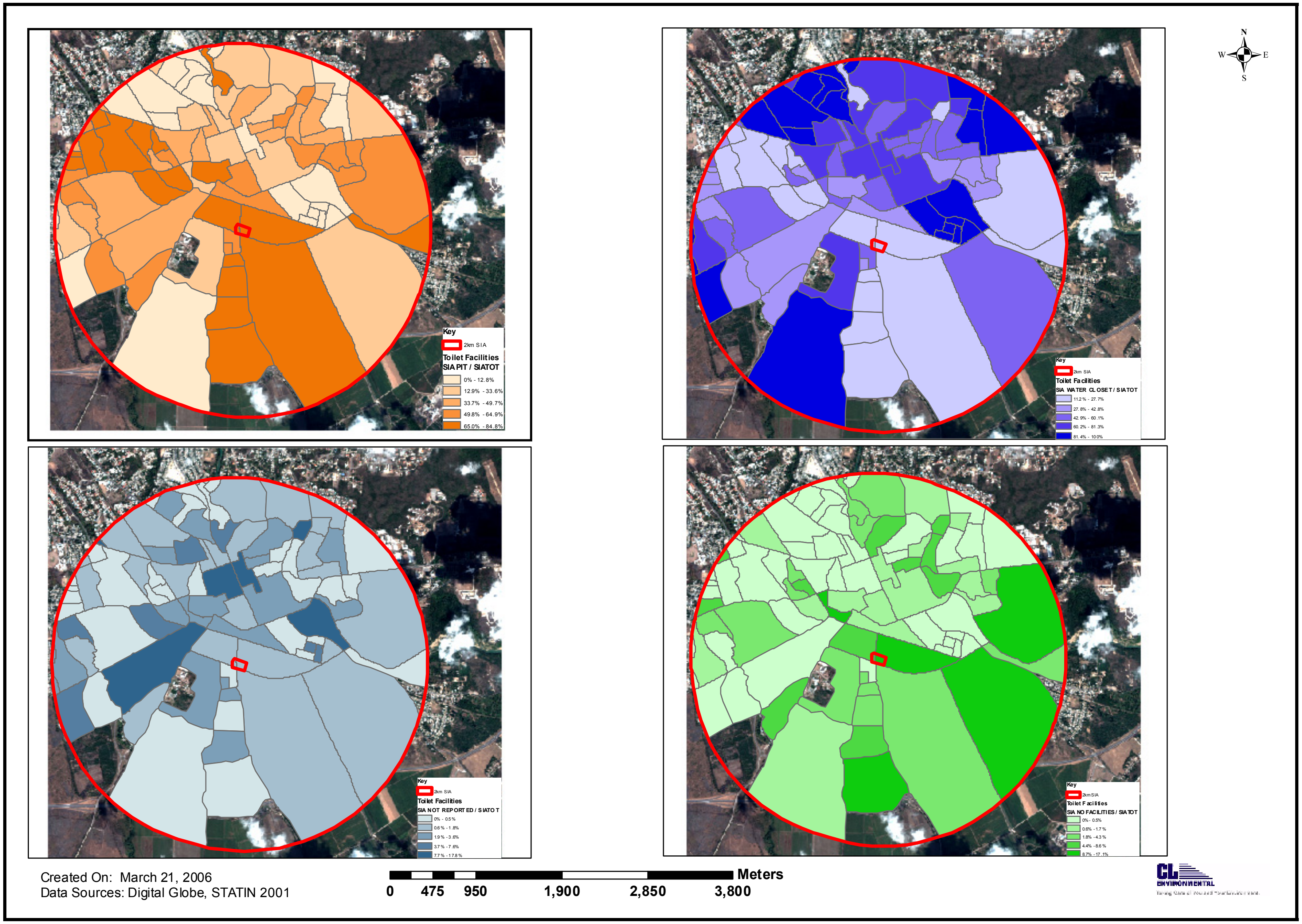
Table 19 Comparison between the parish and the study area by sewage disposal methods as a percentage of the households.

METHOD OF DISPOSAL	LOCATION	
	ST. CATHERINE (%)	STUDY AREA (%)
Pit Latrine	33.3	43.4
Water Closet	63.5	52
Not Reported	1.4	2
No Facility	1.8	2.6

(Source: STATIN Population Census 2001)

The grey-water system will handle flows from face basins only. It will consist of trap gully basins (for removing the primary solids) and a soak-away pit. The black water system will handle the sewage flows from the toilets and will consist of a septic tank and Evapotranspiration (ET) bed.

The collection, treatment and disposal of wastewater from the proposed development are not expected to have a negative impact on the environment.



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Data Sources: Digital Globe, STATIN 2001

Figure 34 Percentage house households by enumeration districts by toilet facilities

5.6.3.5 Solid Waste Generation

The Metropolitan Parks and Markets Waste Management Limited do solid waste collection within the study area. Presently, collection is done twice (2) per week. Along the main road, garbage is collected daily by MPM Waste Management Limited. This service is provided free (partial covered by property taxes) for the households within the area. The waste is transported to the Riverton City dump located in St. Catherine, approximately 14 km (≈ 9 miles) from the proposed Cement Grinding plant.

It is estimated that households in the study area generated approximately 43,430 kg (≈ 43.4 tonnes) of solid waste in 2001. Based on the growth of the population, it has been estimated that at the time of this study, approximately 48,660 kg (≈ 48.6 tonnes) of solid waste was being generated and it is expected that within the next twenty five years, if the population growth rate remains the same to be 85,913 kg (≈ 85.9 tonnes).

The 2001 census data indicated that approximately 59% of the households in the parish of St. Catherine had their garbage collected by public means (MPM Waste Management Limited). It showed that the preferred method of disposal was by public collection (Table 20). The data also showed that a higher percentage (63.4%) of the households in the study area had their garbage collected by both public means. With the exception of those households that disposed of their garbage by burning, all the other categories of garbage disposal in the study area were higher than in the parish. The high percentage (26.8%) of households burning their garbage as a means of disposal is a cause for concern, as it has the potential to impact on ambient air quality by creating air pollution.

Table 20 Percentage households by method of garbage disposal

DISPOSAL METHOD	ST. CATHERINE (%)	STUDY AREA (%)
Public Collection	58.5	63.4
Private Collection	0.3	0.4
Burn	33.7	26.8
Bury	0.8	0.9
Dump	5.1	6
Other Method	0.3	1
Not reported	1.2	1.5

(Source: STATIN Population Census 2001)

Figure 35 depicts the percentage of households in each enumeration district that had their garbage collected regularly by public means.

The proponents will make arrangements with a private contractor to visit the site on a weekly basis to remove the solid waste to the Riverton Landfill which has the capacity to handle the additional waste that is expected to be generated from the proposed development.

It is anticipated that the development will not have a negative impact on garbage collection within the study area.

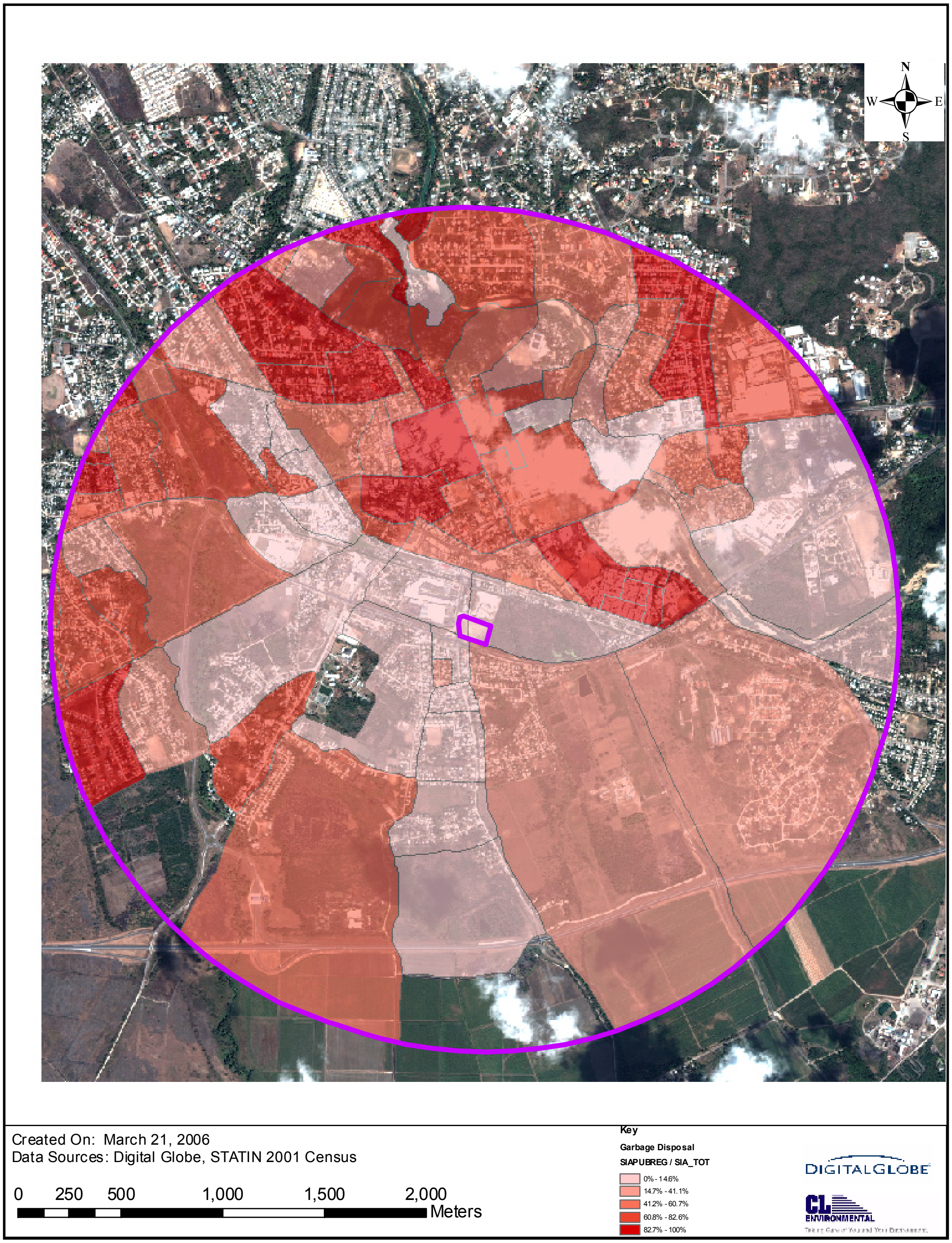

Figure 35 **Map showing the percentage of households per enumeration district that have garbage collected regularly by public means**

