EnviroPlanners Ltd.

ENVIRONMENTAL IMPACT ASSESSMENT

1/2/2018

Proposed Quarrying and Mineral Processing (Limestone & Gypsum Quarries – CCCL)

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ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED QUARRYING AND MINERAL PROCESSING (Limestone & Gypsum Quarries) AT HARBOUR HEAD AND HALBERSTADT QUARRY ST. ANDREW, JAMAICA

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

1.1.1 Project Background

Caribbean Cement Company Limited (CCCL), through its subsidiary Jamaica Gypsum and Quarries Limited (JGQ), operates quarries all within close proximity (< 7 km radius) of the cement plant at Rockfort, St. Andrew. These quarries supply the raw material inputs to the cement manufacturing process which includes; limestone, shale, gypsum and pozalano.

Supplies at the Gypsum Quarry in Halberstadt and the Limestone Quarry in Harbour Head are at a critical level and as such additional deposit needs to be secured. Additional deposits have been identified in areas adjacent to the respective quarries and this Environmental Impact Assessment (EIA) has been conduct and is being presented to support applications submitted to the National Environment Planning Agency (NEPA) for environmental permit/s to quarry the respective identified deposits.

It is to be noted that the development proposed for both quarry sites is an extension/expansion of an existing permitted operations to adjacent lands. The existing infrastructure, monitoring and management plan would continue to apply. No additional equipment or process will be introduced and it is not anticipated that there will be a net increase in the rate of mining/extraction.

Halberstadt Gypsum Quarry: In 2013 Supplies at the Bito Gypsum Quarry was depleted of mineable ore and reclamation activities began in 2014. As a result, CCCL having obtained the relevant permit re-opened the Halberstadt Gypsum Quarry, approximately 2 km northeast of the Bito Quarry. Though dormant for 40 years, this quarry is the only known economical reserve of gypsum remaining in Jamaica and it is intended for this quarry to supply the cement plant with the gypsum required in the manufacturing of Ordinary Portland and Blended Cements; as well as for export.

Caribbean Cement Company Limited (CCCL), through its subsidiary Jamaica Gypsum and Quarries Limited (JGQ), had applied to the National Environment Planning Agency (NEPA), for permit to operate a quarrying and mineral processing facility at Halberstadt in St. Andrew. Based on a thorough Environmental Impact Statement which was prepared by CL Environmental the Agency approved a permit to mine one hectare of the possible 6.7 hectares.

Subsequently, a permit application to mine an additional 1 hectare contiguous with the existing approved mining area was submitted and the permit granted. The information presented in this report focuses on the remaining 4.7 hectares, but within the context of the total gypsum deposit of approximately 6.7 hectares.

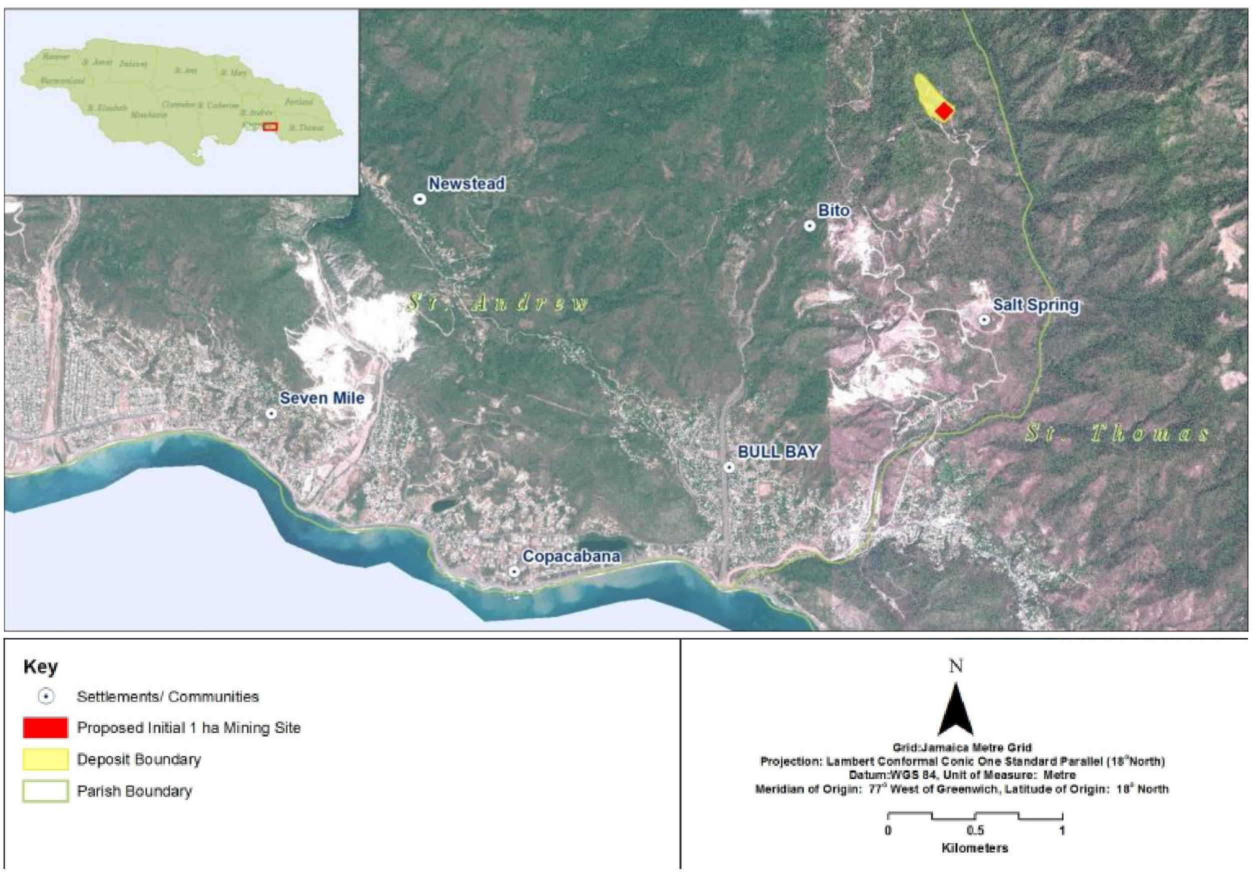

Figure 1.1.1: Proposed Halberstadt Gypsum Quarry Location – Source 2013 EIS

<u>Harbour Head Limestone Quarry</u>: Limestone represents 80% of the raw material necessary for the production of clinker and by extension, cement. Given that the chemistry directly affects the quality of the end products, it is necessary to plan ahead to ensure the limestone reserves are optimized. As such the following parameters must be taken into consideration:

i) The quantities of Limestone present in the area;
ii) The quality of said Limestone; based on both Calcium Carbonate ($CaCO_3$) and the Magnesium Oxide content, (MgO).
iii) Quality maps; these maps are necessary as they provide a guide to the spatial variations of the above-mentioned quality indicators in the limestone.

The mineral currently available from the existing Limestone Quarry poses a serious challenge to derive to correct blend proportion. Based on borehole sample analysis the chemistry of the mineral from the proposed Harbour Head Quarry is ideal for blending with Limestone form the existing Quarry.

The proposed Caribbean Cement Company Limited (CCCL) Harbour Head quarry site is located adjacent to the western boundary of the existing Limestone Quarry at Harbour Head in St Andrew (Figure 1.1.2).

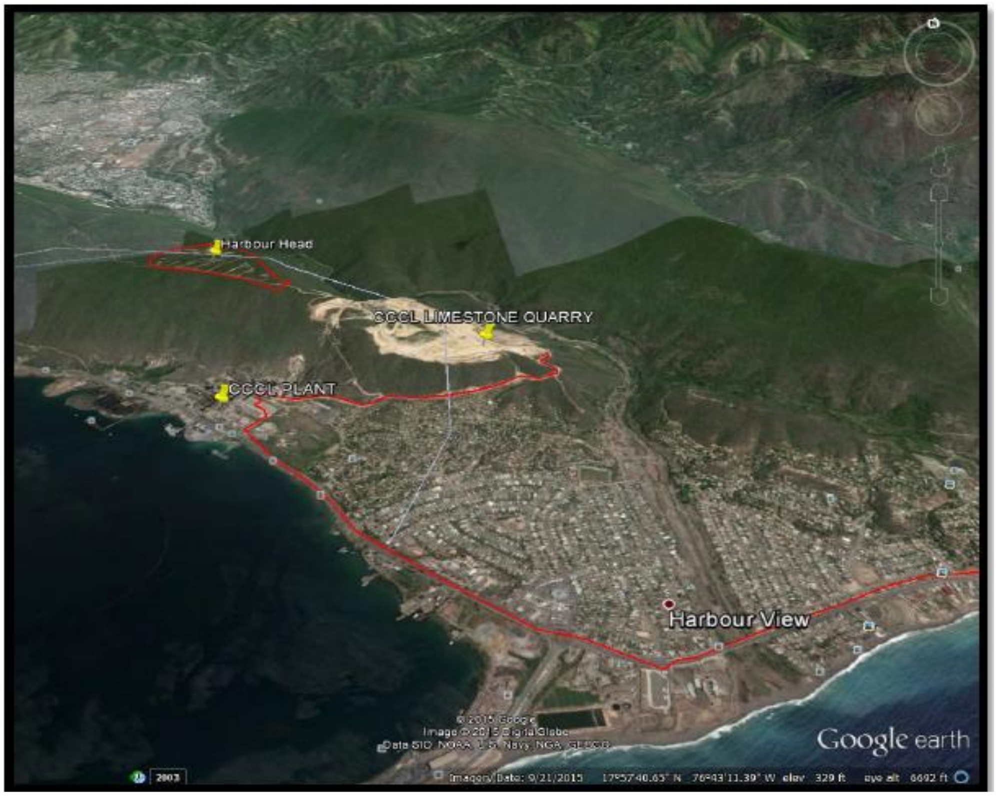

Figure 1.1.2: Proposed Harbour Head Limestone Quarry

1.1.2 Project Design – Harbour Head

The development of the CCCL Harbour Head quarry is planned in three phases: Pre-operation phase; Operation phase and Rehabilitation phase. The pre-operation phase provides information on the site including the physical and chemical characteristics of the geological material to assist with the development of the quarry and design of the mining plan. This will include construction of access roads, subsurface exploration work (drilling and sampling) and physical and chemical analysis.

Preliminary exploration drilling and sampling was conducted at the Harbour Head Project site to gather information in order to ensure that the material meets the required specification for the cement plant.

Exploration was carried out across a large section of the delineated area to provide a holistic representative set of results. A total of 30 exploratory boreholes were drilled to a depth ranging from 45m (150ft) to 52.5 (175ft) with samples collected at 1.5m (5ft) intervals. Geological log profiles were then created for each hole using the samples recovered. Following this, the samples were then chemically analyzed by CCCL's lab. Drill hole site layout plan is shown in Figure 4.2

1.1.3 Project Design – Halberstadt

NHL Engineers Ltd conducted a subsurface geological survey based on drilling of boreholes, to determine the reserve capacity of the gypsum deposits at the Halberstadt quarry. Information from the drill holes indicated the following:

- Clays, sand and gravel to depths ranging from 0-15m
- Clayey shales, Sandstone of variable depth
- Gypsum/anhydrite at depths ranging from 10m-60m

Results of laboratory analysis for the gypsum showed an average percentage gypsum of approximately 50% with a high of 90%. The reserve estimation was obtained by a simplified representative cross-sectional area of the deposit which varies from 5,625m² to 3600m². The presumptive profile indicates that the effective depth of length of gypsum deposit is about 450m. A conservative volumetric estimate of the deposit is 2,586,500m³.

The average content of the gypsum is approximately 52% based on laboratory test which therefore gives a volumetric reserve estimate of 1,350,804m³. In applying the in-situ densities (bulk densities) of gypsum and anhydrite (2.33t/m³ and 2.9t/m³ respectively), it gives a reserve estimate of 3,147,373 tonnes of gypsum and 3,586,418 tonnes of anhydrite. This compares favourably with CCCL's internal reserve estimate of 6.3 million tonnes.

1.1.4 Project Operations and Maintenance – Harbour Head

The life of the Harbour Head limestone deposits will depend on the rate at which material is extracted. The rate of extraction of the reserves will be a direct result of the following:

- The demand for the limestone based on 2016 production budget (Table 4.1.2) and on the 5-year production budget (Table 4.1.3).
- The ability of the established and current Quarry to meet the demands and estimated targets.
- The blending systems implemented to optimize reserves.

- Whims of the weather. Mining is planned throughout the year, although it is expected that mining will be reduced in the peak of the rainy season.

The quality of the Limestone in the Harbour Head area is not homogenous. The chemistry of the limestone acts as a direct influence on the quality of the material mined. Thus, blending is necessary to achieve optimum quality standards before materials are entered into production. The mining sequence will therefore be determined firstly by the quality requirements, then by quantity requirements and the required stipulations for mining best practices.

Mining is projected over a 5-yr period, from year 2016 -2020, with yearly extraction figures ranging from 970,000.60 Tonnes to 1,091,780.46 Tonnes and total extraction of 5,150,030.68 Tonnes (Table 4.1.3). The proposed expansion (new area) at Harbour Head will account for approximately 80% of the material mined from both quarries.

1.1.5 Project Operations and Maintenance - Halberstadt

Development Stage

The Halberstadt quarry, which had been dormant for many years commenced mining operations on a 1-hectare block in 2014. The accessible mineral in the 1 hectare was only recently exhausted and a permit recently approved for an additional 1-hectare expansion. The site can therefore be considered to be an active quarry and the existing infrastructure will be utilized to continue the mining operations for the remaining 4.7 hectares of the total possible 6.7 hectares. Test holes drilling has already been done at a spacing of 30 m. This information has been used to develop a mining progression plan.

Mining Schedule

The mine schedule will be for the benches containing BH 103 and BH 105 and was proposed to be mined in 2017, down to a depth of 12 m each.

Mining Method

The mining method to be employed is open-pit mining, by benching. Material will be extracted by drilling and blasting and subsequent to this an excavator will be used to load the material into a mobile crusher.

1.2 DESCRIPTION OF THE EXISTING ENVIRONMENT

1.2.1 Location & Description – Harbour Head

The proposed Caribbean Cement Company Limited (CCCL) Harbour Head quarry site is located at Harbour Head in the eastern section of St Andrew (Figure 4.1.2). The project site stretches from the top of the ridge to the north-eastern side of the mountain slope. The south-western section is situated on gentle sloping terrain, while the north-eastern section is dominated by steep topography. The south-western boundary is defined by a Jamaica Public Service Company (JPSCo) service road for its transmission towers. Similarly, the north-eastern boundary is defined mainly by the Yallahs pipeline which is routed along the steep north eastern slope of the mountain range (Figure 4.1.3). The existing CCCL limestone quarry is located adjacent to the southeastern boundary of the site.

The total size of the proposed Harbour Head Quarry site is approximately 20 hectares (50 acres).

1.2.2 Location & Description - Halberstadt

The Halberstadt Quarry is located towards the eastern boundary of the parish of St. Andrew, less than 1 km west of the parish of St. Thomas. It is situated approximately 1.5 km north of Salt Spring, St. Andrew and 1.2 km northeast of Bito, St. Andrew on faulted mountains at a height of between 500 metres and 600 metres above sea level overlooking the valley of Bull Park River (Figure 5.2.1). The area consists of a rugged terrain, characterized by steep slopes, high ridges and narrow gullies, which drain into the Bull Park Gully.

The total size of the Halberstadt property is approximately 13 hectares, of which 6.7 hectares is covered by deposits of gypsum and anhydrite. An estimated 1 hectare of the 6.7 hectares was approved for mining following the granting of a mining licence by the Mines and Geology Division (MGD) in 2013 and a permit for additional 1-hectare expansion recently approved.

1.2.3 Biological – Harbour Head

Floral species observed were divided into two main categories for the purpose of the study, namely natural vegetation – comprising predominantly **trees**[1], **vines**[2] and **bromeliads**[3] and gap occupiers – comprising **herbs**[4], and **grasses**[5] found in areas where tree cover had been disturbed.

The vegetation type distinction was made because it was quickly determined in the field that there was very little room for under-canopy vegetation growth where un-disturbed forest vegetation existed and that much of the non-tree vegetation existed along the sides of the pathways that had been excavated through the forest cover

An examination of the manner in which floral compositions varied over the study site was attempted, primarily to facilitate the determination of where particular flora of significance might be distributed. Of the 34 species of plants identified during transect surveys of the proposed site, one species, the Broom Thatch Palm (***Thrinax parviflora***) was determined to be endemic.

1.2.4 Biological - Halberstadt

Literature reviews, as well as the identification of characteristic flora within the vegetation assemblages found surrounding the CCCL Gypsum site lead to the characterization of the forest at the site as a Tall, Open, Dry Forest[6] assemblage. The authors of the 2013 Environmental Impact Statement prepared for the location[7] outlined that the general area had been disturbed by mining operations that had been terminated over 40 years ago.

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1 Tree – A woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground - Wikipedia.org

2 Vine – A climbing or trailing woody-stemmed plant.

3 Bromeliad- A plant of tropical and subtropical America typically having short stems with rosettes of stiff, spiny leaves. Some kinds are epiphytic.

4 Herb – Any seed-bearing plant which does not have a woody stem and dies down to the ground after flowering - google definition

5 Grass –Vegetation consisting of typically short plants with long, narrow leaves growing wild or cultivated on lawns.

6 A Tall Open Dry Forest is an open natural woodland or forest with trees at least 5m tall and crown not in contact, in drier part of Jamaica with species indicators such as Red Birch Tree (***Bursera simaruba***) **-** Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

7 CL Environmental Co. Ltd October 2013

The location had naturally re-vegetated over the period leading up to the re-commencement of mining operations over a year ago.

1.2.5 Socioeconomic Environment - Harbour Head

The only populated areas or social or economic activities within the 1km sphere of influence from the project site as shown in Figure 2.2.2 is the CCCL Plant and existing Limestone Quarry.

1.2.6 Socioeconomic Environment - Halberstadt

The EIS of 2013 done by CL Environmental presented comprehensive information on the same region and is considered to be still applicable and was therefore adopted for this report extracts of which are presented below; the full report is included in the (Appendix 5) presented as a attachment to this document.

1.2.6.1 Demography and Housing

The total population within the Social Impact Area (SIA) in 2011 was approximately 990 persons (STATIN 2011 Population Census). Examination of the 2001 population data showed that there were approximately 1,144 persons within the 2-km radius of the proposed plant location in 2001. From this population, and that calculated for the year 2011 (990 persons), it was estimated that the actual growth within the SIA between 2001 and 2011 was approximately -1.44% per annum.

The 15-64 years' age category accounted for 68% of the 2011 population for the SIA, with the age 0-14 years (26%) and the age 65 and over category accounting for 7%. The segment of a population that is considered more vulnerable are the young (children less than five years old) and the elderly (65 years and over). In this population, approximately 7% were in the young category and this is similar to the 7% within the 65 years and older category as mentioned previously.

The child dependency ratio for the SIA in 2011 was 379 per 1000 persons of labour force age; old age dependency ratio stood at 101 per 1000 persons of labour force age; and societal dependency ratio of 480 per 1000 persons of labour force. This indicates that the youth (child dependency) is more dependent on the labour force for support when compared with the elderly.

The land area within the SIA was calculated to be approximately 14,597,712.6 m2 (14.6 km2). With a population of 990 persons, the overall population density was calculated to be 68 persons/km2. This population density is considerably lower than the regional level for the parishes of St. Andrew, which is approximately 1,321 persons/km2 and St. Thomas, 127 persons/km2, as well as the national figure of 246 persons/ km2).

Most persons within the SIA attained a secondary school education (68.0%) followed by those attaining a primary education (20.7%). Secondary educational attainment is higher in the SIA than the parishes of St. Andrew and St. Thomas and the island; however, there were noticeably lower percentages of those attaining a university, other tertiary or other educational level. Statistics for pre-primary and no education are similar amongst all extents examined. The relatively high proportion of the population in proximity to the quarry location attaining a secondary education suggests that the labour pool is relatively educated, and as such, there should be no problem in obtaining non-technical workers from the community.

The SDC 2009 Community Profile data revealed that 45% of the Bito community households were headed by unemployed persons. In contrast, only 6% of households were headed by unemployed persons in the community of Bloxborough.

There were 272 housing units, 291 dwellings and 293 households within the SIA in 2001. The average number of dwellings in each housing unit was 1.1 and the average household to each dwelling was 1.0. The average household size in the SIA was 3.9 persons/ household (Table 6.40). Comparisons of the SIA with national and regional ratios indicate that they were generally similar except for the higher SIA average household size.

In 2001, 35.9% of the households in the SIA owned the land on which they lived. Approximately 6.6% leased the land on which they were, 16.1% rented, 24.5% lived rent free, 9.7% “squatted” and 0.1% had other arrangements. Compared to higher percentages of no reports for the national (21.9%) and St. Andrew (35.2%) extents, the SIA had a very low percentage (7.1%) of persons not reporting the type of ownership arrangements they had. The relatively higher percentage of households in the SIA living rent free and squatting indicates that there were a higher percentage of households in the SIA compared to the national and regional setting with temporary living arrangements. Sixty-three percent (62.7%) of the households within the SIA received their domestic water supply from the National Water Commission (NWC). It was reported by SDC that over 95% of the residents in the communities of Bito and Bloxborough utilize cellular services for communication in 2009. In the community of Bito, 64.5% of residents used electricity for lighting whilst in Bloxborough, 66% used this source of lighting (SDC 2009 socioeconomic survey). These figures are comparable with those estimated for the SIA (61.9%).

It is estimated that approximately 174,609.9 litres/day (~46,127.1 gals/day) of wastewater is generated within the study area (for 2013) and is expected to decrease to 121,554.6 litres/day (~32,111.3 gals/day) over the next twenty-five years based on calculated growth rates. It is estimated that households in the study area generated approximately 1,204.2 kg (~1.2 tonnes) of solid waste in 2001. Based on the population growth, it has been estimated that at the time of this study (20123), approximately 1,171.4 kg (~1.17 tonnes) of solid waste was being generated and it is expected that within the next twenty-five years, if the annual population growth rate remains the same (-1.44%), the amount will be 813.8 kg (~0.8 tonnes).

1.2.6.2 Cultural and Heritage

Halberstadt is named after a town in Germany. The Tainos were the first occupants of the area evidenced by the find of a cave containing the skeletal remains of at least 34 individuals and other artefacts in 1895. The Halberstadt property has seen various land uses over the past centuries. In 1763 sugar was the main produce but by 1811 the estate was producing 6,588 bushels of coffee. In 1824 the estate possessed 156 enslaved persons. The estate has passed through several owners such as Jakob Kellerman, John Mais, John Weiss and Beresford Gossett. The location of the quarry was once the provision grounds, Guinea grass and ruinate. As in the historical period the site is found to be in ruinate and Guinea grass piece. This clearly accounts for the absence of archaeological features and artefact assemblages.

1.3 Air Quality and Air Dispersion Modeling

An air dispersion modeling exercise involving the AERMOD air dispersion model was conducted to predict the impact of air emissions on ambient air quality from two proposed quarries to be located at Halberstadt and Harbour Head in St. Andrew, Jamaica. The proposed project involves the quarrying and mineral processing of gypsum and limestone at Halberstadt and Harbour Head, respectively. The operation at Halberstadt will process 200,000 tonnes per year of gypsum from 6.7 hectares of land, while that at Harbour Head will process 800,000 tonnes per year of limestone from 20 hectares of land. It is envisaged that each operation would involve activities such as drilling, blasting, material transport and stockpiling, as well as the crushing or processing of materials. The quarries are approximately 8.5 km apart and were modeled in a single model domain of 20 x 20 km, with its centre being the centroid of all air pollutant sources identified at both quarries.

Other sources that could contribute to the overall air quality impact within the air shed were considered in the air dispersion modeling analyses and they included sources at Jamaica Public Service Company (JPS) Rockfort Power Plant, Jamaica Private Power Company (JPPC), Jamaica Flour Mills (JF Mills), Jamaica Gypsum and Quarries Port facility and Caribbean Cement Company (CCC) manufacturing facility.

The emission rates for the criteria pollutants of particulate matter (TSP and PM_{10}), sulphur dioxide (SO_2), nitrogen oxides (NO_X), and carbon monoxide (CO) that are being emitted from the proposed quarries were determined based on the use of USEPA AP42 emission factors and project data. Emission rates for the other facilities were obtained from the Air Dispersion Modeling Report for Caribbean Cement Company Limited dated September 2015, the Air Dispersion Modeling Report for Halberstadt Gypsum Quarry dated October 2013, and the 2015 Annual Air Emissions Summary Reports for JF Mills and CCC.

Building and terrain effects were also included as part of the modeling analyses, and the meteorological data set was defined using the 2011-2015 modeled data with the grid center at the centroid of sources at both proposed Halberstadt and Harbour Head

Quarries. The surface meteorological data was preprocessed, along with the upper air data using the AERMET software programme in order to generate the meteorological input files required by the AERMOD air dispersion model.

The receptor grid system was also determined using a multi-tier grid system that included a 100-meter grid within 3 km from the centroid of project sources (UTME 323110 and UTMN 1987820) and a 500-meter grid spacing between 3 and 10 km from the centroid of project sources. Special receptors inclusive of schools, churches, police stations, postal agencies, post offices, a football stadium, recreation areas, health centers and ambient air quality monitoring stations were also included as part of the receptor network.

With all the input files established, the air dispersion model was executed. The model was run using the rural option based on the Auer (1978) Land Use categories, and the Ozone Limiting Method (OLM) was applied for conversion of NO_X to NO_2 with a NO_2/NO_x ratio of 0.1.

The 2012 annual average ozone concentration (27 $\mu g/m^3$) for the Kingston area that was obtained at an ambient air quality monitoring station at Rockfort, was applied to the OLM.

Tables ES-1 to ES-3 show the results of the model runs for the proposed quarries and their comparisons with the national ambient air quality standards (NAAQS) and/or Guideline Concentrations (GCs), as well as the Significant Impact Concentrations (SICs).

Table 1.3.1: Summary of Model Results for Halberstadt Quarry

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Gypsum Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	34.4	325210	1988120
	Annual	20	60	20	2.9	324710	1987720
PM_{10}	24-hr	9	150	80	22.6	325210	1988120
	Annual	20	50	20	1.5	324710	1987720
NO_2	1-hr	0	400	N/A	2.4	324810	1988020
	24-hr	0	N/A	80	0.34	324750	1987877
	Annual	0	100	20	0.1	324710	1987720
SO_2	1-hr	0	700	N/A	169.0	324810	1988020
	24-hr	0	280	80	23.8	324750	1987877
	Annual	0	60	20	7.4	324710	1987720
CO	1-hr	0	40000	2000	0.34	324810	1988020
	8-hr	0	10000	500	0.13	324610	1988120

Table 1.3.2: Summary of Model Results for Harbour Head Quarry

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Limestone Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	84.3	316142	1988285
	Annual	20	60	20	8.6	316277	1988292
PM_{10}	24-hr	9	150	80	37.2	316142	1988285
	Annual	20	50	20	3.8	316277	1988292
NO_2	1-hr	0	400	N/A	1.4	315610	1988820
	24-hr	0	N/A	80	0.36	316277	1988292
	Annual	0	100	20	0.04	316110	1988320
SO_2	1-hr	0	700	N/A	98.7	315610	1988820
	24-hr	0	280	80	25.8	316277	1988292
	Annual	0	60	20	2.7	316110	1988320
CO	1-hr	0	40000	2000	0.2	315610	1988820
	8-hr	0	10000	500	0.085	316277	1988292

Table 1.3.3: Summary of Model Results for Quarries

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Gypsum & Limestone Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	84.4	316142	1988285
	Annual	20	60	20	8.6	316277	1988292
PM_{10}	24-hr	9	150	80	37.2	316142	1988285
	Annual	20	50	20	3.8	316277	1988292
NO_2	1-hr	0	400	N/A	2.4	324810	1988020
	24-hr	0	N/A	80	0.36	316277	1988292
	Annual	0	100	20	0.1	324710	1987720
SO_2	1-hr	0	700	N/A	169.0	324810	1988020
	24-hr	0	280	80	25.8	316277	1988292
	Annual	0	60	20	7.4	324710	1987720
CO	1-hr	0	40000	2000	0.34	324810	1988020
	8-hr	0	10000	500	0.13	324610	1988120

The maximum ambient model predictions for the quarries, both separately and in combination, revealed total compliance for all averaging periods for the various pollutants analyzed. There was also compliance with all applicable significant impact concentrations, except the 24h TSP for the Harbour Head quarry and both quarries together. Notwithstanding this exceedance, the 75% threshold of the applicable standard was not exceeded after the recommended background concentration was added to the predicted concentration.

1.4 Identification of Impacts and Recommended Mitigation

1.4.1 Site Clearance/Preparation and Construction

Table 1.4.1: Site Clearance/Preparation and Construction

Impacts	Mitigation
Vegetation/Habitat Disturbance	• Limit the development of roadways to the existing road network. • The removal of endemic species, especially in the area surrounding the site, should be avoided. If removal is necessary, a nursery or buffer should be established for the maintenance and propagation of the endemic species and other naturally occurring plants. These plants may later be reintroduced into the area based on a rehabilitation plan. • Leaving or planting strips of vegetation on steep slopes to help prevent erosion. • Vegetation and soil should be removed together (mixed) so that the plant matter helps to hold the soil. Alternatively, vegetation can be stripped and stockpiled and then spread over the newly made stockpiles of soil. • The natural vegetation surrounding the quarry should be retained (such as in a buffer area) so as to help minimize dust emissions.
Noise Pollution	• Use equipment with low noise emissions as stated by manufacturer, and fitted with noise reduction devices such as mufflers • Operate noise-generating equipment during regular working hours (e.g. 7am – 7pm) to reduce potential of creating noise nuisance at night • Quarry workers operating noise-generating equipment should be equipped with noise protection (ear muffs, ear plugs)
Air Quality	• Quarry Roads should be dampened every 4- 6 hour or within reason to prevent a dust nuisance, and on hotter days this frequency should be increased • Minimize cleared areas to those that are needed to be used • Cover or wet stockpile materials such as over-burden • Where unavoidable, persons working in dusty areas should be provided and fitted with N95 respirators

Solid Waste Generation	• Skips and bins should be strategically placed within the quarry area. • The skips and bins at the quarry site should be adequately designed and covered to prevent access by vermin and minimize odour. • The skips and bins at the quarry site should be emptied regularly to prevent overfilling. Disposal of the contents of the skips and bins should be done at an approved disposal site.
Wastewater Generation/Disposal	• Provide portable sanitary conveniences workers and visitors for control of sewage waste. A ratio of approximately 25 workers per chemical toilet should be used
Transportation and Traffic	• Traffic entering of leaving the site will be scheduled for off peak hours to minimize additional congestion at the intersection and or disruptions in the regular traffic flow. • Erection of signs ahead of the works warning motorists of the heavy/construction units entering the Bull Bay Main Road right of way. • Flagmen should be utilized to minimize the likelihood of accidents when heavy units are entering the roadway.