5.6.3.6 Roads, Transportation and Traffic

The proposed development site is located approximately 1 km (1/2 mile) south of the Town Centre of Spanish Town (the old capital of Jamaica) and approximately 14 km (≈ 9 miles) west of Kingston (capital of Jamaica). Depending on the traffic conditions, it takes anywhere between half and hour to an hour to drive from Kingston. The Nelson Mandela Highway runs from Kingston to the Spanish Town by-pass, which is immediately south of the proposed development site. The surface of these roads is in a relatively good state of repair. Access to the proposed site may be done from the Spanish Town by-pass by entering on the March Pen secondary road which has a relatively poor road surface. Another route is travelling through the town of Spanish Town passing along the Spanish Town to Twickenham Park main road and turning onto March Pen Road (Figure 36). The preferred access road option is along the Spanish Town by-pass, as this will provide easier access to the main by the larger vehicles. This access point / intersection is controlled by a traffic signal, thereby reducing the potential for accidents. Roads in other parts of the study area are in varying states of repair.

Although the railroad system in Jamaica at present is not functioning as a commuter transport, there are plans to resuscitate it. Presently, the railway line is used by the bauxite companies. The lines that are currently used are approximately 900m west of the proposed site. In the future rail may be a viable means of transporting raw materials and finished goods.

Transportation within the study area is provided by a fleet of taxis, “robot taxis” (unlicensed), buses and private cars.

Figure 36 **Map depicting the proposed site and access road**

Traffic counts were conducted by the National Works Agency at the Spanish Town/March Pen road intersection on November 23, 2005 for a twelve hour period (Figure 37).

From the data there were 9,366 vehicles arriving at the intersection from the west and 9,158 from the east. Of the 9,366 vehicles arriving from the west at the intersection, 1,344 (14.3%) turned north onto March Pen road, 87 (<1%) turned south onto March Pen Road and 7,935 (84.7%) went straight through the intersection.

One thousand nine hundred and fourteen (1,914) vehicles traveling east turned north onto March Pen road, 130 turned south into March Pen road and 7,114 traveled through the intersection.

There were a total of 8,211 vehicular trips along the northern section of March Pen road. Of this a total of 3,599 vehicles traveled north along March Pen road of which 53.2% turned from vehicles traveling from the east, 37.3% from vehicles traveling from the west and 9.5% from vehicles north across through the intersection. There were 4,612 vehicles traveling south along the northern section of March Pen road.

This section (northern section) of the March Pen road is of importance as it is along this stretch of roadway that the proposed cement grinding plant will be located. Traffic along this roadway is constituted of mainly cars (≈ 95%) and trucks ≈ 5 %.

The construction activities will potentially have a negative impact on the area as the activities will also have the potential to increase traffic snarls in the short term. During operation on a daily basis, it is anticipated that approximately four trucks/day will be used to transport raw materials to the plant and approximately 20 trucks/day will be arriving and leaving with finished goods. In addition, there will be approximately 10 trucks delivering clinker over a one week period twice per year. This has the potential to increase accidents as it will involve the transportation of raw materials and finished goods by trucks which will have to turn across the flow of traffic.

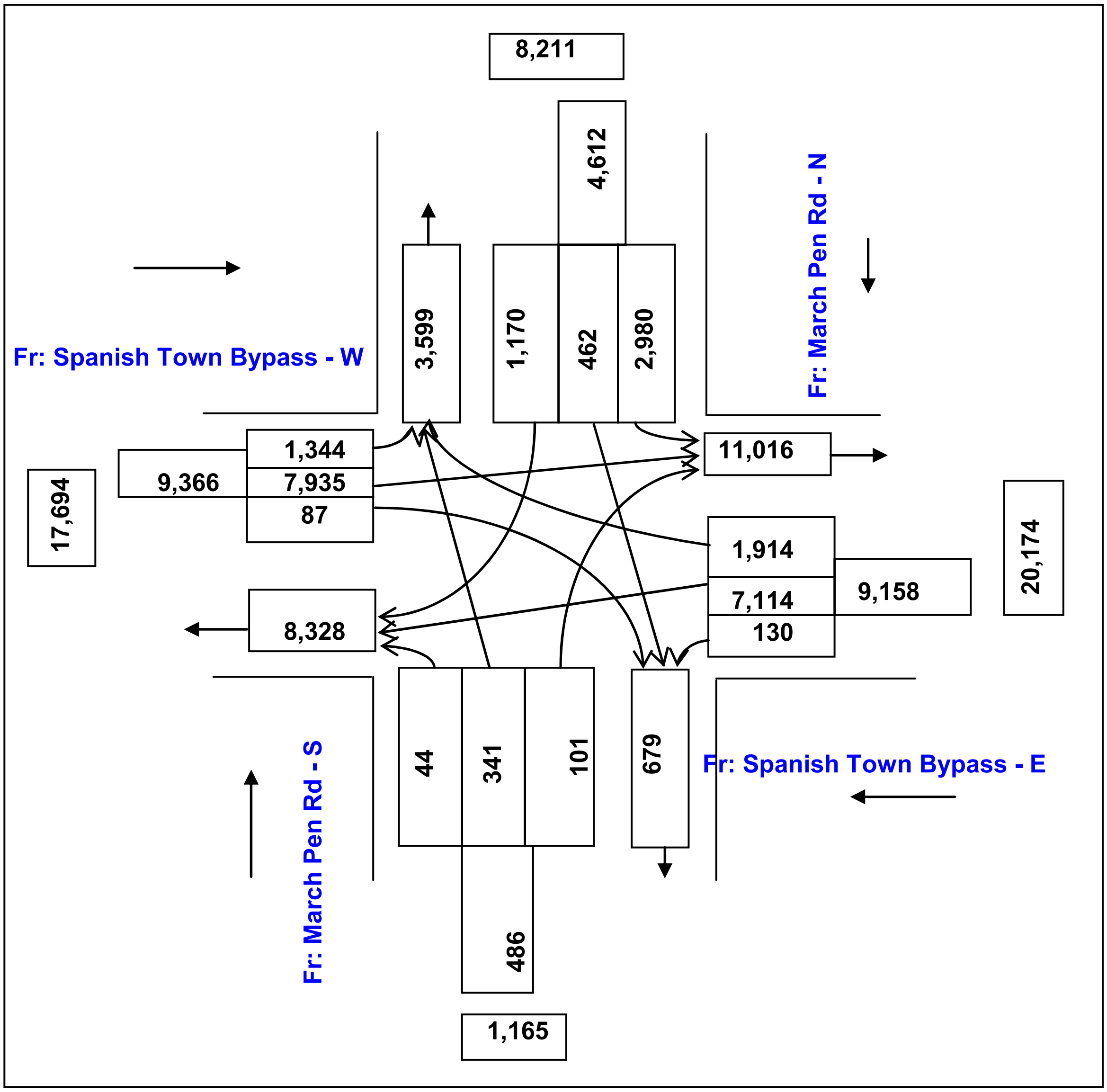

Figure 37 Traffic count at the Spanish Town bypass/March Pen Road intersection

5.6.3.7 Health Care

Persons within the study area obtain their health care at a number of health centres and private doctors. The closest hospital to the proposed site is located in Spanish Town. It is a Type B Hospital, located at approximately 1 km (0.5 mile) from the proposed site. This Hospital has approximately three hundred and twenty (320) beds and provides the following services; Internal Medicine, Obstetrics/Gynaecology, Laboratory, Radiology, Physiotherapy; Pharmacy, Accident/Emergency Services; Paediatric; Orthopaedics; Nutritional Counselling and Anaesthesiology. The Hospital sees approximately three hundred persons per day.

The construction and operation of the proposed development is not expected to have a negative impact on the health system within the study area.

5.6.4 Other Services

5.6.4.1 Fire Station

The fire station that would respond to an emergency at the proposed site is located within Spanish Town some 0.5 km (≈ 0.3 miles) from the proposed development site. Currently, this station has one fire engine with a water capacity of 1,818 – 2,273 litres (400-500 imperial gallons). If additional help were needed, backup would be called from Portmore ≈ 10 km (≈ 6 miles) or the Old harbour fire station some ≈ 19 km (≈ 12 miles) or Linstead fire stations ≈ 23 km (≈ 14 miles).

The proposed development will have its own designed fire control system, with a fire hydrant and fire extinguishers.

If these are put in place then, it is not anticipated that there will be any problems as it relates to a fire event at the proposed development.

5.6.4.2 Police Station

The Spanish Town police station is responsible for policing the area in proximity to the proposed cement grinding plant. From time to time there are major upsurges in gun crimes with shootings being foremost.

Crime may be expected to be a major problem in proximity to the proposed site.

5.6.4.3 Post Office

The residents and businesses in proximity to the proposed cement grinding plant are served by the Spanish Town post office approximately 2 km away. The mail is delivered by a number of postmen.

5.6.5 Historical/Cultural Site

The Jamaica National Heritage Trust has no historical or cultural sites on its register for the proposed cement grinding plant site. Within the study area are 3 identified sites of historic interest. These are the Old Cast Iron Bridge, the Spanish Town Cathedral, and the main square at Spanish Town.

This bridge spans the Rio Cobre River at the eastern end of Spanish Town and can be seen from the bridge that is currently being used. The abutment of the bridge is constructed with cut stone while the bridge is cast iron with dimensions of ≈24.7m in length and ≈4.6m in width (≈81ft long and ≈15ft wide). This bridge was erected in 1801 at a cost of four thousand pounds. It is the oldest bridge of its kind in the Western Hemisphere (http://www.jnht.com/st_cather/ironbrdg.html).

The Spanish Town Cathedral, also known as the St. Catherine Parish Church, was built in the second half of the seventeenth century. After the conquest of Jamaica by the British in 1655, the British destroyed the original Catholic Church and replaced it with the Anglican Church, which is now the St. Catherine Parish Church or the Spanish Town Cathedral. In 1712 the church was destroyed by a hurricane.

The church once contained the oldest Baptismal and Marriage Records in the island. It is also associated with important personalities in Jamaica some of whom are buried there - for instance, Sir Thomas Modyford, Governor 1664 - 1671, and the Earl of Effingham, Governor 1790 - 1791.

The Cathedral is a mixture of many architectural styles combining round headed and pointed arches, classical quoins, and medieval buttresses. The tower, added in 1817, is crowned with one of the few steeples found in the Caribbean (http://www.jnht.com/churches/cathedra.htm).

The main square at Spanish Town, following the lines of the original Spanish Plaza, is considered one of the finest Georgian Squares in the world and is, perhaps, the grandest public space in the English speaking Caribbean. As the centre of the administrative capital of Jamaica from 1534 until 1872, the square had special and varied historical significance for almost 500 years. It was here that the proclamation of Emancipation abolishing slavery in Jamaica was made from the steps of King's House in 1838, shortly after Queen Victoria had come to the throne of Great Britain (http://www.jnht.com/st_cather/sptwn_sq.html).

The proposed development is not anticipated to infringe on any sites of historic or cultural importance.

5.6.6 Aesthetics and Security

The proposed development has the potential to impact negatively on the aesthetics of the proposed site from the standpoint of both residents of March Pen and motorist traversing the Spanish Town by-pass.

The planting of vegetation such as trees and flowering plants such as *Bougainvillea* along the boundaries of the proposed property along with "green areas" will have the potential for the site to become aesthetically pleasing to the observer.

To provide security and limited access to the proposed cement grinding plant, the developer is planning to fence in the site with a concrete perimeter wall. Access to the property will be through a security post at the main entrance and a gated entrance for the raw materials storage area.

5.6.7 Community Perception

Of those interviewed, the majority (96%) are of the opinion that the proposed Clinker Grinding Plant is suitable for the area. This positive response was on the condition that the proposed development should not have any adverse health hazards caused by dust pollution, and the possibility of employment generation for the community.

Approximately 57.8% of those interviewed said that the proposed development would have no impact on them, 24.4% said that it would provide employment, 6.7% said that it would provide general improvement to the immediate community, 4.4% said that it may cause health problems such as sinusitis and 2.2% each said that it would improve the infrastructure stock, increase costumers due to the fact that more persons would be working and had no idea what impact, if any, the building of the plant would have on them.

They ranked crime and violence, the need for more employment (especially for youth) and the lack of opportunity and development as the most pressing issues in the community. They also said that they wanted improved roads and drains, a health centre, community centre (with football and netball court), skills training centre and more business and development. In addition, a number of interviewees expressed their desire to see “zinc fences” within their community to be removed.

6.0 ANALYSIS OF ALTERNATIVES

The discussion and analysis of alternatives in Environmental Impact Assessments should consider other practicable strategies that will promote the elimination of negative environmental impacts identified. This section is a requirement of the National Environment and Planning Agency (NEPA), and is critical in consideration of the ideal development with minimal environmental disturbance.

This draft report has identified the major environmental impacts noted by scientific experts.

The following alternatives have been identified. They are discussed in further detail below:

- The "No-Action" Alternative.
- The proposed Development as described in the EIA.

6.1 THE "NO-ACTION" ALTERNATIVE

The "no action" alternative is required to ensure the consideration of the original environment without any development. This is necessary for the decision-makers in considering all possibilities.

The "without project scenario" would mean that the project site would remain in a pre-site preparation state.

- Squatters would move in and occupy the site, either physically or as an area to dump their waste (or use as a "sanitary convenience").
- Similarly, unscrupulous commercial entities would seize the opportunity to illegally dispose of their solid waste, at the site.
- Poor drainage, ponding and stagnating water would become a regular feature of the site.
- The site would fall into disrepair and become an aesthetic "eye-sore", with the potential to be a haven for vermin and disease.
- Underutilization of the land resources, at the site, would continue.

- Reduces competition in the cement market which has the potential to prevent improved manufacturing efficiencies with the resultant benefit to the consumer.

The "without project scenario" is viewed as an unfavourable project alternative.

6.2 THE PROPOSED DEVELOPMENT AS DESCRIBED IN THE EIA

The proposed project has a number of positive features which will spin-off from its implementation. These include:

- A boost to the struggling local cement industry.
- Increased competition which has the potential to lower cement costs thus benefiting the consumer.
- Improve site drainage at the project site.
- Employment for local residents (in the capacity of managers, plant operators, domestic workers, skilled and unskilled labour, etc.).
- Maximizing the use of underutilized natural resources at the project site.
- Improving general aesthetics on the project site, boosting the aesthetics of the surrounding region.

Generally, the proposed project would fit in favourably with the present and future requirements of the Jamaican construction industry. **The "with project scenario" is viewed as a more favourable project alternative of the "without project scenario" discussed above**.

6.3 OVERVIEW OF ALTERNATIVE ANALYSIS

Since 2000, however, the construction sector has shown signs of a turnaround. This has been fuelled the demand for construction materials including cement. The local manufacturing of items used in the construction sector is dominated by the manufacture and trade in cement and the production output of the Kingston-based Caribbean Cement Company Limited (CCCL). Since 1999, annual cement production at CCCL has been:

	Metric Tonnes	US$ (millions)
1999	613,080	93.95
2000	521,343	72.51
2001	596,247	76.47

In the same period according to figures from the Statistical Institute of Jamaica, imports of Building cement into Jamaica since 1999 have been as follows. It is noteworthy that in no year prior to 1999 did the annual cement importation figure exceed US$1 million. In addition to building cement, small amounts of other types of cement such as Portland cement, Hydraulic cement and Aluminous cement were also imported.

	US$(million)
1999	6.40
2000	12.96
2001	5.73

Activities in the cement sector have continued to be in the news, not because of the expansion of production but rather because of the contraction in production and the importation of cement by CCCL.

In most recent company reports CCCL reported the following figures in metric tones.

2003 Operating Highlights

Cement Sales	605,400
Cement Production	607,682
Clinker Production	600,980

2004 Operating Highlights

Cement Sales	803,855
Cement Production	808,070
Clinker Production	605,814

The figures suggest increasing demand for cement which has not been met by local production to date. The expanding market seems to support more local production of cement.

Based on the above, the most environmentally sound and cost effective option would be that described in Section 6.2.

7.0 ENVIRONMENTAL IMPACT IDENTIFICATION & MITIGATION

An environmental impact is defined as any change to an existing condition of the environment. The nature of the impacts may be categorised in terms of:

- Direction - positive or negative
- Duration - long or short term
- Location - direct or indirect
- Magnitude - large or small
- Extent - wide or local
- Significance - large or small

To systematically identify the impacts associated with the proposed development, an impact matrix was constructed which arrayed the main project activities against the relevant environmental factors. This matrix is shown in Table 21 and Table 22.

Table 21 Impact Matrix for Site Preparation and Construction

ACTIVITY/IMPACT	DIRECTION		DURATION		LOCATION		MAGNITUDE		EXTENT		SIGNIFICANCE	
	Pos	**Neg**	**Long**	**Short**	**Direct**	**Indirect**	**Major**	**Minor**	**Wide**	**Local**	**Large**	**Small**
1. **Site Preparation**												
Vegetation Removal												
Habitat Removal												
Increased infiltration/runoff		X		X		X		X		X		X
Dust		X		X		X		X		X		X
Noise		X		X		X		X		X		X
2. Material Transport												
Dusting & spillage		X		X		X		X	X			X
Traffic congestion, road wear		X		X		X		X	X			X
3. Improper Material Storage												
Dusting		X		X		X		X		X		X
Groundwater contamination		X	X			X		X		X		X
Suspended solid runoff		X		X		X		X		X		X
4. Construction Works												
Noise		X		X		X		X		X		X
Dust		X		X		X		X		X		X
Changes in drainage network		X		X		X		X		X		X
Visual intrusion		X		X		X		X		X		X
5. Construction Crew												
Sewage generation		X		X		X		X		X		X
Solid waste generation		X		X		X		X		X		X
Emergencies/Accidents		X		X		X	X	X		X		X
6. Landscape & Replanting												
Vegetation/habitat reintroduction	X		X		X			X	X			X
8. Employment												
Job creation	X			X		X		X	X	X		X

Table 22 Impact Matrix for Operational Phase

ACTIVITY/IMPACT	DIRECTION		DURATION		LOCATION		MAGNITUDE		EXTENT		SIGNIFICANCE	
	Pos	**Neg**	**Long**	**Short**	**Direct**	**Indirect**	**Major**	**Minor**	**Wide**	**Local**	**Large**	**Small**
1. Wastewater Treatment												
Water quality	X		X			X	X		X		X	
Wastewater treatment	X		X		X		X		X		X	
Poorly maintained wastewater infrastructure/ET bed		X	X			X	X		X		X	
2. Drainage/Storm Water												
Improved flood/drainage infrastructure	X		X		X		X			X		X
Poorly maintained drainage infrastructure		X	X			X	X			X	X	
3.Grinding/Bagging Facility												
Ambient dust levels		X	X			X		X		X		X
Ambient air quality emissions		X	X			X		X	X			X
Ambient noise levels		X	X			X		X		X		X
Water resource usage		X	X			X		X		X		X
Energy/Electricity usage		X	X			X	X		X			X
Solid waste generation		X	X			X		X		X		X
Occupational Health & Safety		X	X			X	X	X		X	X	X
Natural Hazard Vulnerability		X	X			X		X		X		X
Aesthetics/Visual intrusion	X		X			X		X		X		X
4. Transportation/Traffic												
Traffic nuisance		X	X			X		X	X			X
Traffic accidents		X	X			X		X	X			X
Noise		X	X			X		X	X			X
5. Emergency Response												
Emergencies/Accidents		X	X			X		X		X		X
6. Employment												
Job creation	X		X			X		X		X		X

7.1 SITE PREPARATION/CONSTRUCTION PHASE

7.1.1 Impact: Vegetation Clearance

Site clearance and construction practices generally mean the removal of existing vegetation. These practices remove protective plant cover and expose the soil to erosive surface runoff, during heavy rainfall. The inappropriate disposal of the cleared vegetation could lead to burning onsite and associated negative impacts on local air quality.