1.4.2 Operations

Table 1.4.2: Operations

Impacts	Mitigation
Rock Blasting	• Directional controlled blasts • Constructing rockfall protection mesh systems, for example catch fences, rockfall drapery or rockfall netting, which are made from high-tensile steel wire.
Soil Loss and Erosion	• Implementation of check dams which are small dams, temporary or permanent, constructed across a channel or drainage ditch. They are constructed not only to capture the runoff sediment directly, but also to decrease the volume and discharge runoff sediment (sediment control). • The introduction of reinforcement elements such as metal soil nails or anchors to increase the shear strength of the rock and to reduce the stress release created subsequent to soil cutting. Gravity walls or concrete walls with counterforts may also be introduced.

	• Re-profiling the slope with the purpose of improving stability by either reducing the slope angle or cutting benches into the face of the soil. There are three options: Balanced cut and fill, full bench cut or through cut. • Erecting gabion walls from the foot of the slope along its faces which act as a type of low gravity retaining structure. These are generally wire frames filled with aggregates. • The implementation of soil erosion preventative measures, for instance, geo-mats, geogrids or brushwood mats, as water near the surface of the hillside may cause the erosion of surface material.
Surface and Subsurface Water Pollution	• Only clean uncontaminated water should be discharged, under the approved licence, to surface waters including clean dewatering from the quarry floor to minimize surface water run-off into the quarry workings. • All the run-off from roads and paved areas should pass through adequately sized and located oil/petrol interceptors before discharge to surface water drainage. Refueling should only take place on such paved areas with oil/petrol interceptors • All above ground chemical (petroleum/oil) storage tanks should be adequately bunded to protect against oil spillage. Bunding should be impermeable and capable of retaining a volume equal to 110% of the capacity of the largest tank. Drainage from bunded areas should be collected and disposed of in a safe manner and to the satisfaction of the planning authority • The quarry operator should maintain on site an adequate supply of containment booms and suitable absorbent materials to contain and absorb any spillage; • Washing ponds (used to separate the suspended solids during the aggregate washing process) should be carefully designed and operated to ensure that where practicable water is recycled and not discharged to watercourses. • The haul road is to be properly graded and drained to prevent run-off from cutting into banks of the road, avoiding erosion. • Sufficient sewage and storm water treatment should be provided on site; strict control of run-off from pits, quarries, spoil heaps, embankments and all other parts of sites, including access roads and wheel-wash facilities is required; • Groundwater can be adversely affected by residues from explosives used in rock quarries. It is important that blast operatives ensure that all material is ignited; Use of explosive slurries in karst terrain should be avoided.

Drainage and Flooding	• The surface runoff traversing the site should be channeled through proposed earth swales with implemented check dams where possible. In addition, drains located on the boundary of the site should be bounded with compacted berms designed to be 0.3m above the estimated water level. • The flows generated from the site catchment should, where possible, pass through a detention basin prior to final discharge to natural depression within the topography of the site.
Vegetation/Habitat Disturbance	• A phased approach to mining activities is recommended. • Establish a site rehabilitation plan for the site. • A buffer zone of minimal to no activity should be established surrounding the proposed area. The vegetation in this area may then become a natural seed-source to the mined-out lands after closure. If considered, seedlings may also be actively transplanted from this area as well. • The staged and sequential clearing of vegetation over the life of the quarry should be contemplated. • Vegetation should only be cleared where it is absolutely necessary for operation. • As the quarry expands, the time between clearing and quarrying should not be protracted. • When trucking material it should be covered for the duration of the trip and when idle.
Noise Pollution	• Use equipment with low noise emissions as stated by manufacturer, and fitted with noise reduction devices such as mufflers • Operate during regular working hours (e.g. 7am – 7pm) to reduce potential of creating noise nuisance at night • Conduct annual noise assessment to determine if the noise from quarry operations is having negative impact on the environment.
Air Dispersion and Quality	• It should be noted that the calculation of the dust emissions from the unpaved haul roads assumed that the roads would be sprayed with water, and therefore the spraying of the unpaved haul roads with water is a recommended mitigation measure.
Vibration	• All blasts must be so designed to minimize ground vibration. Prior warning and explanation should be given to residents in the area before blasting occurs.
Storage of Quarry Material	A set of management guidelines should be implemented in order to curtail the impact of stored quarried material, identify formalized storage sites and for the appropriate management using quarried material. The storage and use of stored material is required to be managed to:

	• Efficiently utilize material previously quarried; • Minimize the spread of environmental pathogens (infectious); • Ensure legal requirements are met for storing quarried material.
Transportation and Traffic	• Erection of signs ahead of the works warning motorists of the heavy units entering the Bull Bay Main Road right of way. • Flagmen should be utilized to minimize the likelihood of accidents when heavy units are entering the roadway. • It is further recommended that a maintenance plan be put in place to address the issue of the PC road degradation over the operational life of the quarry. This is needed because it is anticipated that even though the trucks may be within the weight limits, the PC roads in the unpaved areas especially will deteriorate with continued used by trucks from the quarry.

1.5 Conclusion

The proposed expansion of the Harbour Head Limestone Quarry and the Halberstadt Gypsum Quarry is critical for the continued medium and long-term viability of the operations for manufacturing of Portland cement by CCCL. There have been environmental challenges associated with the operations of these quarries over the years, for which consistent adherence to implementation and monitoring of recommended mitigation measures is needed.

There will be increased loss of vegetation, however this impact may be minimized by the progressive rehabilitation of mined out areas. The air dispersion modeling revealed that there is not expected to be a significant increase in impact and all parameter should be in compliance with local air quality standards.

The proposed expansion at the Harbour Head quarry is not likely to have an impact on any neighbouring community. The expansion at Halberstadt is not expected to result in an increase in activity as the rate of extract will remain at current level or may even be reduced as the New owners of CCCL, (CEMEX) has taken a strategic decision to reduce export of gypsum and retain the reserves for local production. However greater attention must be paid to the consistent application of mitigation to reduce the impact of noise and dust on the communities traversed by the trucks transporting the mineral to the CCCL plant.

2 INTRODUCTION

2.1 Project Background

Supplies of available/accessible material from the permitted areas at the Gypsum Quarry in Halberstadt and the Limestone Quarry in Harbour Head are at a critical level and as such additional deposit needs to be secured. Additional deposits have been identified in areas adjacent to the respective quarries and this Environmental Impact Assessment (EIA) has been conduct and is being presented to support applications submitted to the National Environment Planning Agency (NEPA) for environmental permit/s to quarry the respective identified deposits.

Having conducted this environmental assessment is has been noted that what is proposed for both quarry sites are extension/expansion of an existing permitted operations to adjacent lands contiguous with existing operations which in the case of Halberstadt is owned and for Harbour Head is leased. The existing infrastructure, monitoring and management plan would continue to apply. No additional equipment or process will be introduced and it is not anticipated that there will be a net increase in the rate of mining/extraction.

Recognizing the regulatory approvals required to allow for a project of this nature and magnitude, an environmental permit application pursuant to the Natural Resources Conservation (Permits and Licenses) (Amendment) Regulations 2015, was submitted to the National Environment and Planning Agency (NEPA). Based on a screening done by the Agency, it was determined that an Environmental Impact Assessment was required. A Terms of Reference was drafted by NEPA and presented to CCCL on 9 December 2015, which was accepted.

2.2 Project Objective and Execution

2.2.1 Harbour Head

Limestone represents 80% of the raw material input necessary for the production of clinker and by extension, cement. Given that the chemistry directly affects the quality of the end products, the most critical chemical component is the ration of Calcium Carbonate content ($CaCO_3$) to Magnesium Oxide content, (MgO) present in the limestone.

The mineral currently available from the existing Limestone Quarry poses a serious challenge to derive to correct blend proportion to meet the requirement of ordinary Portland cement, manufactured by CCCL. Based on borehole sample analysis, the chemistry of the mineral from the proposed Harbour Head Quarry is ideal for blending with Limestone form the existing Quarry. The proposal based on the respective chemical content is to obtain 80% of the limestone from the new location and the other 20% from the existing mine. This is expected to provide an optimal blend.

The proposed site for the extension of the Caribbean Cement Company Limited (CCCL) Harbour Head limestone quarry is located adjacent to the western boundary of the existing Limestone Quarry at Harbour Head in St Andrew. (See Figure 2.2.1 below)

Figure 2.2.1: Map of the Proposed Harbour Head Limestone Quarry

Based on the location of the site proposed for the expansion of the limestone quarry at Harbour Head; apart from CCCL operations there are no residential community within a 1km zone of influence (Figure 2.2.2).

Figure 2.2.2: Google Map showing a 1km zone of influence

2.2.2 Halberstadt

In 2013 Supplies at the Bito Gypsum Quarry was depleted of mineable ore and rehabilitation activities began in 2014. As a result, CCCL having obtained the relevant permit re-opened the Halberstadt Gypsum Quarry, approximately 2 km northeast of the Bito Quarry. Though dormant for 40 years, this quarry is the only known economical reserve of gypsum remaining in Jamaica and it is intended for this quarry to supply the cement plant with the gypsum required in the manufacturing of Ordinary Portland and Blended Cements; as well as for export.

Caribbean Cement Company Limited (CCCL), through its subsidiary Jamaica Gypsum and Quarries Limited (JGQ), had applied to the National Environment Planning Agency (NEPA), for permit to operate a quarrying and mineral processing facility at Halberstadt in St. Andrew. Based on a thorough Environmental Impact Statement which was prepared by CL Environmental the Agency approved a permit to mine one hectare of the possible 6.7 hectares.

Subsequently, a permit application to mine an additional 1 hectare contiguous with the existing approved mining area was submitted and the permit approved. The information presented in this report focuses on the remaining 4.7 hectares, but within the context of the total gypsum deposit of approximately 6.7 hectares.