Given the fact that the project site is already clear and, therefore, does not support any vegetation (or significant fauna), the impact of pre-construction site preparation exercises will not have a significant impact upon onsite floral or fauna. Concurrently, however, the exposed top soil means that the project site is susceptible to high volumes of surface water runoff/discharge, in the form of flash flooding, soil erosion and impaired surface water quality (due to high suspended solids, oil and grease, etc). These elements have the potential to negatively impact not just the project site, but wider adjacent areas and properties.

7.1.1.1 Mitigation

i. Areas of exposed soil should be replanted with grass, as soon as possible, after site preparation and construction to help mitigate against flash flooding and soil erosion.

ii. Adequate temporary drainage channels should be constructed (and bermed) to help facilitated the egress of onsite (heavy rainfall event) flood waters, off the proposed project site. These temporary drainage channels must be constructed in such a manner that they, (a) feed into existing, offsite, natural/engineered drains (e.g. the engineered drainage works under Spanish Town by-pass) and (b) do not result in compromise and overtopping of existing offsite drainage features.

7.1.2 Impact: Construction of Proposed Drainage Works

Site specific run-off was calculated for the standard 2 Year Return Period event, for both pre-project (see Table 4) and post-project (see Table 23) scenarios (using the Rational Method).

Table 23 Post project drainage calculation

Input Parameters	All site	Units
Catchment	2	
Area	13,845	m2
Main stream length, L	212	m
Distance from outlet to centroid, Lc	106	m
Lower elevation	36.15	m
Upper elevation	38.11	m
Slope	0.9%	
Ct	1.50	
Cp	0.17	
Runoff Coefficient, C	95.0%	
Curve Number, CN	96	
Box Channel		
Length of main channel	212	m
Slope	0.93%	
Mannings Coefficient	0.013	
Width	**0.9**	m
Depth	**0.6**	m
Depth + freeboard	0.86	m
R	0.3	m
P	2.1	m
A	0.54	m2
Velocity	3.0	m/s
Flow	1.62	m3/sec
Tt	0.04	hours
Hydrology		
Time entry	0.083	hours
Rainfall-24 hours (1 in 50 year return period)	98	mm/24hours
Output		
Time of Concentration		
Tc-Australian	0.1	hours
Tc-FAA	0.1	hours
User switch (Box = 1, V = 2, Pipe = 3)	1	
Tc-Manning	0.12	hours
Tc-used	0.12	hours
Maximum potential retention, S	10.6	
Rainfall intensity for tc	8.80	
Effective Runoff (SCS)	**0.231**	**m3/s**
Effective Runoff (Rational)	**0.220**	**m3/s**

The post-project (peak) runoff was estimated to be 0.23 cubic metres per second. This represents a 22% increase over the pre-development peak runoff rates (see Section 4.5). Hydraulic analysis of the proposed site drains indicate that these drains should be adequate for carrying the 2 Year Return Period event.

Generally, post development site runoff tends to carry sediment and oil. In the absence of appropriate screening/filtration these would have negative impacts on existing, offsite, drainage features (and their water quality).

7.1.2.1 Mitigation

i. The proximity of the marsh lands to the site is indicative of significant storm water flows and the low elevations of the proposed project site. A **flood plain map** should be created for the general area to ensure that:
    a. the filling of the land does not jeopardize the flood plain regime in the area, and
    b. adequacy of floor levels in the processing plant.

ii. Storm water should be controlled (i.e. bermed off, channelled or put into under-ground pipes), before it enters the site, to ensure that the processing plant is not jeopardized during heavy rains.

iii. An **oil-water separator, with a sedimentation fore bay,** should be incorporated in the pavement of the proposed site (where the drains all congregate).

iv. A **detention basin,** utilizing some of the natural marsh features already existing on the site, should be incorporated in the design (after the oil-water separator) to eliminate the impact of the increased run-off area.

7.1.3 Impact: Construction of Proposed Wastewater Treatment Facility

Estimates (using current/existing precipitation and evaporation rates for the project site) indicate that the **area required** for the ET bed (i.e. 1,287 m^2; See Table 24) is considerably larger than the 75 m^2 **area proposed** for its construction. The number of on-duty workers, used for the calculation, was an inflated (i.e. design) over estimate of 54 workers. Whereas it is expected that workday will be divided into two shifts (and half the actual total workforce would be onsite at any given time), a halving of the required ET bed area (i.e. 1,287 m^2 divided by 2) still indicates that the proposed 75 m^2 area is inadequate. Based on these calculations, the proposed ET bed is expected to overflow (i.e. when the facility is fully functional).

Table 24 Evapotranspiration bed requirements

SEWAGE GENERATION		
Number of workers	54	
Per Capita sewage generation	10	IGPD
Total sewage flow	**540**	**IG**
	2430	**litres per day**

EVAPO-TRANSPIRATION BED		
Area provided	75	m2
Annual Evaporation	1873	mm/year
Annual Precipitation	-1184	mm/year
Area required	**1287**	**m2**

7.1.3.1 Mitigation

i. The ET bed should be re-designed/re-sized to meet the prevailing meteorological (i.e. precipitation and evaporation) conditions, at the project site.

ii. Alternatively, another WWTP design should be considered. If this is the case, any proposed, alternate, WWTP must meet NEPA's wastewater discharge standards.

iii. Grease traps should to be incorporated in the wastewater treatment system to ensure that the treatment processes are not overloaded by the kitchen wastewater.

7.1.4 Impact: Noise Pollution

Construction works necessitates the use of heavy equipment. This equipment includes bulldozers, backhoes, etc. They possess the potential to have a direct negative impact on the environment, in the form of noise they generate, during their operation.

7.1.4.1 Mitigation

i. Use equipment indicated, by the various manufacturers/suppliers, as having low noise emissions.

ii. Use equipment that is properly fitted with noise reduction devices (i.e. mufflers, etc).

iii. Restrict the operation and use of noise-generating equipment to regular working hours (i.e. 7 am – 7 pm), reducing the potential of creating a noise nuisance during the night.

iv. Supply construction workers, operating noisy equipment, with appropriate personal noise protection gear (e.g. ear muffs, ear plugs, etc.). As a general rule-of-thumb, workers operating equipment generating noise levels of ≥ 85 dBA (decibels) continuously for 8 hours or more should be equipped with ear muffs. Workers experiencing prolonged noise levels of 70 - 80 dBA should wear earplugs.

7.1.5 Impact: Air Quality

Site preparation and construction has the potential to have a two-fold direct negative impact on air quality. The first impact is air pollution generated from construction equipment and transportation. The second is from fugitive dust from dusty access roads, cleared site areas and raw materials stored on site. Fugitive dust has the potential to negatively impact the health of road users, construction workers, adjacent resident populations and vegetation.

7.1.5.1 Mitigation

i. The access roads to site should be monitored. Dust, and any other material, falling on these (i.e. as a result of transportation/construction activities), should be cleaned up and removed.

ii. Particularly in ungrassed, exposed areas, the construction site should be dampened every 4 - 6 hours (or within reason) to prevent a dust nuisance. On hotter days, this frequency should be increased.

iii. Re-vegetation of exposed, cleared, areas should be done as soon as possible.

iv. Stored construction materials (e.g. top soil, marl), should be covered or wetted (to prevent a dust nuisance).

v. Construction workers, working in dusty areas, should be provided and fitted with N95 respirators.

7.1.6 Impact: Employment

During the construction phase of the project, it is estimated that an average of approximately 25 persons will be employed. This is viewed as a potential significant positive impact.

7.1.6.1 Mitigation

Not required.

7.1.7 Impact: Solid Waste

During the construction phase of the proposed project, solid waste generation may occur mainly from two sources:

i. From the construction campsite (e.g. food cartons, packaging material, etc.); and

ii. From construction activities (e.g. site excavation, etc.).

7.1.7.1 Mitigation

i. Skips and bins should be strategically placed within the campsite and construction site.

ii. These skips and bins should be adequately designed and covered to prevent odour, a dust nuisance and access by vermin.

iii. The skips and bins, at both the construction campsite and construction site, should be emptied regularly to prevent overfilling.

iv. Disposal of the contents of the skips and bins should be done at an approved disposal site. The Riverton Landfill (in Kingston) is recommended. Appropriate permission should be sought (i.e. from The National Solid Waste Management Authority).

7.1.8 Impact: Wastewater Generation and Disposal

With every construction campsite comes the need to provide construction workers with showers and sanitary conveniences. The disposal of the wastewater, generated at the construction campsite, has the potential to have a minor negative impact on groundwater.

7.1.8.1 Mitigation

i. Provide portable sanitary conveniences, for the construction workforce. A ratio of approximately 25 workers per chemical toilet should be used.

7.1.9 Impact: Transportation of Raw Material and Equipment

The transportation and use of heavy equipment and trucks is required during construction. Trucks will transport raw materials and heavy equipment. This has the potential to directly impact traffic flow along the Spanish Town Bypass and uncovered material may result in a dust nuisance.

7.1.9.1 Mitigation

i. Adequate and appropriate road signs should be erected to warn road users of the construction activities. For example, reduced speed near the entrance road. This should be done in conjunction with the Ministry of Transport and Works.

ii. Raw materials, such as marl, sand and top soil, should be adequately covered within the trucks (to prevent any escaping into the air or onto the roadway).

iii. The transport and movement of equipment (trucks) should be limited to working hours, i.e. 8:00 am - 4:30 pm.

iv. Heavy equipment should be transported during early morning (i.e. 12 am – 5 am), with appropriate pilotage.

v. The use of flagmen should be employed to regulate trucks entering and exiting the access to the main road/by-pass.

7.1.10 Impact: Storage of Raw Material and Equipment

Construction raw materials, for example top soil and marl, will be stored onsite. There will be a potential for them to become air or waterborne. Stored fuels and the repair of construction equipment has the potential to leak hydraulic fuels, oils etc.

7.1.10.1 Mitigation

i. Raw materials, with the potential to generate dust, should be covered or wetted frequently (to prevent them from becoming, respectively, waterborne and airborne).

ii. Raw material should be placed on hardstands, surrounded by berms.

iii. Hazardous chemicals, fuels and oils should be properly stored in appropriate containers and these should be safely locked away. Conspicuous warning signs should also be posted around hazardous waste storage and handling facilities.

iv. Refueling and maintenance of heavy construction vehicles, temporarily residing at the site, should be done at specified areas or makeshift "depots" (where measures are in place to deal with spillages and temporary storage of oily wastes). Preferably these depots should be located in an area that would ultimately be permanently paved (e.g. the parking lots) thereby covering any contaminated soil.

v. The fuel depot site should be covered with a thick layer of marl which would absorb the spills. This marl layer may subsequently be removed for proper disposal.

7.1.11 Impact: Emergency Response

Construction of the proposed development will involve approximately 25 construction workers. The possibility of minor and major accidental injury is high.

7.1.11.1 Mitigation:

i. A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers.

ii. Make prior arrangements with health care facilities (e.g. Spanish Town Hospital) to accommodate any eventualities.

iii. Material Safety Data Sheets (MSDS) should be store onsite.

7.1.12 Impact: Post Construction Landscaping

In addition to enhancing the aesthetic appeal of the project site, landscaping provides the means for partially restoring some of the site's natural elements. It also provides alternative habitats for fauna, particularly the birds. Landscaping exercises, therefore, are considered to have a major positive impact.

7.1.12.1 Mitigation

Not required.

7.2 OPERATIONAL PHASE

7.2.1 Impact: Drainage and Water Quality

As indicated under Section 7.1.2, post development site runoff generally tends to carry sediment and oil. The implementation of the suggested mitigation methods, recommended under Section 7.1.2 should be appropriate in ensuring there are no negative impacts on existing, offsite, drainage features (or their water quality). The latter recommendations should also be adequate in mitigating the compromise of existing and installed drainage works, reducing the potential risk of onsite and offsite localized flooding.

However, the absence of appropriate follow-up inspection (and maintenance of the installed infrastructure) could lead to a "break-down in the system", rendering the suggested mitigative measures/infrastructure ineffective, with obvious potential negative impacts.

7.2.1.1 Mitigation

i. Onsite drainage channels should be inspected (and maintained) on a regular basis, to ensure they remain unblocked and clear.

ii. Similar inspection and maintenance should be conducted on the **oil-water separator and sedimentation fore bay**.

iii. Storm water drainage channels, in the adjoining areas, should be periodically checked and inspected to ensure that traditional drainage pathways (to and from the site) remain unblocked.

7.2.2 Impact: Water Supply

Water supply in the region is from a direct connection to the National Water Commission's (NWC) transmission main. Commercial establishments, along the Spanish Town bypass, generally have an adequate supply of water. The proposed development will require approximately 7,465 litres per day (1,642 gpd) and this additional demand is not expected to compromise water supply, in the region.

7.2.2.1 Mitigation

Not required.

7.2.3 Impact: Wastewater Disposal/Water Pollution

The implementation of the suggested mitigation methods, recommended under Section 7.1.3, should be appropriate in ensuring there are no negative impacts, related to wastewater disposal, during the operational phase of the project.

However, as is the case with installed post-project drainage infrastructure, the absence of appropriate follow-up inspection (and maintenance of the installed wastewater infrastructure) could lead to a "break-down in the system", rendering the suggested mitigative measures/infrastructure ineffective.

7.2.3.1 Mitigation

i. The ET bed should be inspected (and maintained) on a regular basis, to ensure it is operating effectively and optimally.

ii. Grease traps, within general wastewater treatment system, should be inspected (and maintained) on a regular basis, to ensure they remain unblocked, clear and functional. [Note: clean grease traps help reduce the potential of offensive odours, at the site.]

7.2.4 Impact: Solid Waste Generation and Disposal

The project has the potential of increasing solid waste at the site, mainly in the form of day-to-day solid waste generated directly by the on-duty workforce and the manufacturing process. There will also be a need to periodically remove the screenings and grit from the site's drains and grease traps. The volume of day-to-day solid waste, screenings and grit, however, are not expected to be large and, therefore, do not warrant any special considerations, other than the mitigative measures recommended below.

Traditionally, the proposed operation is very efficient; and does not generally produce little solid waste. As a result, waste from the actual processing plant is expected to minimal and insignificant.

7.2.4.1 Mitigation:

i. Provision of adequately designed bins and skips to prevent access by vermin.

ii. Monitor skips so that they do not become overfilled.

iii. Ensure that the solid waste collected is disposed of at an approved dumpsite (e.g. the Riverton Landfill, in Kingston).

7.2.5 Impact: Transportation/Traffic

The development is expected to increase the traffic along the access roads, as there will be approximately two delivery trucks for raw material per day travelling along the March Pen access road and between 5 and 10 trucks transporting finished product.

7.2.5.1 Mitigation:

i. Add adequate and appropriate signs (including speed limits) along the roadway in proximity to the access roads.

7.2.6 Impact: Energy

The production of cement is energy intensive. Grinding is estimated to be around 25% of energy used in the overall cement production process. While energy use is unavoidable, it is a significant environmental impact from the view point of resource conservation. It is estimated that 45 kWh/tonne cement will be consumed by the plant.

The major factors driving the need for process optimization (in the cement industry) are the high costs of milling and the effect of particle size on product quality. Improving consistency, reducing over grinding, and adhering to tighter specifications are all process optimization challenges for cement manufacturing.

In respect to the energy/ eelectricity requirements of the project, daily electricity consumption of the proposed project is estimated at 400 to 500 kWh. The main supplier of the latter will be JPSCo Ltd. Presently, JPSCo Ltd confirms that they have adequate output capacity to meet the needs of the proposed project and commercial establishments, along the Spanish Town bypass, generally have an adequate supply of electricity. The additional demand of the proposed project is not expected to compromise electricity supply, in the region.

An onsite back-up diesel standby generator will also be installed. Fuel will be stored in an above ground steel tank.

7.2.6.1 Mitigation

i. The issue with respect to mitigation will be the optimization of the process to ensure efficient use of energy.

ii. Over grinding uses excess energy, so it is important to ensure the maintenance of an optimal particle size distribution (during the production process). Particle size controls the final strength of the cement and so needs careful monitoring at the time of manufacture.

7.2.7 Impact: Dust

Dust is a significant consideration both from the point of its nuisance effect to surrounding facilities/communities, worker safety and production efficiency. Loss of dust represents loss of raw material or product. It is a significant environmental impact. The sources of dust are in transportation of raw materials (port to plant), storage of raw materials, conveyance during the production process, mixing, grinding and bagging.

Modern equipment is equipped with high efficiency dust collection systems. Equally important will be house keeping. Running the plant in an environmentally friendly way has direct bearing on the profitability and image of the company. It also improves the employee morale.

7.2.7.1 Mitigation:

i. Cover trucks during transportation.

ii. Store raw materials sealed silos.

iii. Cover the conveyor belt system.

iv. Install dust collectors at mixing, grinding and bagging unit operations (for monitoring ambient levels).

v. Effective preventative maintenance programme.

vi. Effective housekeeping.

vii. Redundancy in plant design.

7.2.8 Impact: Heat

Heat will be generated during the grinding operation. The issue of heat stress with regard to worker safety is a potential impact which can be mitigated in terms of proper ventilation of the area and protection of the worker.

7.2.8.1 Mitigation:

i. Proper ventilation of the area.

ii. Protection of the worker.

iii. Monitor the time spent by workers in areas with elevated temperatures to ensure that they are not exceeding the prescribed work times based on the clothing being worn and the physical fitness of the person.

7.2.9 Impact: Noise

The operation of the plant will generate noise which could be a potential impact to neighbours and a direct impact on worker safety.

7.2.9.1 Mitigation:

i. Use equipment indicated, by the various manufacturers/suppliers, as having low noise emissions.

ii. Use equipment that is properly fitted with noise reduction devices (i.e. mufflers, sound proofing etc).

iii. Ensure that the proposed vegetation (trees etc.) is planted.

iv. Ensure that the perimeter wall is constructed/re-established and maintained.

v. Supply construction workers, operating noisy equipment, with appropriate personal noise protection gear (e.g. ear muffs, ear plugs, etc.). As a general rule-of-thumb, workers operating equipment generating noise levels of ≥ 80 dBA (decibels) continuously for 8 hours or more should be equipped with ear muffs. Workers experiencing prolonged noise levels of 70 - 80 dBA should wear earplugs.

vi. Establish a hearing conservation plan for employees especially those working in the production area.