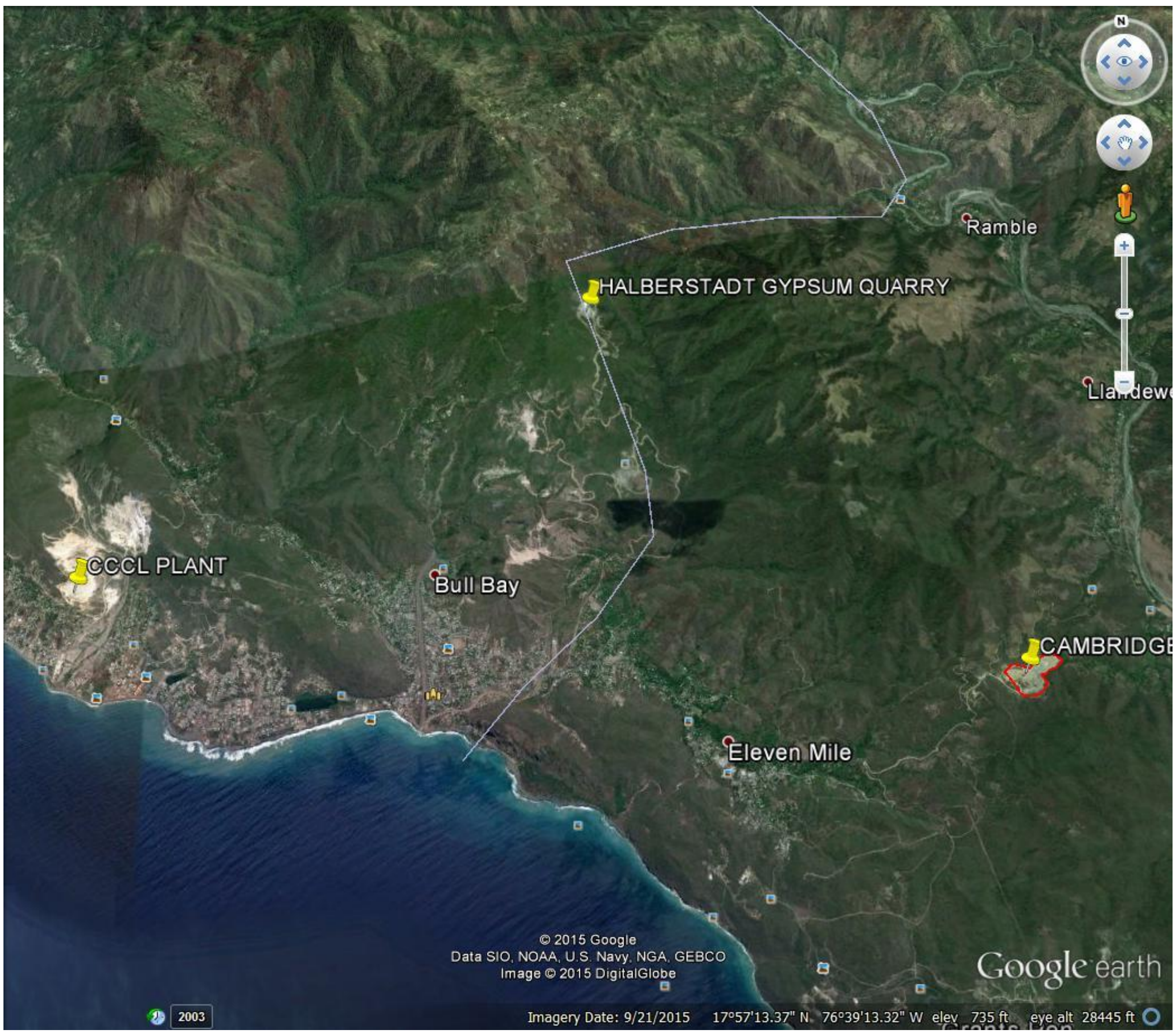


Figure 2.2.3: Google map showing location of Halberstadt Gypsum Quarry

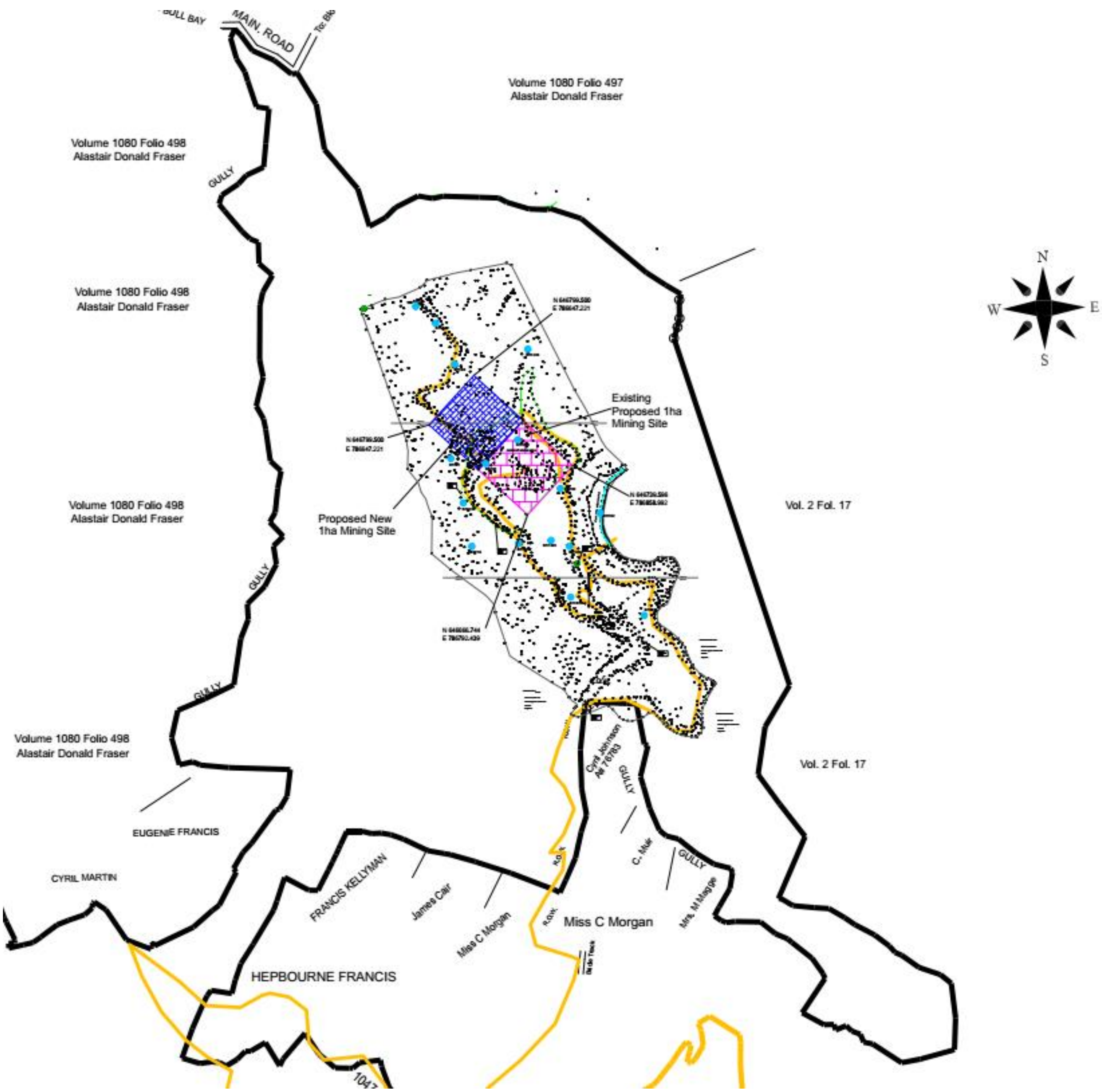


Figure 2.2.4: Halberstadt Gypsum Boundary Map showing boundary of the overall 13.5 hectares; the ~6.7 hectares of deposit; the mined out 1 hectare and the recently approve 1 hectare extension

2.3 Methodology

The Environmental Impact Assessment will provide a comprehensive evaluation of the site, in terms of predicted environmental impacts, needed mitigation strategies, potentially viable alternatives to the development proposed ensuring compliance with all related legislation.

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. The members of the EIA Professional Team are given in (Appendix 2). An interactive approach among the environmental team members and other project professionals was adopted and was facilitated by team meetings as required.

Baseline data for the study area was generated using a combination of Field studies; Analysis of maps, plans, aerial photos; Review of engineer's reports and drawings; Review of background project documents and EIA/EIS reports for other proposed projects completed in the area; Structured interviews; Internet searches; Agency requests and document searches. Searches were undertaken through the Water Resources Authority (WRA), Mines and Geology Division (MGD), National Water Commission (NWC) and the Office of Disaster Preparedness and Emergency Management (ODPEM). In addition, website searches of the National Environment and Planning Agency (NEPA), Meteorological Service of Jamaica, and NWC were undertaken to obtain any further relevant information.

3 LEGISLATION AND REGULATORY CONSIDERATIONS

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 and rationale of an EIA has been summarized as follows[1]:

Beyond preparation of technical reports, EIA is a means to a larger end - the protection and improvement of the environmental quality of life. It is a procedure to discover and evaluate the effects of activities on the environment - natural and social. It is not a single specific analytical method or technique, but uses many approaches as appropriate to the problem.

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

In undertaking the EIA, a review was conducted of pertinent policies, legislation and regulations of the Government of Jamaica in relation to the proposed project. International obligations such as treaties and protocols to which the Government of Jamaica is signatory were also reviewed in light of the development. We have examined several critical areas that are applicable to the proposed project.

3.2 National Legislative Framework

This list includes:

- The Natural Resources Conservation Authority (NRCA) Act (1991)
- Natural Resources Conservation Regulations 1996, amended 2015
- Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013
- Natural Resources Conservation Authority (Air Quality) Regulations, (2002)
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996), amended 2015
- Watersheds Protection Act (1963)
- Water Resources Act (1995)
- Flood Water Control Act (1958)
- Office of Disaster Preparedness and Emergency Management Act (1998)
- Petroleum and Oil Fuel (Landing and Storage) Act (1925) Amended 1990
- Mining Act (1947) Amended 1995
- Quarries Control Act (1984)
- The Jamaica National Heritage Trust Act (1985)
- Wildlife Protection Act (1945) Amended 1991 – Amended Regulation 2016
- Forrest Act (1996)
- The Pesticides (Amendment) Act (1996)
- Clean Air Act (1964)
- Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000) Amended 2015
- Parish Council Act 1901 (Amended 2007)
- Town and Country Planning Act (1957) Amended 1987
- Local Improvement Act (1914) Amended 1991
- Building Act 2016
- Factories Act (1943) Amended 2009
- Land Development and Utilization Act (1966)

- Public Health Act (1985)
- National Solid Waste Management Authority Act (2001)
- Country Fires Act (1942)
- Land Acquisition Act (1947)
- Registration of Titles Act (1989)
- Noise Abatement Act (1997)
- Water Quality Standard

3.2.1 The Natural Resources Conservation Act (1991)

The NRCA Act (1991) is the overriding legislation governing environmental management in Jamaica. It requires that all new projects, (or expansion of existing projects), which fall within prescribed categories be subject to an environmental impact assessment (EIA).

The regulations require that eight (8) copies of the EIA Report be submitted to the Authority for review. There is a preliminary review period of ten (10) days to determine whether additional information is needed. After the initial review the process can take up to ninety (90) days for approval. If on review and evaluation of the EIA the required criteria are met, a permit is granted. In the event that the EIA is not approved, there is provision for an appeal to be made to the Minister.

Specifically, the relevant section(s) under the Act which address the proposed project are:
Section 10: Empowers the Authority to request EIAs for the construction of any enterprise of a prescribed category.

Section 12: Addresses the potential for contamination of ground water by trade effluent and sewage.

Section 15: Addresses the implementation of stop orders and fines associated with the pollution of water resources.

Section 16: Authorizes the government to intervene in order to prevent the contamination of ground water.

Section 17: Addresses the authority of the government to request in writing, any information pertaining to the:

1. performance of the facility
2. quantity and condition of the effluent discharged
3. the area affected by the discharge of effluent

The NRCA Act is the parent act to the giving power to drafting of Natural Resources Conservation Regulations 1996, amended 2015, and the Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013

3.2.2 Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013

Wastewater refers to water that has been used and contains dissolved or suspended solids and is carried from residential, business or industrial sources. Under these regulations, the operation of a treatment plant for the discharge of trade effluent or sewage effluent requires a licence. Specifications for treatment plants, outfalls, monitoring and reporting and standards (Table 3.2.1) are also detailed

Table 3.2.1: Trade Effluent Standard

PARAMETER	TRADE EFFLUENT LIMIT
Ammonia/ammonium measured as NH_4	1.0 mg/L
Barium	5.0 mg/L
Beryllium	0.5 mg/L
Biological oxygen demand (BOD)	<30 mg/L
Boron	5.0 mg/L
Calcium	No standard
Chemical Oxygen Demand (COD)	<100mg/L or <0.01 kg/1000 kg product
Chloride	300 mg/L
Colour	100 TCU
Cyanide (free)	0.1 mg/L
Cyanide (Total as CN)	0.2 mg/L
Detergent	15 mg/L
Dissolved oxygen (DO)	>4mg/L
Faecal Coliform	<100 MPN/100 ml
Fluoride	3.0 mg/L
Iron	3.0 mg/L
Magnesium	No standard
Manganese	1.0 mg/L
Nitrate as NO_3	10 mg/L
Oil and Grease	10 mg/L or < 0.01 kg/1000 kg product
PH	6.5 - 8.5
Phenols	0.1 mg/L
Phosphate as PO_4	5 mg/L
Sodium	100 mg/L
Sulphate	250 mg/L
Sulphide	0.2 mg/L
Temperature	±2° of ambient
Total Coliform	<500 MPN/100 ml
Total Dissolved Solids (TDS)	1000 mg/L
Total Organic Carbon (TOC)	100 mg/L
Total Suspended Solids (TSS) (maximum monthly average)	50 mg/L
Total Suspended Solids (TSS) maximum daily average	<150mg/L
Trace Metals:	
Zinc	1.5 mg/L
Lead	0.1 mg/L
Cadmium	0.1 mg/L
Arsenic	0.5 mg/L
Chromium	1.0 mg/L
Copper	0.1 mg/L
Mercury	0.02 mg/L
Nickel	1.0 mg/L
Selenium	0.5 mg/L
Silver	0.1 mg/L
Tin	No standard
Total Heavy Metals	2.0 mg/L

3.2.3 Natural Resources Conservation Authority (Air Quality) Regulations, (2002)

Under section 38 of the NRCA Act, regulations pertaining to air quality in Jamaica are stipulated. The National standards, known as the National Ambient Air Quality Standards (NAAQS), are categorized into two groups. In one group, there are the primary standards, designed to protect human health and in the other, there are the secondary standards designed to protect the environment and limit property damage.

Part I of this Act stipulates license requirements and states that every owner of a major facility or a significant facility shall apply for an air pollutant discharge license. Part II speaks to the stack emission targets, standards and guidelines.

The Act states that no person shall emit or cause to be emitted from any air pollutant source at a new facility, any visible air pollutants the opacity or pollutant amount of which exceeds the standards.

Every owner of a facility with one or more air pollutant source or activity shall employ such control measures and operating procedures as are necessary to minimize fugitive emissions into the atmosphere and such owner shall use available practical methods which are technologically feasible and economically reasonable and which reduce, prevent or control fugitive emissions so as to facilitate the achievement of the maximum practical degree of air purity.

Under this Act, a "major facility" is described as any facility having an air pollutant source with the potential to emit:

- One hundred or more metric tons/year of any one of total suspended particulate matter (TSP);
- Particulate matter with a diameter less than ten micrometres (PM10);
- Sulphur oxides measured as sulphur dioxide (SO_2);
- Carbon monoxide (CO);
- Nitrogen oxides (NOx) measured as equivalent nitrogen dioxide;
- Five or more tons/year lead;

- Ten or more tons per year of any single priority air pollutant; or
- Twenty-five or more metric tons per year of any combination of priority air pollutants;

3.2.4 The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)

Section 9 of the NRCA Act declare the entire island and the territorial sea as 'prescribed area', in which specified activities require a permit, and for which activities an environmental impact assessment may be required. The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996) and the Permits & Licensing Regulations was passed as a result of section 9 of the NRCA Act.

3.2.5 Watershed Protection Act (1963)

This Act provides for the protection of watersheds and areas adjoining watersheds and promotes the conservation of water resources. The entire island however is considered to be one watershed, but for management purposes is divided into smaller units. There are 26 watershed management units declared under the Act. The Act makes provision for conservation of watersheds through the implementation of provisional improvement schemes whereby soil conservation practices are carried out on land. No regulations have ever been prepared under this Act and therefore voluntary compliance and training have been the only measures available to ensure appropriate management practices in watersheds in Jamaica.

3.2.6 Water Resources Act (1995)

The Water Resources Act (1995) was promulgated in the Jamaican Parliament in September 1995 and ratified in April 1996. This Act established the Water Resources Authority (WRA), which is authorized to regulate, allocate, conserve and manage the water resources of the island. The WRA is also responsible for water quality control; as stipulated under Section 4 of the Act the WRA is responsible for providing any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources.

Section 25 advises that a proposed user will have to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, under Section 21 it states that if the water to be used will result in the discharge of effluents, an application for a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister.

3.2.7 Flood Water Control Act (1958)

The Flood Water Control Act of 1958 is administered by the National Works Agency and designates specific personnel with the responsibility of and the required power to ensure compliance with the legislation.

Any Government department/agency or any statutory body or authority appointed by the Minister may enter land in flood-water control area to:

- Survey, measure, alter or regulate watercourses, maintain or build tools required to undertake works
- Clean watercourse or banks of such and deposit where required
- Construct, improve, repair or maintain floodwater control works

Wilfully or maliciously blocking, obstructing, encroaching on or damaging any watercourse, pipes or appliances used to execute works under the Act is an offence.

3.2.8 Office of Disaster Preparedness and Emergency Management Act (1998)

This Act was established by the Office of Disaster Preparedness and Emergency Management (ODPEM) to develop and implement policy and programmes to achieve and maintain an appropriate state of national and sectoral preparedness for coping with emergency situations. Caribbean Cement Company should have its own disaster and emergency response plan specific to its operations, to minimize loss of life, injury and damage to structures.

3.2.9 Petroleum and Oil Fuel (Landing and Storage) Act (1925) Amended 1990

This extends to the storage of petroleum in quantities greater than one hundred and twenty imperial gallons in a building specially appointed for this purpose by the Minister.

3.2.10 Mining Act (1947) Amended 1995

Any person who prospects or mines on any lands in this Island otherwise than in accordance with the provisions of this Act shall be guilty of unlawful prospecting or unlawful mining (as the case may be) and shall be liable on summary conviction before a Resident Magistrate to a fine not exceeding two thousand dollars or to imprisonment with hard labour for a term not exceeding twelve months, and in addition the court before which such person is convicted shall order the forfeiture of all minerals obtained in the course of such unlawful prospecting or mining, or if such minerals cannot be forfeited, the payment of such sum as the court may assess as the value of such minerals.

The Governor-General may appoint a Commissioner of Mines (hereinafter referred to as "the Commissioner"), a Deputy Commissioner of Mines, and such other officers as may be necessary for the carrying into effect of the provisions of this Act.

It shall be the duty of the Commissioner, in addition to any other duties provided in this Act, to exercise general supervision over all prospecting and mining operations in this Island.

3.2.11 Quarries Control Act (1984)

The Quarries Control Act is administered by the Mines and Geology Division It regulates the extraction of material such as sand, marl, gypsum, and limestone for construction purposes. Quarry zones and licenses, quarry tax, enforcement, safety, Quarry Advisory Committee, fines for illicit quarrying and bonds for restoration are addressed in this act.

Under this act, the Quarries Advisory Committee, which advises the Minister on general policy relating to quarries as well as on applications for licenses, was established. On the recommendation of the Quarries Advisory Committee, the Minister may declare an area in which quarry zones are to be established and establish quarry zones within any such specified area. A license is required for establishing or operating a quarry, unless the Minister decides to waive this requirement.