7.2.10 Impact: Air Quality

The operation has the potential to impact the existing air shed by introducing particulate matter (PM10), sources of which include the storage piles of clinker, limestone, gypsum, dust collector and storage silos, cement mill, movement of vehicles along roadway in the plant and the unloading of raw materials.

7.2.10.1 Mitigation

i. The transportation roads to site should be monitored during transfer of raw materials. Dust, and any other material, falling on these (i.e. as a result of transportation), should be immediately cleaned up and removed.

ii. Ensure that the pollution control devices are properly maintained and are in full working condition.

iii. Install hoods in vicinity of transfer points with venting to one of the existing dust collectors.

iv. Stored piles should be properly covered to prevent particulate matter from becoming entrained in the wind.

v. Any spill of raw material or finished product within the factory should be immediately cleaned up to prevent the material form becoming airborne.

vi. Employees working in dusty areas should be provided and fitted with N95 respirators.

7.2.11 Impact: Occupational Health and Safety

The total planned workforce will be in the order of approximately 100 people, working in two shifts. The employees will face exposure to heat, air pollution (particulates) and noise. Potential health and safety impact are regarded as significant.

7.2.11.1 Mitigation:

i. A proper health and safety programme has to be implemented and maintained, on an ongoing base.

ii. Baseline conditions for heat, particulates and noise need to be established.

iii. These parameters should be monitored against local safety regulations and, in the absence of the latter, against OSHA standards.

iv. A training programme for workers should also be part of the safety strategy.

v. The proposed plant should strive to maintain the highest safety and housekeeping standards.

7.2.12 Impact: Earthquake Hazard

From the catalogue of earthquakes impacting Jamaica (over the last 300 years), most of the larger earthquakes recorded/reported were offshore. The earthquakes occurring on land tend to be of low magnitude.

The proposed site is in a zone with one of the highest frequencies of earthquakes (i.e. greater than 6) on the Modified Mercalli scale. At this magnitude, there is the potential for earth movement and building/facility damage.

7.2.12.1 Mitigation

i. Structures at the site will be low-rise, resulting in a moderate to low earthquake hazard (in respect to life and property).

ii. Buildings at the site will be designed and constructed to withstand moderate to large earthquakes.

7.2.13 Impact: Employment

During this phase, an average of approximately 100 workers will be needed for the operation of the facility. This represents an increase in the level of employment within the study area and is viewed as a potential minor positive impact.

7.2.13.1 Mitigation

Not required.

7.2.14 Impact: Emergency Response

The operation of the proposed development will involve workers who may become ill or become involved in accidents. In addition, disasters such as fires etc. are real possibilities.

7.2.14.1 Mitigation:

i. Make prior arrangements with health care facilities (e.g. Spanish Town Hospital) to accommodate/facilitate ill and injured employees.

ii. Design and implement an emergency response plan with the assistance of the Office of the Disaster Preparedness and Emergency Management (ODPEM).

iii. Coordinate with mutual aid organisations/agencies (e.g. the local fire brigade).

iv. Install fire hydrants within the proposed development.

8.0 ENVIRONMENTAL MANAGEMENT PLAN

8.1 OVERVIEW

The company should develop a waste management programme centred on a waste minimization approach. In this regard, the definition of waste is expanded to consider the use of all resource, that is 'waste is a resource out of place'. In this section of the report waste management is dealt with not only in terms of thee the waste which is generated but also from the perspective of resource efficiency like water and energy.

Waste can be defined as: "something for which you have no use, that is not going to be used for its original purpose and which requires work to be carried out on it before it can be made useful." Waste minimisation is about reducing waste at source and avoiding its creation in the first place. A waste minimization strategy is part of sound environmental management but also makes good business sense because by reducing the amount of waste it generates a company can maximise output, reduce costs and increase profitability. Waste minimisation is both a component of and a result of resource efficiency which involves making the best use of all available resources.

There is more to the cost to waste management than the cost of waste disposal that is the cost taken off-site. Waste studies have shown that the hidden costs involved in waste management are on average more than ten times greater than the direct costs of waste disposal. Hidden costs may include:

- Discarded raw materials (slippages etc)
- The labour and energy costs involved in producing discarded finished goods or rejects
- The value of lost sales

There are also costs associated with hidden wastes including:

- Poor purchasing and stock controls
- Chemicals that may have been leaked or spilt
- Gas from exhausts

- Excessive heating and lighting
- Faulty machinery

It is only once all of these factors are taken into account that a business can accurately assess the true cost of its waste. Mainland should institute a comprehensive waste management programme guided by the concept of waste minimization and resource efficiency.

8.2 HOW TO ESTABLISH WASTE MANAGEMENT PROCEDURES?

The fundamentals of waste management involve the following steps:

Minimising Your Waste

(Reduce your waste at source and trying not to create it in the first place.)

↓

Recycling Your Waste

(Reclaim materials from waste to reprocess new products.**)**

↓

Disposing of Your Waste

(Last option either burial or treatment of waste which cannot be recycled.)

Waste recycling is a vital part of environmental best practice for businesses. It needs to be considered once steps have been taken to minimise the amount of waste being produced – and ways of reusing it have been investigated. As well as being beneficial for the environment, recycling makes good business sense by helping to minimise the costs associated with waste collection, transport and disposal.

The company as part of its waste management programme should develop best practice. ‘Best practices" are intended as guidelines, and should be applied with existing policies, regulatory considerations, cost-effectiveness and technological feasibility considerations borne fully in mind. Over time, these best practices should continue to evolve and move progressively towards pollution prevention. The following are areas within which best practice should be established.

8.2.1 Procurement

- Evaluate potential purchases as outlined *Material Management Environmental Guidelines*;
- Provide green procurement training to officers with purchasing authority to improve decision-making, such as *Implementing Environmental Purchasing Policies* which minimise waste;
- Adopt just-in-time delivery of all standard items on a competitive basis; and
- Phase out all warehousing space for standard items as the just-in-time system comes into place.

8.2.2 Waste Management

- Identify waste reduction opportunities, taking advantage of existing auditing tools and procedures;
- Develop and implement a waste reduction action plan, including an awareness program for employees;
- Separate waste streams at source to facilitate reuse, recycling and proper disposal;
- Centrally collect environmentally-harmful wastes, and store and dispose of them safely; and

8.2.3 Water Usage

- Identify water savings opportunities, taking advantage of existing audit tools and procedures;
- Develop and implement a water conservation plan;
- Optimize water efficiency, review bills, monitor flow meters and implement preventive maintenance programs;
- Specify water-saving equipment and devices for future purchases, such as water-efficient fixtures including toilets, faucets, showerheads and appliances;
- Retrofit toilets, urinals, showers, faucets, and drinking fountains to reduce water use; and

- Use greywater for landscaping and irrigation purposes where feasible.

8.2.4 Energy

- Review energy use in the facility;
- Develop and implement energy management plans, including preventative maintenance;
- Assess the energy efficiency knowledge requirements of building operators and managers and provide the required training;
- Install all economically attractive energy retrofits; and
- Facilitate building occupant energy conservation.

8.2.5 Motor Vehicle Fleets

- Manage fleet vehicles in accordance with economic and environmental objectives;
- Maximize fuel efficiency to conserve energy and reduce emissions;
- Purchase vehicles of appropriate engine size to meet operational requirements;
- Perform regular maintenance on vehicles to ensure maximum operating efficiency; and
- Conduct driver education for enhanced energy savings and safety.

8.2.6 Human Resource Management

- Infuse environmental awareness into all training programs, particularly orientation and
- Institute worker safety programme.

9.0 ENVIRONMENTAL MONITORING PROGRAMME/WASTE MANAGEMENT PLAN

9.1 MONITORING DURING SITE CLEARANCE AND CONSTRUCTION PHASE OF THE PROPOSED DEVELOPMENT

- Daily monitoring to ensure that the cleared areas and access roads are not creating a dust nuisance. Any temporarily installed (onsite and offsite) drainage works should be inspected, at these times, to ensure they are clear and functioning properly. Where suitable and practical, instructions may also be given for the temporary (or permanent) grassing/re-vegetation of areas where the top soil is likely to remain exposed to soil erosion, over an extended period of time.

  The project engineer / construction site supervisor should monitor or nominate a named person to carry out this activity. NEPA should conduct spot checks to ensure that this stipulation is followed.

  It is not anticipated that this exercise will incur additional costs.

- Daily inspections to ensure that construction activities are not being conducted outside of regular working hours (e.g. 7 am – 7 pm). In addition, a one off noise survey should be undertaken to determine workers exposure and construction equipment noise emission.

  The project engineer / construction site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that the hours are being followed. CL Environmental Co. Ltd., or any other suitable qualified company or individual may conduct the noise survey.

  The monitoring of the construction work hours is not expected to incur any costs. The noise survey is estimated to cost approximately **J$12,000**.

- Undertake daily inspections of trucks carrying raw material to ensure that they are not over laden as this will damage the public thoroughfare and onsite lead to soil compaction. Also to ensure that they are covered and not spilling materials along the roadway.

  Person(s) appointed by the developer may perform this exercise.

No additional cost is anticipated for this exercise.

- Conduct daily inspections to ensure that trucks carrying raw materials and heavy equipment are parked at the designated area on the proposed site so as to prevent traffic congestion and accidents.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Conduct daily inspections to ensure that flagmen are in place and that adequate signs are posted along the roadway. This is to ensure that traffic along the Spanish Town By-pass have adequate warnings and direction.

  Person(s) employed by developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal. Additionally, solid waste generation and disposal of the campsite should also be monitored.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Weekly assessment to determine that there are adequate numbers of portable toilets and that they are in proper working order. This will ensure that sewage disposal will be adequately treated.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Monitor and ensure that approved suppliers and sources of local materials are used. Inspection of quarry licences should be conducted to ensure that they are legal. Copies of these licences should be kept on file.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Daily monitoring of vehicle refuelling and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of soil contamination from spills. Spot checks should be conducted by NEPA.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Where possible, construction crews should be sourced from within the study area. This will ensure that the local community will benefit from the investment.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

- Daily inspection of construction activities to ensure that the proposed wastewater infrastructure, drainage infrastructure and building plans are followed and are being constructed properly. NEPA and the local Parish Council can provide checks and balances.

  Person(s) appointed by the developer may perform this exercise.

  No additional cost is anticipated for this exercise.

9.2 MONITORING DURING THE OPERATIONAL PHASE OF THE PROPOSED DEVELOPMENT

- Onsite drainage channels should be inspected (and maintained) on a monthly basis, during the dry season, and a weekly basis, during the wet season; to ensure they remain unblocked and clear. Similar inspection and maintenance should be conducted on the **oil-water separator and sedimentation fore bay**. In addition, storm water drainage channels, in the adjoining areas, should be checked and inspected, on a monthly basis, to ensure that traditional drainage pathways (to and from the site) remain unblocked.
- The evapotranspiration bed, and general wastewater treatment facility/infrastructure, should be inspected (and maintained) on a regular basis, to ensure it is operating effectively and optimally. At the very least, the recommended frequency is once a month. Grease traps, within general wastewater treatment system, should be inspected

(and maintained), during this exercise, to ensure they remain unblocked, clear and functional.

- Solid waste handling and disposal should be monitored, on a weekly basis, to ensure there are adequate numbers of bins and skips, for receiving the solid waste generated at the site. The individual in charge of this should ensure that, (i) the skips are not being overfilled (i.e. they have sufficient capacity to handle the daily waste), and (ii) the collected solid waste is being disposed of at the designated and approved dumpsite.
- Plant operations and efficiency should be monitored on a daily basis to ensure the grinding (and bagging) process is operating efficiently and energy consumption is as optimal/efficient as it can be, under the circumstances.
- Ambient dust levels should be monitored at the mixing, grinding and bagging facilities on a quarterly basis.
- Heat levels should be monitored at the facility on a quarterly basis. Daily spot checks should be done to ensure workers are, (i) suitably equipped for the various work environments in which they work, and (ii) utilising the protective equipment, provided.
- Noise levels should be monitored at the facility on a yearly basis. (i) Hearing conservation plans should be established for the facility, (ii) ensure that signs are in place in areas with high noise ratings, (iii) ensure workers are properly equipped with hearing protection devices such as ear muffs and plugs; in particular those workers that are exposed to noise levels of 85 dBA or more during their eight hour shift.

10.0 BILBLIOGRAPHY

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APPENDICES

APPENDIX 1: BOREHOLE LOGS FROM SOIL INVESTIGATIONS

CLIENT: PROJECT:Soil Investigation ADDRESS:	Location Reference MAINLAND Datum Elevation	Type/Size Hollow Stem 6.25" Diameter Auger; 3.25" I.D. Stem, 140 lbs Cathead Drop Hammer for SPT.

Sample Types ■ Wash ◩ Grab ☒ Split Spoon ☰ T. W. Tube ◨ R. Core

Depth (ft.)	Soil Description	Strata Plot	Water Level	SPT Blow Count	samples: Type	samples: ID Mark	samples: Recovery	Plasticity 20 – 80 Wet Unit Weight ☐ (kip/cu.ft) .07 – .13	Standard Penetration Test (Blows/ft.) 20 – 100 Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 – 5.0
00	Brown Silty Topsoil								
	Dump Material Brown Silty Clay + Traces of Calcareous Gravel			1 2 3	☒	1	10		
5	Firm to Very Stiff Brown Silty Clay			2 3 3	☒	2	10		
				4 9 10	☒	3	6		
10				6 14 15	☒	4	8		
15	Dense Brown M-F Sand			9 15 17	☒	5	18		
20	+ Some Silty Clay Here		▲	10 14 18	☒	6	18		
25				10 18 22	☒	7	18		
				11 19 21	☒	8	16		
30				13 18 25	☒	9	17		

**note 51 represent refusal on spoon

NHL ENGINEERING LTD

CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	11.11.05	B.H. No.	Sht. 3of 5
Completion	11.11.05	BH#1	FIG. No.
Final W. L.	N/A		

CLIENT:
PROJECT: Soil Investigation
ADDRESS:

Location Reference
MAINLAND
Datum
Elevation

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types ■ Wash ◪ Grab ☒ Split Spoon ☰ T. W. Tube ◨ R. Core

Depth (ft.)	Soil Description	Strata Plot	Water Level	SPT Blow Count	Type	ID Mark	Recovery
0	Dark Brown Clayey Topsoil						
	Brown Very stiff - Hard Silty Clay			6 9 12	☒	1	8
5				8 10 11	☒	2	10
				5 20 25	☒	3	8
10	Brown Dense - Very Dense M - V Fine sand			21 25 35	☒	4	10
15				20 22 26	☒	5	10
20				26 18 30	☒	6	11
25	Brown Very Stiff Silty Clay			27 24 26	☒	7	8
30				29 20 18	☒	8	12

Plasticity 20 80
Wet Unit Weight ☐ (kip/cu.ft) .07 .13
Standard Penetration Test (Blows/ft.) 20 100
Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 5.0

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS
29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates
Start	06.12.05
Completion	06.12.05
Final W. L.	N/A

Job No. ....
B.H. No. BH#2
Sht. 2of 5
FIG. No.

CLIENT: PROJECT:Soil Investigation ADDRESS:	Location Reference MAINLAND Datum Elevation	Type/Size Hollow Stem 6.25" Diameter Auger; 3.25" I.D. Stem, 140 lbs Cathead Drop Hammer for SPT.

Sample Types ■ Wash ◿ Grab ☒ Split Spoon ☰ T. W. Tube ◧ R. Core

Plasticity 20 – 80

Wet Unit Weight ☐ (kip/cu.ft) .07 – .13

Standard Penetration Test (Blows/ft.) 20 – 100

Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 – 5.0

Depth (ft.)	Soil Description	Strata Plot	Water Level	SPT Blow Count	Type	ID Mark	Recovery
00	Brown Silty Topsoil						
	Brown Stiff to Very Stiff Silty Clay			12 15 18	☒	1	9
5				15 19 22	☒	2	10
				6 9 15	☒	3	14
10				10 12 14	☒	4	10
	Brown Stiff to Very Stiff Clayey Silt + Some M-F Sand						
15				8 10 9	☒	5	15
20				4 3 8	☒	6	14
	Brown Stiff to Very Stiff Silty Clay						
25				4 3 10	☒	7	12
30				8 10 12	☒	8	14

**note 51 represent refusal on spoon

NHL ENGINEERING LTD

CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates	Job No.	
Start	06.12.05	B.H. No.	Sht. 3of 5
Completion	06.12.05	BH#3	**FIG. No.**
Final W. L.	N/A		

CLIENT:
PROJECT: Soil Investigation
ADDRESS:

Location Reference
MAINLAND
Datum
Elevation

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types ■ Wash ◿ Grab ☒ Split Spoon ☰ T. W. Tube ◧ R. Core

Plasticity 20 80
Wet Unit Weight ☐ (kip/cu.ft) .07 .13
Standard Penetration Test (Blows/ft.) 20 100
Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 5.0

Depth (ft.)	Soil Description
0 – 6.5	Dark Brown Moist Stiff Silty Clay + Traces of Gravel
6.5 – 15	Brown Stiff to Very Stiff Silty Clay
15 – 25	Brown Compact to Dense M-F Sand
25 – 30+	Brown Very Stiff Silty Clay

SPT Blow Count	Type	ID Mark	Recovery
3 4 6	☒	1	10
3 5 7	☒	2	9
5 8 11	☒	3	8
7 14 16	☒	4	8
8 12 15	☒	5	10
6 12 15	☒	6	12
13 16 20	☒	7	14
10 15 18	☒	8	16

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates
Start	21.10.04
Completion	21.10.04
Final W. L.	N/A

Job No. ....

B.H. No.

BH # 4

Sht. 4of 5

FIG. No.

CLIENT:
PROJECT: Soil Investigation
ADDRESS:

Location Reference
MAINLAND
Datum
Elevation

Type/Size
Hollow Stem 6.25" Diameter Auger;
3.25" I.D. Stem, 140 lbs Cathead
Drop Hammer for SPT.

Sample Types ■ Wash ◩ Grab ☒ Split Spoon ☰ T. W. Tube ◧ R. Core

Plasticity 20 – 80
Wet Unit Weight ☐ (kip/cu.ft) .07 – .13
Standard Penetration Test (Blows/ft.) 20 – 100
Undrained Unconfined Shear Strength (kip/sq.ft) Comp. Test + Vane Shear 1.0 – 5.0

Depth (ft.)	Soil Description	SPT Blow Count	Type	ID Mark	Recovery
0–11	Brown Stiff to Very Stiff Silty Clay	7 8 9	☒	1	14
		9 9 12	☒	2	12
		7 10 15	☒	3	12
		9 21 25	☒	4	14
11–31	Brown Dense Silty Sand	8 16 22	☒	5	13
		31 19 13	☒	6	14
		20 15 18	☒	7	14
		20 14 16	☒	8	9

**note 51 represent refusal on spoon

NHL ENGINEERING LTD
CONSULTING ENGINEERS

29 Monroe Road
Kingston 6, Jamaica

OFFICE BOREHOLE RECORD

	Dates
Start	13.12.05
Completion	13.12.05
Final W. L.	N/A

Job No. ....

B.H. No.
BH # 5

Sht. 1of 5
FIG. No.