3.2.12 Jamaica National Heritage Trust Act (1985)

The Jamaica National Heritage Trust Act of 1985 established the Jamaica National Heritage Trust (JNHT). The Trust's functions outlined in Section 4 include the following responsibilities:

- To promote the preservation of national monuments and anything designated as protected national heritage for the benefit of the Island;
- To carry out such development as it considers necessary for the preservation of any national monument or anything designated as protected national heritage;
- To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected.
- Section 17 further states that it is an offence for any individual to:
- Willfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a national monument or protected national heritage;
- Alter any national monument or mark without the written permission of the Trust;
- Remove or cause to be removed any national monument or protected national heritage to a place outside of Jamaica.

The JNHT has been written to advising them of the project and to determine if there are any known heritages or archaeological sites of interest within the project area. No written response was received, up to the time of the submission of this report.

3.2.13 Wildlife Protection Act (1945) Amended Regulations of 2016

The Wild Life Protection Act of 1945 is mainly concerned with the protection of specified faunal species. Under this Act, the removal, sale or possession of protected animals; use of dynamite, poisons or other noxious material to kill or injure fish; and the discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and streams are prohibited. In addition, this Act protects several rare and endangered faunal species including six species of sea turtle, one land mammal, one butterfly, three reptiles and a number of game birds. The establishment of Game Sanctuaries and Reserves is authorized under this Act.

3.2.14 Forrest Act (1996)

The 1996 Forest Act repealed the 1937 legislation and was the legal basis for the organization and functioning of the Forestry Department. The Forestry Department is an independent entity established in 1942, subsequent to the Forest Division of the Department of Agriculture (1938) and the Forest Branch of the Lands Department (1937). In 1938, the Forest Branch gazetted some 78,800 hectares of Crown Lands as forest reserves, this making up more than 75% of the present-day forest reserves. Following this, these reserve areas were added to by purchase, lease and other arrangements.

The Forestry Department is the lead agency responsible for the management and conservation of the forest resources in Jamaica. The management of forests on a sustainable basis in an aim to maintain and increase the environmental services and economic benefits is the Forestry Department's main function.

The following are some offences under this act:

- Cut a tree in forest reserve without valid permit
- Fell, cut, girdle, mark, lop, tap, uproot, burn, damage, debark, strip/remove leaves of a tree
- Kindle, keep, carry lit material
- Clear or break up land
- Establish or carry on forest industry
- Remove soil, gravel or sand
- Unlawfully/illegally affix forest officer mark to any tree/timber
- Alter, deface/obliterate mark placed by forest officer on tree/timber
- Pasture/allow cattle trespass

There are also a set of Forest Regulations (2001) which are administered by the Forestry Department as well.

3.2.15 The Pesticides (Amendment) Act (1996)

The Pesticides (Amendment) Act of 1996 amended sections of the principal act, which came into effect in 1975 and established the Pesticides Control Authority. This Act gives the Authority the responsibility of controlling the importation, manufacture, packaging, sale, use and disposal of pesticides. Section 11 states that the Authority is required to keep a register or record of all relevant information such as registered pesticides, restricted pesticides, pest control operators and persons licensed to import or manufacture pesticides. Under Section 16 of the Act, the Authority may also, with the approval of the Minister, make regulations which relate to areas such as:

- Aerial application of pesticides;
- Supervision required for the use of pesticides, the prescribed protective clothing to be worn and other precautionary measures;
- The permissible levels of pesticides to be used;
- The periods during which particular pesticides may or may not be used on certain agricultural crops;
- The disposal of pesticides and packages.

3.2.16 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 considers necessary or proper for the performance of his duties.

3.2.17 Endangered Species Act (2000) Amended 2015

The Endangered Species (Protection, Conservation and Regulation of Trade) Act was created in 2000 in order to ensure the codification of Jamaica's obligations under the Convention for the International Trade in Endangered Species of Wild Fauna and Flora. This Act governs international and domestic trade in endangered species in and from Jamaica. Under this act, the functions of NEPA include the grant of permits and certificates for the purpose of international trade, the determination of national quotas and the monitoring of the trade in endangered species. Sea turtles, in addition, to yellow snakes and parrots are often traded illegal internationally and are endangered.

3.2.18 Parish Council Act Amended 2007

Under the Parish Council Act each Local Planning Authority may revoke or alter regulations concerning the construction and restrictions as to the elevation, size and design of buildings built with the approval of the relevant Minister. It may also make regulations concerning the installation of sewers on premises.

3.2.19 Town and Country Planning Act (TCP Act), 1957 (Amended 1987)

This act provides the statutory requirements for the orderly development of land (planning) as well guidelines for the preparation of Development Orders, stipulations for Advertisement Control Regulations, Petrol Filling Stations and Tree Preservation Orders. It establishes the Town and Country Planning Authority, which in conjunction with the Local Planning Authorities, (Parish Councils), are responsible for land use zoning and planning regulations as described in their local Development Orders. The Town and Country Planning Act is administered by the National Environment and Planning Agency.

3.2.20 Local Improvement Act, 1944

The Local Improvements Act is the primary statue that controls the subdivision of land.

3.2.21 Building Act (2016)

This Act repeal the Kingston and St. Andrew Building Act and the Parish Councils Building Act and make new provisions for the regulation of the building industry: to facilitate the adoption and efficient application of national building standards to be called the National Building Code of Jamaica for ensuring safety in the building environment, enhancing amenities and promoting sustainable development: and for connected matters.

The objectives of this Act are to:

a) regulate the design, construction, maintenance, demolition, removal, alteration, repair and use of buildings and building work so as to protect the public safety and health;

b) give effect to the National Building Code of Jamaica;

c) facilitate:

i. the adoption and efficient application of internationally-recognized building standards; and

ii. the accreditation of building products, construction, methods, building components and building systems;

d) enhance amenities in general and require the construction of buildings that provide easy access and adequate amenities for persons with disabilities in particular;

e) promote cost effectiveness in the construction of buildings;

f) promote the construction of environmentally and energy efficient buildings;

g) establish an efficient and effective system for issuing building permits and certificates of occupancy and for resolving building disputes, including through alternative dispute resolution;

h) regulate the standard of training and certification and provide for the licensing of building practitioners and the recognition of building professionals who are regulated under other Acts; and

i) establish a building and an appeal process.

3.2.22 The Factories Act (1943) Amended 2009

Under Section 4 of the Factories Act, the Minister may make regulations generally for giving effect to the purposes of this Act, and for the purposes of ensuring the safety, health and welfare of persons who are employed in any factory or in connection with machinery, and in particular, and without prejudice to the generality of the foregoing provisions, any such regulations may provide for:

- The safe means of approach or access to, and exit from, any factory, or machinery;
- The fencing and covering of all dangerous places or machines;

- Life-saving and first aid appliances;
- Securing safety in connection with all operations carried on in a factory;
- Securing safety in connection with the use of all engines, machinery, and mechanical;
- The proper ventilation of any factory, having regard to the nature of the process carried on therein;
- The sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory;
- The provision and maintenance of appropriate facilities for the welfare of persons employed at any factory.

3.2.23 Land Development and Utilization Act (1966)

Under Section 3 of the Land Development and Utilization Act (1966), the Land Development and Utilization Commission is authorized to designate as agricultural land, any land which because of its "situation, character and other relevant circumstances" should be brought into use for agriculture. However, this order is not applicable to land, which has been approved under the Town and Country Planning Act for development purposes other than that of agriculture. Among the duties of the Commission outlined in Section 14 of the Act is its responsibility to ensure that agricultural land is "as far as possible, properly developed and utilized".

3.2.24 Public Health Act (1985)

The Public Health (Air, Soil and Water Pollution) Regulations 1976, aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms. Under the regulations given:

- No individual or corporation is allowed to emit, deposit, issue or discharge into the environment from any source.
- Whoever is responsible for the accidental presence in the environment of a contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay.
- Any person or organization that conducts activities which release air contaminants such as dust and other particulates is required to institute measures to reduce or eliminate the presence of such contaminants.

- No industrial waste should be discharged into any water body which will result in the deterioration of the quality of the water.

3.2.25 The National Solid Waste Management Authority Act (2002)

The National Solid Waste Management Authority Act (2001) is "an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto". The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

3.2.26 Country Fire Act (1942)

The Country Fires Act of 1942 details legislation associated with setting fire to crop, trash diseased plants, charcoal kilns; fires during night or unattended, prohibited; power of Minister to prohibit setting fire to trash; application for permit; setting fire contrary to order or permit; proof of fire evidence against occupier; occupier to extinguish fire; negligent use of fire and power to enter land and extinguish fire.

The Country Fires Act is administered by the Ministry of Agriculture. The Act designates specific personnel who are given the responsibility of and the required power to ensure compliance with the legislation.

Some offences stipulated in this Act are as follows:

- Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m.
- Leaving a fire unattended in the open air before it is thoroughly extinguished.
- Carrying in or upon any plantation, torch, or other matter in a state of ignition, not sufficiently guarded so as to prevent danger from fire

- By the negligent use or management of fire in any place; or by smoking any pipe, cigar, or cigarette, in any plantation, save and except within a dwelling- house on such plantation, endangers any buildings, fences, lands, cultivated plants, or other property.

3.2.27 Land Acquisition Act (1947)

The Land Acquisition Act was passed in 1947. As stipulated under Section 3 of this Act, any officer authorized by the Minister may enter and survey land in any locality that may be needed for any public purpose. This may also involve:

- Digging or boring into the sub-soil;
- Cutting down and clearing away any standing crop, fence, bush or woodland;
- Carrying out other acts necessary to ascertain that the land is suitable for the required purpose.

The Minister is authorized to make a public declaration under his signature if land is required for a public purpose, provided that the compensation to be awarded for the land is to be paid out of the Consolidated Fund or loan funds of the Government and funds of any Parish Council, the Kingston and St. Andrew Corporation or the National Water Commission.

Once the Commissioner enters into possession of any land under the provisions of this Act, the land is vested in the Commissioner of Lands and is held in trust for the Government of Jamaica in keeping with the details stated in Section 16. The Commissioner shall provide the Registrar of Titles with a copy of every notice published, as well as a plan of the land. The Commissioner will also make an application to the Registrar of Titles in order to bring the title of the land under the operation of the Registration of Titles Act.

3.2.28 Registration of Titles Act (1989)

The Registration of Titles Act of 1989 is the legal basis for land registration in Jamaica, which is carried out using a modified Torrens System (Centre for Property Studies, 1998).

Under this system, land registration is not compulsory, although once a property is entered in the registry system the title is continued through any transfer of ownership.

3.2.29 Jamaica's Energy Policy

The Jamaican economy is not well endowed with petroleum based energy resources and therefore, depends heavily on imports. The policy seeks to diversify Jamaica's energy base with the aim of ensuring adequate and secure energy supply for Jamaica. The Energy Policy addresses issues relating to energy sources such as petroleum, renewable and other fuels. In keeping with the Government of Jamaica's commitment to deregulate and liberalize the Jamaican economy, the involvement of the private sector on a competitive basis is chosen as the best way to modernize and expand the energy sector, so as to achieve the required growth in energy supplies and to improve efficiencies in energy production.

3.2.30 Noise Abatement Act (1997)

The Noise Abatement Act of 1997 was created in order to regulate noise caused by amplified sound and other specified equipment. This act has been said to address "some concerns but is too narrow in scope and relies on a subjective criterion" (McTavish2). Given this, McTavish conducted a study to recommend wider and more objective criteria in accordance with international trends and standards, but tailored to Jamaica's conditions and culture. To date, apart from the Noise Abetment Act (1997), Jamaica has no other National legislation for noise.

3.3 Applicable National Policies

It is understood that policies concerning mining and quarrying activities have been developed for the Draft Kingston and Saint Andrew Development Order 2013.

The Mines and Geology Division has delineated a quarry zone in the Ferry area, located on the boundary of St Andrew and St Catherine, and in the Bito area in St Andrew, while the Cane River area in St Andrew, has been identified as a proposed quarry zone. Quarrying will be permitted in these areas after the necessary licenses have been obtained. Notwithstanding, sites outside of these zones may be quarried once the required licences are obtained under the Quarries and Mining Acts.

- POLICY SP M5 The planning authority will not normally support quarry operations in locations outside of Quarry Zones as identified and approved by the Commissioner of Mines, except in extenuating circumstances.

On completion of quarry operations, it is expected that restoration of the quarried areas will take place in the shortest possible time and to the satisfaction of the planning and other relevant authorities.

- POLICY SP M6 Mining and quarrying plans for all phases of extraction should be submitted to the Commissioner of Mines and all permissions obtained before any such activity commences.
- POLICY SP M7 Rehabilitation plans for each phase of extraction should be prepared and approved by the Commissioner of Mines and all relevant authorities.
- POLICY SP M8 All mined out and quarried lands are to be restored in accordance with conditions of approval and to a vegetative state approved by the relevant authorities, or to a state which is satisfactory to the local planning authority and related authorities.
- POLICY SP M9 In determining the proposed land use for rehabilitated lands, the highest and best use of the lands should be considered and the use must be compatible with the zoning and or surrounding land uses.

3.4 International Legislative and Regulatory Considerations

3.4.1 Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) (1983)

Adopted in March 1983 in Cartagena, Colombia, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, more commonly referred to as the Cartagena Convention, is the sole legally binding environmental treaty for the Wider Caribbean. The convention came into force in 1996 as a legal instrument for the implementation of the Caribbean Action Plan and represents a commitment by the participating countries to protect, develop and manage their common waters individually and jointly. The Convention was ratified by twenty (20) countries and acts as a framework agreement that sets out the political and legal foundations for actions to be developed.

The operational Protocols, which direct these actions, are designed to address special issues and to initiate concrete actions. The Convention is currently supported by three Protocols as follows:

- The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention;
- The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (The SPAW Protocol), which was adopted in two stages, the text in January 1990 and its Annexes in June 1991. The Protocol entered into force in 2000;
- The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region (LBS Protocol), which was adopted in October, 1999.

3.4.2 The Convention on Biological Diversity

Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity (CBD) is committed to promoting sustainable development. The CBD is regarded as a means of translating the principles of Agenda 21 into reality and recognizes that "biological diversity is about more than plants, animals and microorganisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live".

The CBD may be considered the first global, comprehensive agreement which focuses on all aspects of biodiversity, to include genetic resources, species and ecosystems. In order to achieve its main goal of sustainable development, signatories are required to:

- Develop plans for protecting habitat and species.

- Provide funds and technology to help developing countries provide protection.
- Ensure commercial access to biological resources for development.
- Share revenues fairly among source countries and developers.
- Establish safe regulations and liability for risks associated with biotechnology development.

Jamaica's Green Paper Number 3/01, „Towards a National Strategy and Action Plan on Biological Diversity in Jamaica, is evidence of Jamaica's continuing commitment to its obligations as a signatory to the Convention.

4 PROJECT DESCRIPTION

4.1 Harbour Head

4.1.1 Project Location

Harbour Head is located to the northwest of the active Limestone Quarry at the Rockfort Plant. The site sits atop the mountain range which trends roughly in a northwesterly to southeasterly direction. Approximately 1.7 km to the southeast of Harbour head lies the community of Harbour View. The site overlooks the Hope River Valley to the north and a small section of the Rockfort area in the South which comprises mostly industrial plants, see Figure 4.1.1 below.