APPENDIX 2: AIR QUALITY MODEL OUTPUTS

- Cement Mill Dust Collector (Virtual Source)
- Cement Silos Dust Collectors
- Limestone Storage Pile
- Traffic from Cement Trucks Load out and Office Cars (Note 10x Emission rate)
- Vehicle Traffic Raw Materials (Note 10x emission rate)

```
                                                              04/21/06
                                                              12:25:47
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Cement Mill Dust Collector (Virtual Volume Source)

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =       VOLUME
   EMISSION RATE (G/S)      =      .417000E-01
   SOURCE HEIGHT (M)        =       2.0000
   INIT. LATERAL DIMEN (M)  =      12.9500
   INIT. VERTICAL DIMEN (M) =       4.2500
   RECEPTOR HEIGHT (M)      =       2.0000
   URBAN/RURAL OPTION       =        URBAN

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
    40.   100.8        5     1.0    1.0 10000.0    2.00   17.12    7.13    NO
   100.   49.44        5     1.0    1.0 10000.0    2.00   23.25   11.19    NO
   200.   22.72        5     1.0    1.0 10000.0    2.00   33.19   17.37    NO
   300.   13.41        5     1.0    1.0 10000.0    2.00   42.80   22.96    NO
   400.   9.030        5     1.0    1.0 10000.0    2.00   52.09   28.08    NO
   500.   6.597        5     1.0    1.0 10000.0    2.00   61.10   32.81    NO
   600.   5.091        5     1.0    1.0 10000.0    2.00   69.83   37.23    NO
   700.   4.087        5     1.0    1.0 10000.0    2.00   78.32   41.37    NO
   800.   3.379        5     1.0    1.0 10000.0    2.00   86.57   45.28    NO
   900.   2.859        5     1.0    1.0 10000.0    2.00   94.60   49.00    NO
  1000.   2.464        5     1.0    1.0 10000.0    2.00  102.42   52.53    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    40. M:
    40.   100.8        5     1.0    1.0 10000.0    2.00   17.12    7.13    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC    DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)    MAX (M)    HT (M)
--------------     -----------   -------   -------
SIMPLE TERRAIN      100.8           40.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

```
                                                                      04/21/06
                                                                      12:30:49
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Cement Silos Dust Collectors

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      .177000E-02
   STACK HEIGHT (M)       =      12.0000
   STK INSIDE DIAM (M)    =       2.0000
   STK EXIT VELOCITY (M/S)=        .0000
   STK GAS EXIT TEMP (K)  =     300.0000
   AMBIENT AIR TEMP (K)   =     300.0000
   RECEPTOR HEIGHT (M)    =        .0000
   URBAN/RURAL OPTION     =        URBAN
   BUILDING HEIGHT (M)    =        .0000
   MIN HORIZ BLDG DIM (M) =        .0000
   MAX HORIZ BLDG DIM (M) =        .0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------   ----  -----  -----  ------  ------  ------  ------  -----
    40.   8.520        4     1.0    1.0   320.0    6.00    6.35    5.57    NO
   100.   4.797        5     1.0    1.1 10000.0    6.00   10.79    7.46    NO
   200.   1.639        5     1.0    1.1 10000.0    6.00   21.17   14.03    NO
   300.   .8203        5     1.0    1.1 10000.0    6.00   31.18   19.93    NO
   400.   .5018        5     1.0    1.1 10000.0    6.00   40.85   25.30    NO
   500.   .3445        5     1.0    1.1 10000.0    6.00   50.21   30.24    NO
   600.   .2546        5     1.0    1.1 10000.0    6.00   59.27   34.82    NO
   700.   .1980        5     1.0    1.1 10000.0    6.00   68.06   39.11    NO
   800.   .1598        5     1.0    1.1 10000.0    6.00   76.59   43.15    NO
   900.   .1327        5     1.0    1.1 10000.0    6.00   84.89   46.97    NO
  1000.   .1126        5     1.0    1.1 10000.0    6.00   92.97   50.60    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    40. M:
    40.   8.520        4     1.0    1.0   320.0    6.00    6.35    5.57    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

      ***************************************
      *** SUMMARY OF SCREEN MODEL RESULTS ***
      ***************************************

 CALCULATION         MAX CONC     DIST TO    TERRAIN
  PROCEDURE         (UG/M**3)     MAX (M)     HT (M)
--------------    -----------    -------    -------
SIMPLE TERRAIN      8.520           40.         0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

```
                                                         04/21/06
                                                         12:36:42
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Limestone Storage Pile

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                =         AREA
   EMISSION RATE (G/(S-M**2)) =      .920000E-04
   SOURCE HEIGHT (M)          =       1.0000
   LENGTH OF LARGER SIDE (M)  =      10.0000
   LENGTH OF SMALLER SIDE (M) =       5.0000
   RECEPTOR HEIGHT (M)        =        .0000
   URBAN/RURAL OPTION         =        URBAN
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   (DEG)
-------  ----------  ----  -----  -----  ------  ------  -------
    40.   98.23        6     1.0    1.0 10000.0    1.00      0.
   100.   17.90        6     1.0    1.0 10000.0    1.00      3.
   200.   4.902        6     1.0    1.0 10000.0    1.00      3.
   300.   2.348        6     1.0    1.0 10000.0    1.00      2.
   400.   1.412        6     1.0    1.0 10000.0    1.00      2.
   500.   .9618        6     1.0    1.0 10000.0    1.00      2.
   600.   .7075        6     1.0    1.0 10000.0    1.00      3.
   700.   .5486        6     1.0    1.0 10000.0    1.00      3.
   800.   .4419        6     1.0    1.0 10000.0    1.00      3.
   900.   .3663        6     1.0    1.0 10000.0    1.00      3.
  1000.   .3105        6     1.0    1.0 10000.0    1.00      2.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    40. M:
    40.   98.23        6     1.0    1.0 10000.0    1.00      0.

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      98.23          40.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

```
                                                                     04/21/06
                                                                     12:42:52
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Traffic from Cement Trucks Loadout and Office Cars (Note 10x Emission rate)

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                 =         AREA
   EMISSION RATE (G/(S-M**2))  =      .416000E-04
   SOURCE HEIGHT (M)           =       1.0000
   LENGTH OF LARGER SIDE (M)   =      60.0000
   LENGTH OF SMALLER SIDE (M)  =       9.0000
   RECEPTOR HEIGHT (M)         =        .0000
   URBAN/RURAL OPTION          =        URBAN
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC             U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)    (DEG)
-------  ----------  ----  -----  -----  -------  ------  -------
    20.   536.1         6     1.0    1.0 10000.0    1.00      0.
   100.   92.72         6     1.0    1.0 10000.0    1.00      0.
   200.   24.30         6     1.0    1.0 10000.0    1.00      0.
   300.   11.54         6     1.0    1.0 10000.0    1.00      0.
   400.   6.924         6     1.0    1.0 10000.0    1.00      0.
   500.   4.710         6     1.0    1.0 10000.0    1.00      0.
   600.   3.462         6     1.0    1.0 10000.0    1.00      0.
   700.   2.683         6     1.0    1.0 10000.0    1.00      2.
   800.   2.160         6     1.0    1.0 10000.0    1.00      2.
   900.   1.790         6     1.0    1.0 10000.0    1.00      2.
  1000.   1.517         6     1.0    1.0 10000.0    1.00      1.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    20. M:
    35.   592.9         6     1.0    1.0 10000.0    1.00      0.

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO    TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)     HT (M)
--------------    -----------    -------    -------
SIMPLE TERRAIN      592.9           35.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

```
                                                                 04/21/06
                                                                 12:47:35
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

Veh Traffic Raw Materials (Note 10x emission rate)

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                  =        AREA
   EMISSION RATE (G/(S-M**2))   =      .386000E-04
   SOURCE HEIGHT (M)            =       1.0000
   LENGTH OF LARGER SIDE (M)    =      70.0000
   LENGTH OF SMALLER SIDE (M)   =      18.0000
   RECEPTOR HEIGHT (M)          =        .0000
   URBAN/RURAL OPTION           =       URBAN
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

   MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION


BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC            U10M   USTK  MIX HT   PLUME  MAX DIR
   (M)    (UG/M**3)   STAB  (M/S)  (M/S)    (M)    HT (M)   (DEG)
-------  ----------  ----  -----  -----  ------  ------  -------
    40.   675.9        6     1.0    1.0 10000.0    1.00     11.
   100.   186.4        6     1.0    1.0 10000.0    1.00      0.
   200.   51.76        6     1.0    1.0 10000.0    1.00      0.
   300.   24.80        6     1.0    1.0 10000.0    1.00      0.
   400.   14.93        6     1.0    1.0 10000.0    1.00      0.
   500.   10.17        6     1.0    1.0 10000.0    1.00      1.
   600.   7.480        6     1.0    1.0 10000.0    1.00      0.
   700.   5.800        6     1.0    1.0 10000.0    1.00      0.
   800.   4.673        6     1.0    1.0 10000.0    1.00      0.
   900.   3.875        6     1.0    1.0 10000.0    1.00      0.
  1000.   3.286        6     1.0    1.0 10000.0    1.00      0.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    40. M:
    42.   678.6        6     1.0    1.0 10000.0    1.00     11.

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION       MAX CONC    DIST TO   TERRAIN
  PROCEDURE       (UG/M**3)    MAX (M)    HT (M)
--------------    -----------  -------   -------
SIMPLE TERRAIN      678.6          42.        0.


***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

APPENDIX 3: PUBLIC PERCEPTION QUESTIONNAIRE

MAINLAND CEMENT GRINDING PLANT QUESTIONNAIRE

PERCEPTION

Mainland intends to build a Cement Grinding Plant at March Pen road.

1 Do you think this type of development is suitable for this area?

____

2 If no, what kind of development would you like to see happen?

____

3 How will the building of the plant affect you?

____

____

4 Is there anything in particular about your area that you would like to tell us?

____

____

5 What else would you like to see done in your area?

____

____

6 Any other comments:

Signature: ....
Interviewer