Figure 4.1.1: Google Image of site location for Proposed Harbour Head Limestone Quarry (Google Image 2015)

4.1.2 Project Rationale

The exiting Limestone Quarry based on core drilling has shown to have limestone with high levels of Magnesium content, 90 per cent of which will require blending to achieve the chemical specifications for the cement manufacture process. The Quarry's reserves as proven therefore is not sufficient to ensure the Caribbean Cement Company Limited is a going concern. This has made it necessary for the Company to seek additional property with the requisite chemical composition to blend with limestone in the active Quarry. Core drilling conducted in Harbour Head has shown that the chemistry of that limestone is suitable for blending with the dolomitic limestone that exist in the present Quarry. Given that the present limestone Quarry is not at a stage of rehabilitation, the plan is for CCCL to mine and rehabilitate progressively in the Harbour Head Quarry to ensure Mining best practices are not compromised. Figure 4 of the Mine Plan shows the orientation of the benches. Given the access to Harbour Head is from the exiting Limestone Quarry, mining will be limited to the first two benches, rehabilitate, then proceed Westwards in each instance mining and rehabilitating progressively

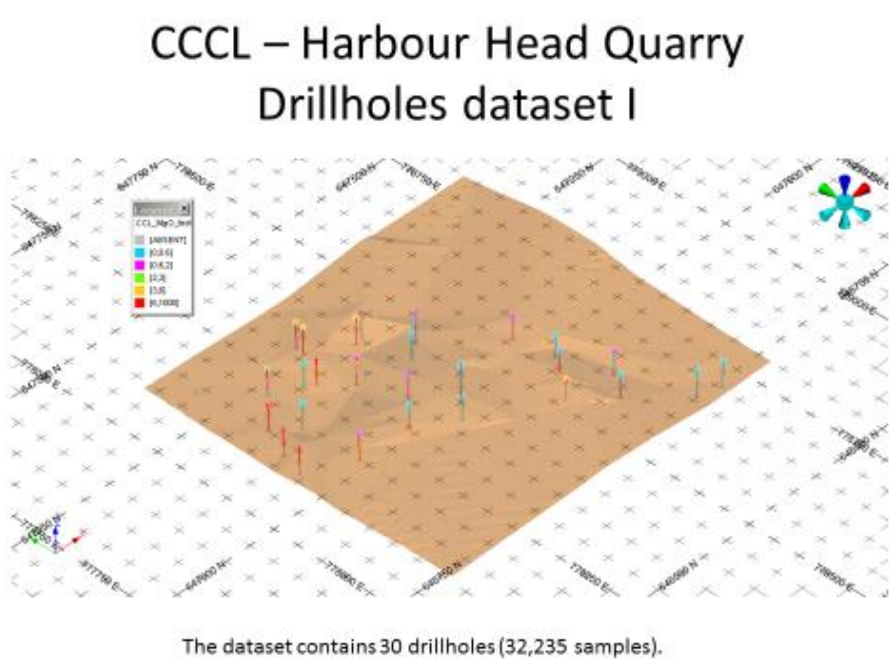


Figure 4.1.2: Harbour Head Quarry Drillholes Dataset i

4.1.3 Site Description

Figure 4.1.3: Google Image of site location for Proposed Harbour Head Limestone Quarry (Google Image 2015)

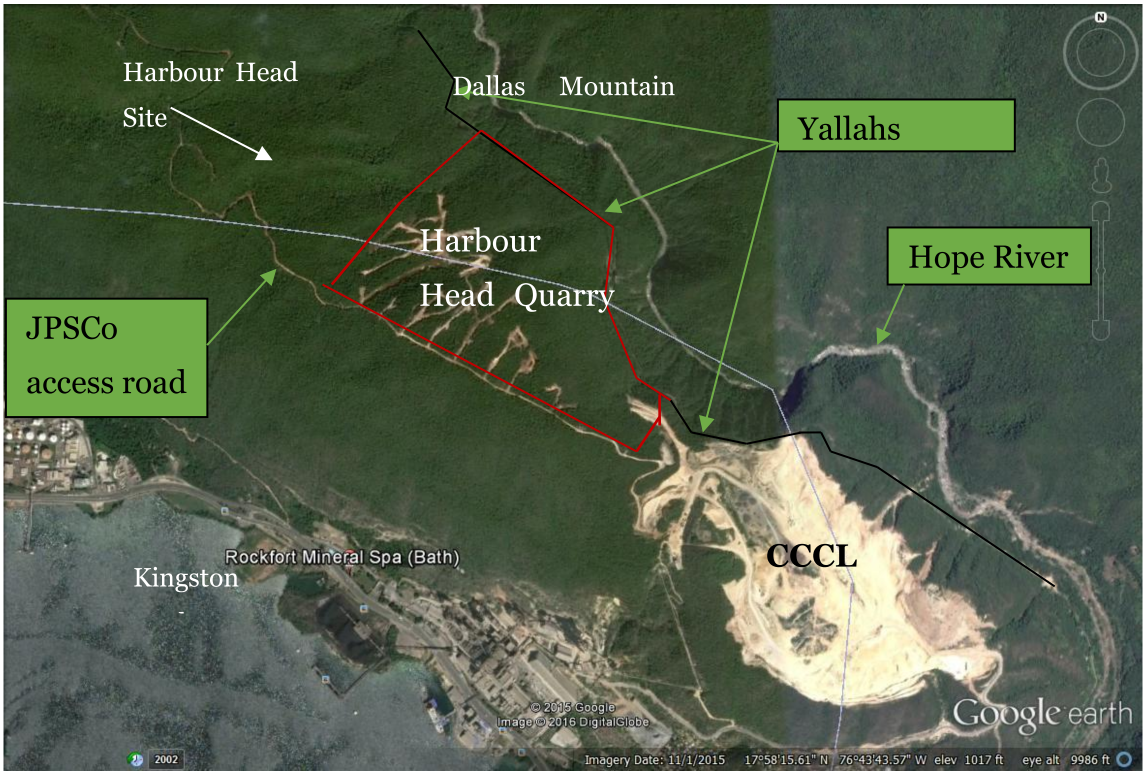


Figure 4.1.4: JPSCo Access road into project site, Yallahs pipeline and newly excavated tracks for exploration drilling. (Google Image 2015)

There are two large dry gullies which pass through the project site; the most northerly cuts on the north-western boundary and drains easterly into the Hope River, while the larger gully drains in a similar direction, but widens considerably into a deep valley in the direction of the Hope River (Figure 4.1.5). Perennial streams or rivers are not a feature of the site, as the surface rock does not support surface flow, but transmits storm water to the subsurface in the form of underground drainage.

The vegetation can be described as dry limestone forest consisting of dense shrubs and small trees (Plate 1.1). Access to the site can be gained through the CCCL plant and the existing limestone quarry. The JPSCo feeder road for its electrical transmission power line provides the main access into the project site (Plate 4.1.2 & Figure 4.1.2).

The new (expansion) of the Harbour Head quarry, as is the case for the existing quarry; is designed so that it will not be visible for surrounding areas such as the Rockfort main road. It will only be visible from an aerial view. The site is 1.5 km from the Rockfort community and 1.72 km from the Harbour View community in eastern Kingston.

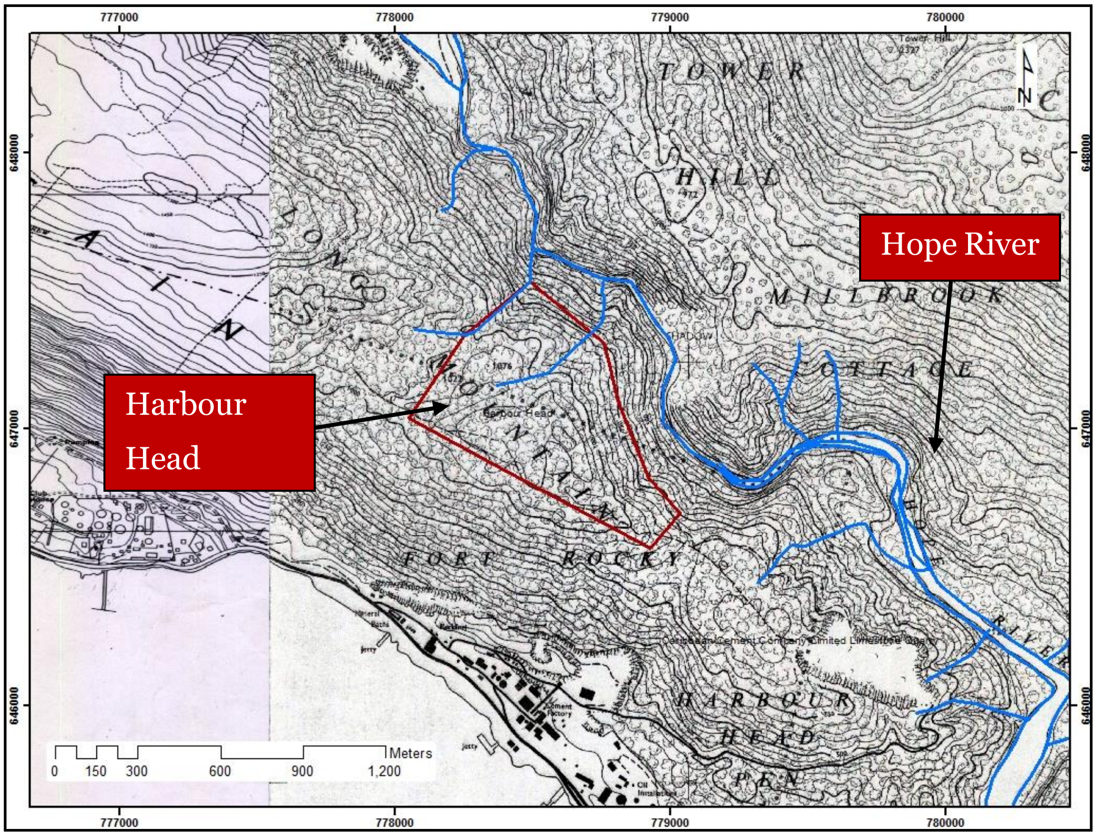


Figure 4.1.5: Topographic map (Scale 1:12500) showing drainage features and Hope River located north east of the site

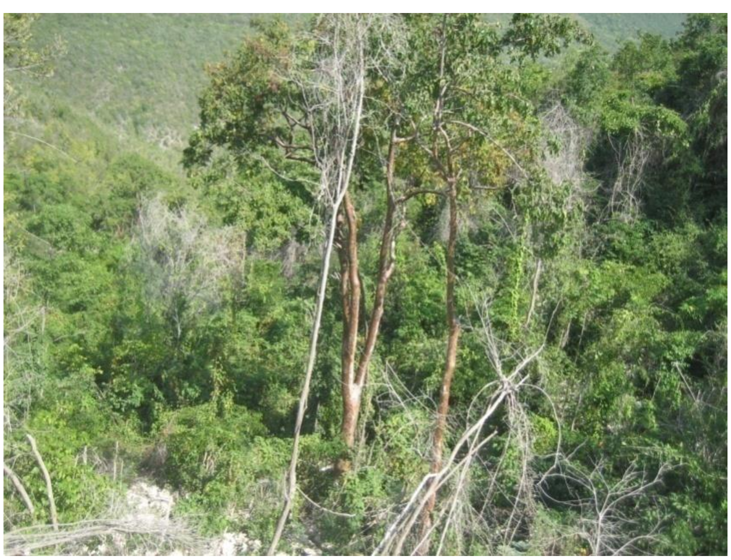


Plate 4.1.1: Thick vegetation typical of dry limestone forest

Plate 4.1.1: Access road for JPSCo Electrical Transmission Tower lines used to access

4.1.4 Phases of the Project

4.1.4.1 Pre- Operation Phase

The development of the CCCL Harbour Head quarry is planned in three phases: Pre-operation phase; Operation phase and Rehabilitation phase. The pre-operation phase provides information on the site including the physical and chemical characteristics of the geological material to assist with the development of the quarry and design of the mining plan. This will include construction of access roads, subsurface exploration work (drilling and sampling) and physical and chemical analysis.

Drilling and Sampling

Preliminary exploration drilling and sampling was conducted at the Harbour Head Project site to gather information in order to ensure that the material meets the required specification for the cement plant.

Exploration was carried out across a large section of the delineated area to provide a holistic representative set of results. A total of 30 exploratory boreholes were drilled to a depth ranging from 45m (150ft) to 52.5 (175ft) with samples collected at 1.5m (5ft) intervals. Geological log profiles were then created for each hole using the samples recovered. Following this, the samples were then chemically analyzed by CCCL's lab. Drill hole site layout plan is shown in Figure 4.1.6

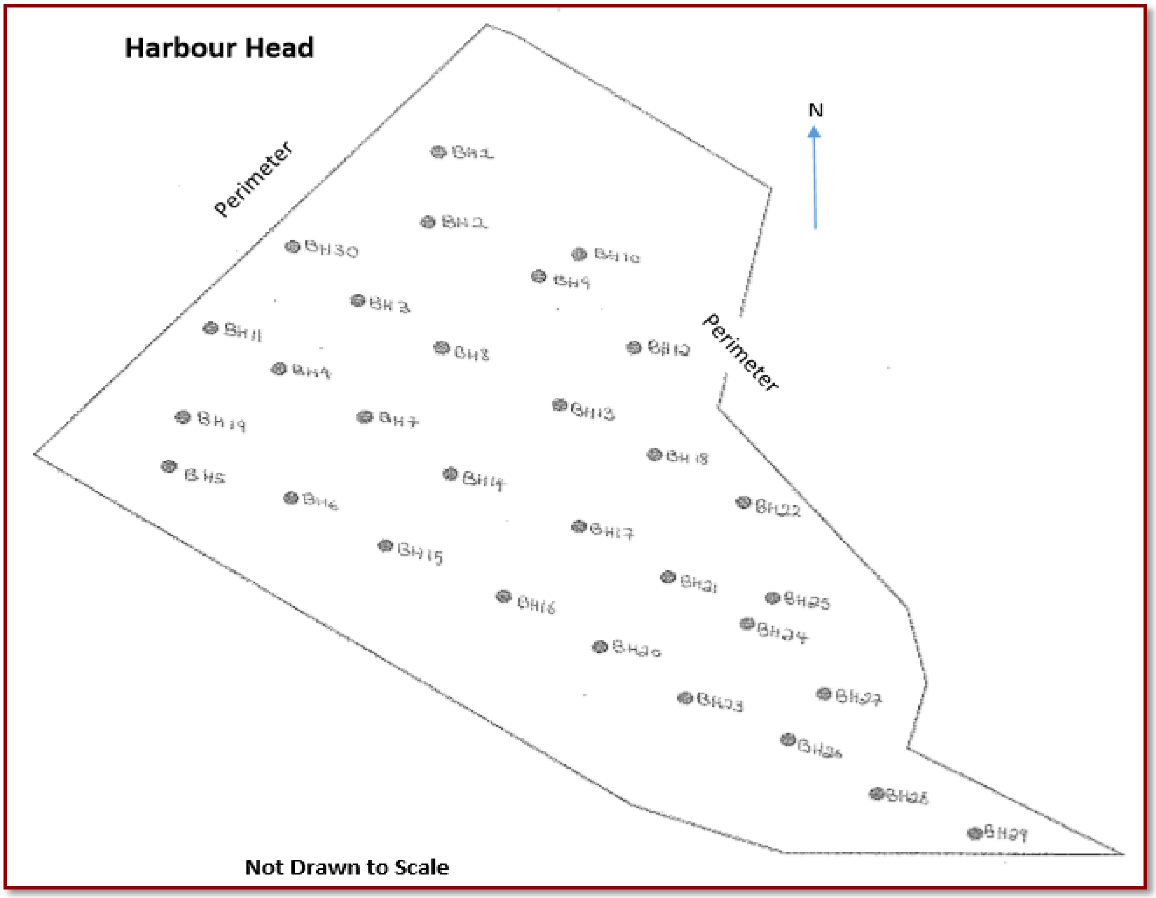


Figure 4.1.6: Exploratory borehole site layout plan for Halberstadt Quarry site

Physical Analysis

The core samples retrieved and logged fall within several categories used to classify limestones.

A majority of the samples display biomicrite properties (see Table 4.1.1). This means that the samples are made up of a mostly mud (micrite) matrix with fossils preserved within. Fossils comprise of corals, bivalves and molluscs mostly. Recrystallization is also very common in the samples. Other core samples show properties of being Packstones, Grainstone as well as Rudstones. Notable is the fact that the nature of the rock samples changes with increasing depth. Samples transition for example, from being a micrite to become a calcarenite (Wackestone) with increasing depth or vice versa. The way in which they change is not limited to either micrites or calcarenites but include several other classifications pulled from Dunham's Scheme.

Chemical Analysis

Focus is placed on the MgO content and Limestone Saturation factor (LSF) for each core drilled due to the significant effect both have on the end products after consumption. The MgO content should be kept low because an excess can cause delayed expansion. Thus, this oxide should not exceed 5% by mass in both clinker and cement. As such the standardized MgO content for company usage is 1.5. Sixty-five percent (65%) of the samples analyzed fall within the "High Magnesium" zone with averages ranging between 2.1% and 11%. The LSF is a ratio of CaO and weighted sum of alumina, silica and ferric oxide. The LSF plays a vital role for cement production because it contains CaO, the primary constituent of cement.

It has been found (Ingram and Daugherty, 1991) that kiln operation and cement quality is improved where the CaO in limestone is more than 44%. The standardized LSF average for the company's usage is 450. The average LSF values are very high for the most part throughout the samples; with a minimum of 72.94 and a maximum of over 137,000 (see Table 1.1 below). Appendix 1 contains detailed chemistry results for each core.

Table 4.1.1: Average Limestone Saturation Factor (LSF) and MgO for each core

HOLE	DEPTH(FT)	DEPTH (M)	MgO	LSF
1	175	53.35	1.17	2,218.00
2	175	53.35	11.34	1,205.00
3	175	53.35	6.44	6,661.00
4	175	53.35	0.33	6,366.00
5	175	53.35	7.12	78,765.00
6	175	53.35	7.35	10,533.60
7	175	53.35	3.17	(15,159.00)
8	175	53.35	3.58	959.70
9	175	53.35	9.44	18,379.00
10	175	53.35	8.33	1,687.29
11	175	53.35	0.4	72.94
12	175	53.35	11.9	942.85
13	175	53.35	0.54	1,579.01
14	175	53.35	0.38	79,937.70
15	175	53.35	53.2	39,719.02
16	150	45.73	2.6	107,138.00
17	150	45.73	0.35	98,625.93
18	150	45.73	0.39	(2,123.70)
19	175	53.35	4.35	108,468.00
20	150	45.73	0.59	137,940.00
21	150	45.73	5	40,651.00
22	150	45.73	2.7	1,366.00
23	115	35.06	6.7	29,662.00
24	150	45.73	4.45	1,694.46
25	150	45.73	0.4	1,569.00
26	150	45.73	2.1	1,551.00
27	150	45.73	0.5	2,173.00
28	175	53.35	0.48	2,963.00
29	175	53.35	0.41	4,187.00
30	175	53.35	1.68	54,261.00

4.1.4.2 Operation Phase

Mining Life Cycle

The life of the Harbour Head limestone deposits will depend on the rate at which material is extracted. The rate of extraction of the reserves will be a direct result of the following:

- The demand for the limestone based on 2016 production budget (Table 4.1.2) and on the 5-year production budget (Table 4.1.3).
- The ability of the established and current Quarry to meet the demands and estimated targets.

- The blending systems implemented to optimize reserves.
- Whims of the weather. Mining is planned throughout the year, although it is expected that mining will be reduced in the peak of the rainy season.

The quality of the Limestone in the Harbour Head area is not homogenous. The chemistry of the limestone acts as a direct influence on the quality of the material mined. Thus, blending is necessary to achieve optimum quality standards before materials are entered into production. The mining sequence will therefore be determined firstly by the quality requirements, then by quantity requirements and the required stipulations for mining best practices.

Mining is projected over a 5-yr period, from 2016 -2020, with yearly extraction figures ranging from 970,000.60 Tonnes to 1,091,780.46 Tonnes and total extraction of 5,150,030.68 Tonnes (Table 4.1.3). Harbour Head will account for approximately 80% of the material mined from both quarries.

Table 4.1.2: Limestone Production Budget for Year 2016

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
107,638	97,571	31,004	106,705	111,997	109,444	111,977	110,319	97,476	110,296	108,197	109,917	1,212,542

Table 4.1.3: Five Year Projection for Limestone Production.

YEAR	2016	2017	2018	2019	2020	TOTAL
BUDGET(TONNES)	970,033.60	999,133.78	1,029,107.80	1,059,981.03	1,091,780.46	5,150,036.68

Pit Design

A system of open pit mining will be applied for the extraction of limestone from the Harbour Head Area. This is best suited as the ratio of overburden to reserves is low and mining will therefore, be economical. This process involves the systematic creation of benches usually with a 3m- 9m (10ft-30ft) difference in height. Less than vertical faces are established to minimize the possibility of rockfalls and to allow for the mitigation of damage to equipment or injury to workmen that may occur due to structural weaknesses of the rock being mined. Benching patterns will therefore be dynamic to satisfy the quantity of the material required by the main plant as well as to satisfy mining best practices.

Extraction Method

All slopes and bench faces are expected to reflect a vertical or near vertical angle. Blasting will be the preferred and primary method of extraction. Where ripping is employed, slope angles will be maintained as same to ensure consistency in bench design.

Haul Roads

Roads are to be a minimum 10m wide with maximum slope of 1:7. The minimum width of the road is required to be at least three times the width of the widest vehicle (4m) accessing the quarry. These include: a water truck, haulage trucks, service pickup trucks and other heavy equipment. Over the life of the mine, the quarry profile will be dynamic and so the roads will have to be redesigned to meet the requirements of best mining practices. All efforts to maintain visibility in the quarry will be taken such that bends are made horizontal or super-elevated.

Quarry Development

The development of the quarry will be controlled by CCCL's Mining Engineer who issues work instructions to Contractors. Control will be maintained by daily site inspections and weekly visits by the Quarry Management team. All overburden will be removed by a bulldozer and maintained in stockpiles for rehabilitation purposes at the end of the Mine Life Cycle.

The quarry will utilize the following Contracted equipment;

1. One (1) bulldozer
2. Two (2) loaders

3. One (1) excavator
4. 25tons road trucks to transport material from the quarry to the Crusher for production.

Material will be ripped using a D9 CAT bulldozer from benches and pushed to the floor into piles. The materials will be stockpiled and then transported by haul trucks to the crusher where it will be stockpiled and further blended before consumption. The quality assurance will be done by grab samples taken from ripped material, which will be crushed and then tested by CCCL's lab. Benches will be created as the mining activities progress. Benches are required to be no more than 9m (30ft) in height. The width of any given bench will be twice its height as is stipulated by mining best practices. A typical bench plan is illustrated in Figure 4.6 Loading and hauling of the finished product is done using a 980C CAT front-end loader and a 345 excavator. Both will be used to load haul trucks (capacity 25 tons) for transport to the Crusher.

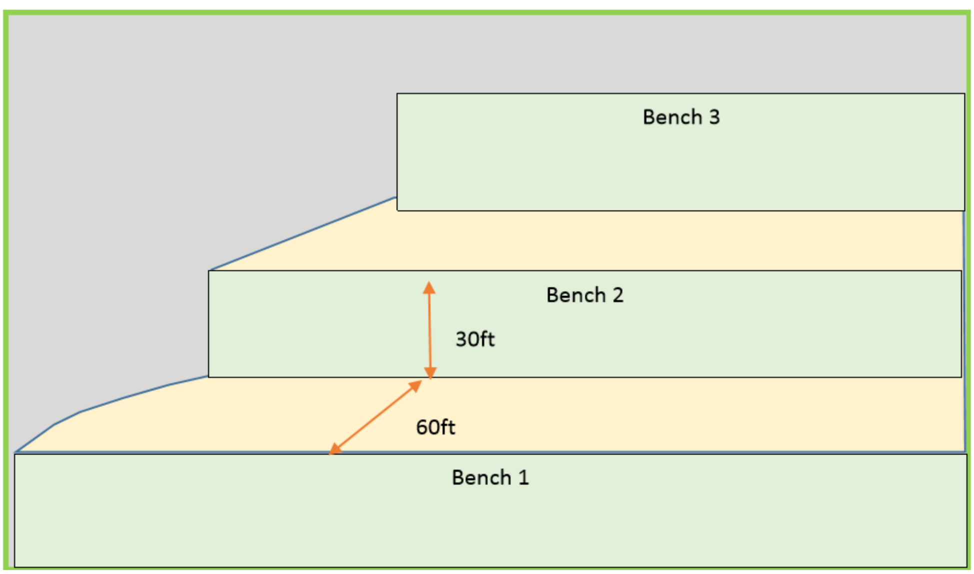


Figure 4.1.7: Typical (Idealized) benching plan where the width is at least twice the value of the height of the bench.

As shown in figure 4.1.7, as part of its preliminary design, CCCL proposes to align benches roughly in a northerly direction maintaining a 15m-22.5m (50-75 feet) buffer-zone between the high-tension utility poles and the water main located in close proximity to the area. The starting point for active mining will be to the south of the area, as indicated in figure 4.1.8

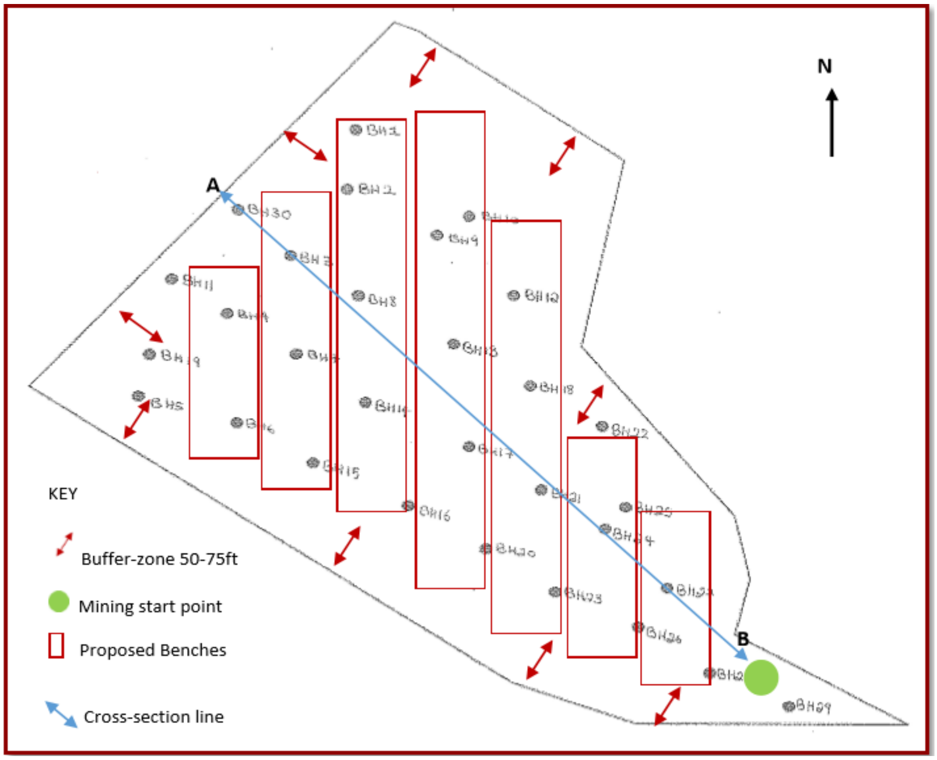


Figure 4.1.8: Planned orientation of benches. Diagram not drawn to scale.

The benches will regress in a westerly direction creating a stepped profile. Figure 4.1.8 illustrates the cross-sectional profile expected as mining progresses. Mining will span the entire area, leaving buffer-zones intact, as all materials will be utilized via blending to meet our quantity and quality requirements.

As indicated in Figure 4.1.8, the diagram is not drawn to scale and so a more accurate representation of the quarry plan will be provided in the detailed quarry plan.

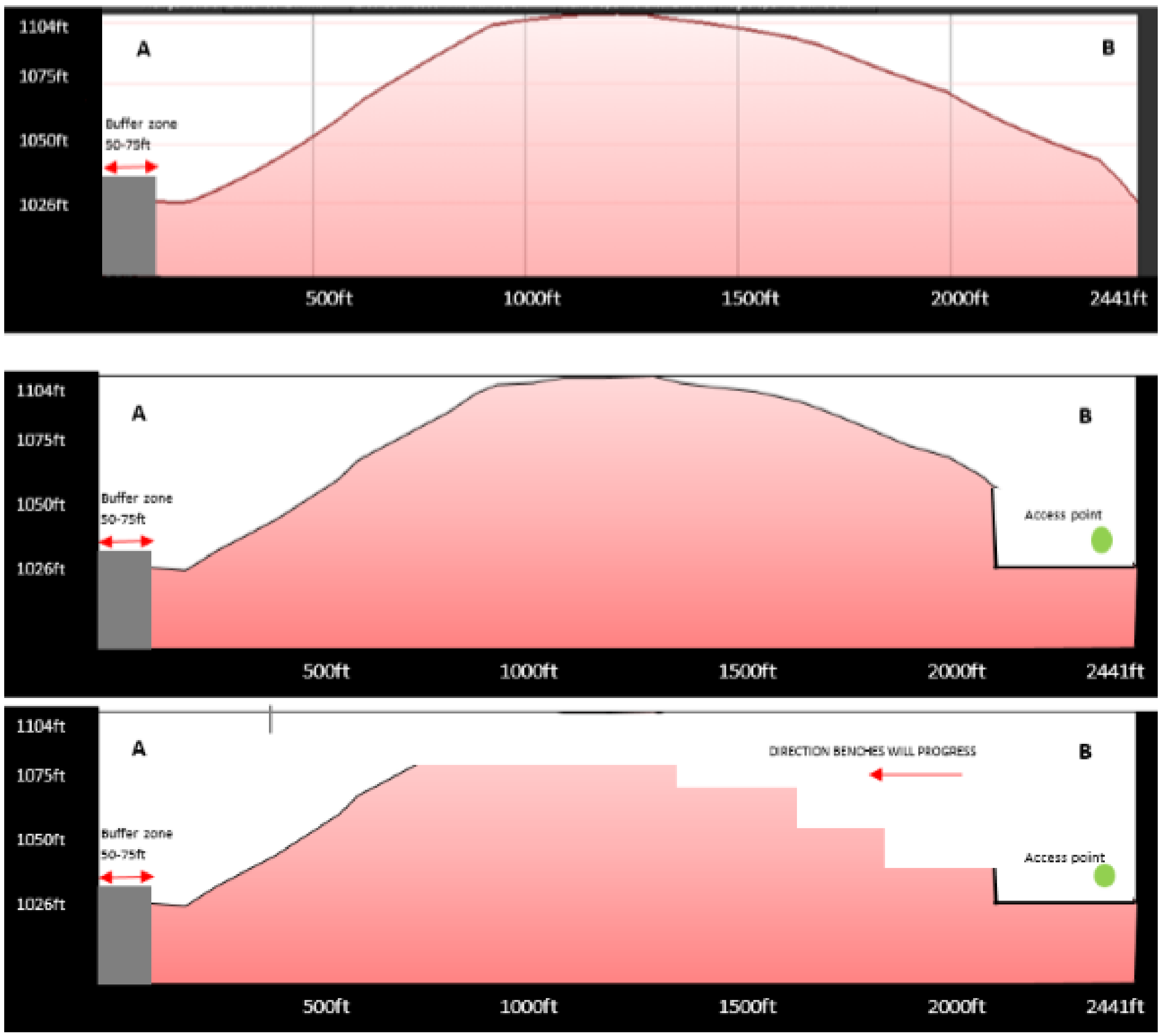


Figure 4.1.9: Cross-sectional bench profile of Harbour Head as mining progresses.

4.1.5 Rehabilitation Plan

4.1.5.1 Rehabilitation of Existing CCCL Quarry (QL 1253)

CCCL Quarry as part of the Rehabilitation Process

As part of its plans for the continued extraction of limestone to supply the cement plant, CCCL proposes to mine 80 percent of the limestone from the New Harbour Head quarry and 20 percent from the existing CCCL quarry (QL 1253). The existing limestone quarry will be in operation simultaneously with the new Harbour Head quarry. It therefore implies that additional areas will be opened up once a new quarry licence is granted to CCCL for the operation of the Harbour Head quarry. Additionally, the CCCL quarry is contiguous with the Harbour Head quarry site which means that there will be continuous stripping of land for mining purposes if rehabilitation of the CCCL quarry does not move in tandem with the opening up of the Harbour Head quarry.

The spatial distribution of magnesium in the limestone and the variations in the chemistry of the quarry material poses a challenge for CCCL, as quarrying of the existing quarry will need to be maintained to allow for blending of high quality vs. low quality limestone in both quarries to supply the cement plant. In order to achieve the objectives of satisfying the legislative requirements and maintaining good quarry practices, a rehabilitation plan/strategy for the existing CCCL quarry should be integrated with the overall quarry plan for the site.

Plate 4.1.2: Existing CCCL limestone quarry (QL 1253)

Plate 4.1.3: Quarry activity at the existing CCCL quarry (QL 1253)

Rehabilitation of Dump Site and Mined out Areas

Rehabilitation of CCCL quarry site (QL 1253) should be seen as an important requirement as part of the overall rehabilitation plan and be combined with the operation and rehabilitation of the Harbour Head quarry. The dump site /solid waste disposal site located on the south-eastern end of the quarry is one of the first areas which should be earmarked for rehabilitation (Plate 4.1.10). The dump should be shaped, capped and graded in accordance with best practices and restored to an acceptable standard.

The other area where rehabilitation could commence is in the mined-out area on to the west-central section of the quarry that is partially covered by secondary re-vegetation. This s to be reclaimed be grading in accordance with best international practices and restored over time to an environmentally acceptable standard.

For the purpose of restoration to a natural habitat, Calliandra species has been found to have the highest growth rate and is very resilient in dry limestone forest conditions based on experiments conducted by Forestry Department of the Ministry of Agriculture in partnership with the Jamaica Bauxite companies for the restoration of mined–out bauxite lands.

Figure 4.1.10: Google image of CCCL quarry (QL 1253) showing location of dump site

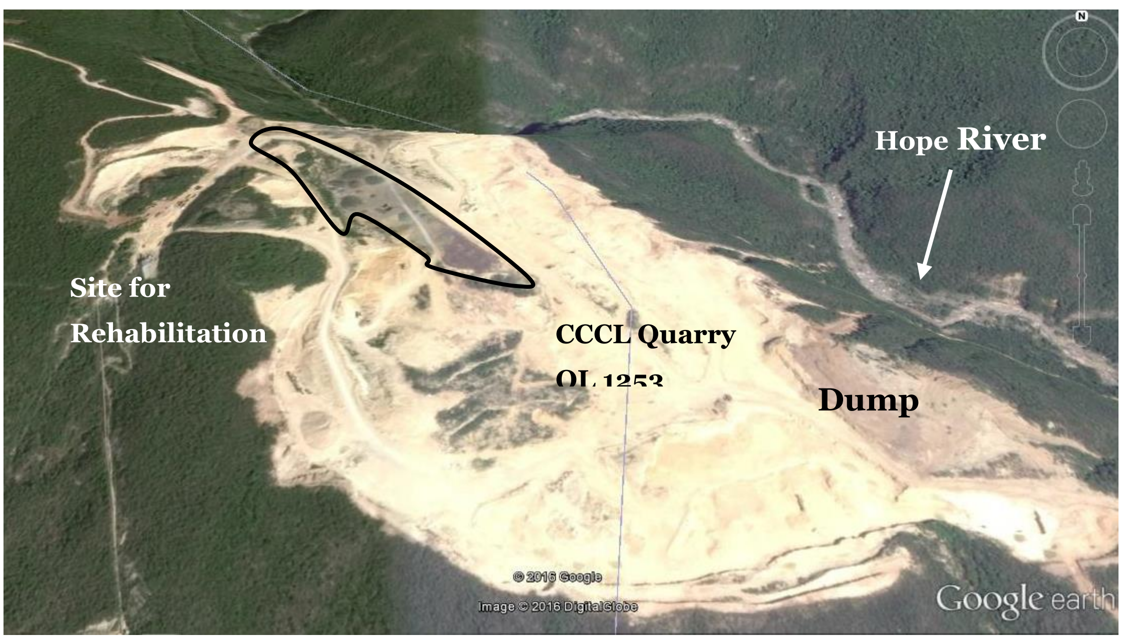


Figure 4.1.11: Google Image showing additional site in CCCL quarry for rehabilitation

<u>Rehabilitation of New Harbour Head Quarry</u>

Public health, Safety and environmental protection are important considerations in the closure of mines. As such, the objectives of this closure plan are as follows:

- Return quarried areas to an environmentally acceptable state
- Ensure that the Quarry site is returned to its original state or as close as possible.
- Ensure that the site does not pose any form of threat to its immediate and surrounding environment after closure.
- Operation Plan meets the rehabilitation objectives of the quarry.
- Ensure that the legislative objectives are met.

The restoration and closure activities at the end of mining will therefore include:

- Progressive restoration during mining. That is, to restore mined out areas which will be divided into production blocks. As one production block is mined out, restoration of that block will be initiated concurrently with the commencement of mining the adjoining block. This is to be done, as far as the nature of the deposit will allow.
- Disposal of wastes from the site in the recommended manner
- Removal of all features that may pose a safety hazard such as loose materials and unstable rocks.
- Artificial drainages will be constructed to channel excess runoff in the mines to the natural waterway.
- Utilization of all stockpiled overburden (soil, subsoil and organic matter) on mined out benches to form the base on which vegetation will be planted.
- Implementation of a landscaping programme which ultimately will lead to the preparation of the land for future use such as for agriculture and/or recreation etc.

4.1.5.2 Rehabilitation Stages

In order to execute a productive and effective rehabilitation, a simplified and systematic approach must be taken. CCCL has the taken initiative to group action plan into Four (4) stages.

Stage (I) -stage before and during initial stages of mining

Stage (II) - stage during and near end of mine

Stage (III) - stage at end of mine for quarry in question

Stage (IV) - stage of total rehabilitation for entire area

Stage 1

This stage will allow the mine plan to incorporate reclamation and rehabilitation in its plans, which will make the execution of rehabilitation easier and more cost effective. At this stage, a specific schedule is not necessary but activities should be incorporated in daily activities. Overburden piles or waste materials (tailings) should be tactfully stored where it can be accessed and not covered by regolith. Top soil can be successfully removed and stored for reapplication at the end of the mine as this will save the company the expensive costs of creating and maturing the soil so it can foster diverse flora and fauna. Water management treatment must also be considered at this stage, alternative artificial drainage should be created or planned to reduce the effect of water affecting the operations and also to present minimal damage to the environmental systems.

Stage 2

This stage is also a cost-effective stage, rather than saving the work for last which will garner massive overhead charges, the cost will be offset by everyday operations. Areas already mined will be backfilled and graded in a systematic way. This will allow pioneering or introduced species of vegetation to colonize and contribute to the development and stabilization of the soil in areas already worked. If the site has major cliff barricades and fences will be installed for human and animal safety. All overburden and waste piles will be totally utilized. If possible, natural drainage systems could be restored otherwise artificially engineered aesthetically pleasing alternatives are to be implemented. All buildings, equipment and infrastructure must be taken into consideration, whether they should be demolished, sold or transformed to other productive uses. This also provides the perfect opportunity to cover any landfills and waste disposal sites.

Stage 3

Here the final stages of backfilling and grading should take place. Permanent Vegetation (trees) will be planted and aesthetically pleasing landscaping can begin. Permanent fencing and barriers are to be installed in areas in which they are needed. The Completed

Environmental Impact Assessment will dictate to some extent the type of vegetation best suited to the area.

Stage 4

This stage is where the final rehabilitation is executed on the entire area. For example, if the area is to be separated into plots for sale or creation of a large-scale farm, or the development of a recreational park. This stage can only be completed when all mining operations cease.

4.1.5.3 Rehabilitation Actions

Several modes of actions will be employed to effectively rehabilitate the quarry. These will include but are not limited to:

1. Systematic grading and levelling of areas that needs to be rehabilitated. For example, if there is a steep cliff, a ramp should be created so instead of a geometric pit a more natural depression is created.
2. Restoration blasting could be employed to get fill material in areas where bench cliffs are too steep, and this will also eliminate the hazards associated with steep cliffs for example rock fall and topples.

Figure 4.1.12 illustrates the basic result if either of the above actions were used.

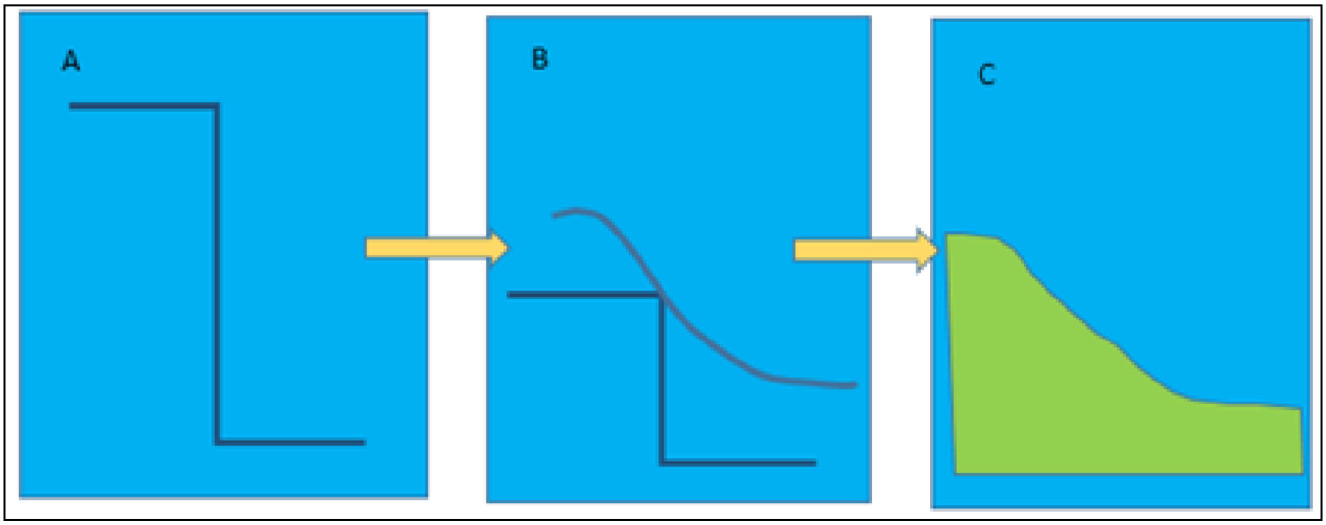


Figure 4.1.12: A-C: a too steep cliff made into a gentle grade using either grading or restoration blasting.

3. Biological engineering will also be employed. This will include the use of the vetiveria zizanioides (Jamaican Cush Cush or Maat grass) among other native vegetation to stabilize the soils and eliminate visual intrusion. The roots of this plant can extend to in excess of three (3) meters (five feet), (Plate 2) Mean tensile strength of the roots of the vetiver roots can be as much as 75 Mpa which is the equivalent strength as 1/6 to that of mild steel employed in the construction industry, (Adams 1972).

Plate 4.1.4: Roots of the Vetiver Grass.

Progressive rehabilitation has already started in the existing Quarry where mined out sections to the North West (property boundary) has been rehabilitated. Top soil from the existing dump was used in the area followed by the planting of trees. This approach will be maintained for all other areas when mining has been completed. Sufficient stockpile of topsoil is maintained at the limestone Quarry for the purpose of this progressive restoration.

4.1.6 Drainage Assessment

4.1.6.1 Description of Pre-Development Conditions

The pre-development conditions were assessed by visiting the site and reviewing (i) Google Earth images, (ii) the 1: 12,500 topographic maps and (iii) other available contoured data of the area. The terrain is undulating with a steep escarpment towards the Hope River to the north. There are no well-defined water channels on the site or the face of the escarpment so that runoff, for the most part, sheet flow down to the Hope River. Notwithstanding, there are a few rills in the topographic relief that will allow for some amount of concentrated flow to occur.

Haul road cuts reveal a white chalky and sometimes friable limestone. This, in addition to loosen material that will be created from the mining activities, will cause material to be easily eroded and transported downslope towards the Hope River during rainfall events.

The land cover shows a thick dense canopy of trees and native vegetation reducing surface runoff to the Hope River. Photographs showing existing site conditions are shown in Figure 4.1.5 – 4.1.9 below.

Plate 4.1.5: Existing conditions at Harbour Head

Plate 4.1.6: Existing conditions at Harbour Head

Plate 4.1.7: Existing conditions at Harbour Head

Plate 4.1.8: Existing conditions at Harbour Head

Plate 4.1.9:

4.1.6.2 Description of Site Conditions during Mining

The Mining Plan indicate that the mined area will be progressively restored as the mining move from one phase to the next. The restoration will involve covering the mined areas with previously removed topsoil and the replanting of trees.

This hydrological assessment is however concerned with the state of the mined area during mining activities. The site condition during mining operations will see the removal of the land cover and topsoil as well as compaction and hardening of the surface by the operation of heavy equipment. Slope changes will also occur due to benching. This condition will lead to increased surface runoff, erosion and sediment transport directly related to the mining activities.

4.1.6.3 Catchment Area Delineation

The catchment areas were delineated manually using the 1:12,500 topographic map and other detailed contour maps of the area. Flow paths were also delineated manually to show the main waterways where concentrated flows are likely to flow. The site was divided into 4 sub-catchments corresponding to the 4 main waterways delineated. A fifth catchment (Basin D2) was also delineated to complete the catchment area for waterway draining Basin D1. The delineated catchment areas are shown in Figure 4.1.13

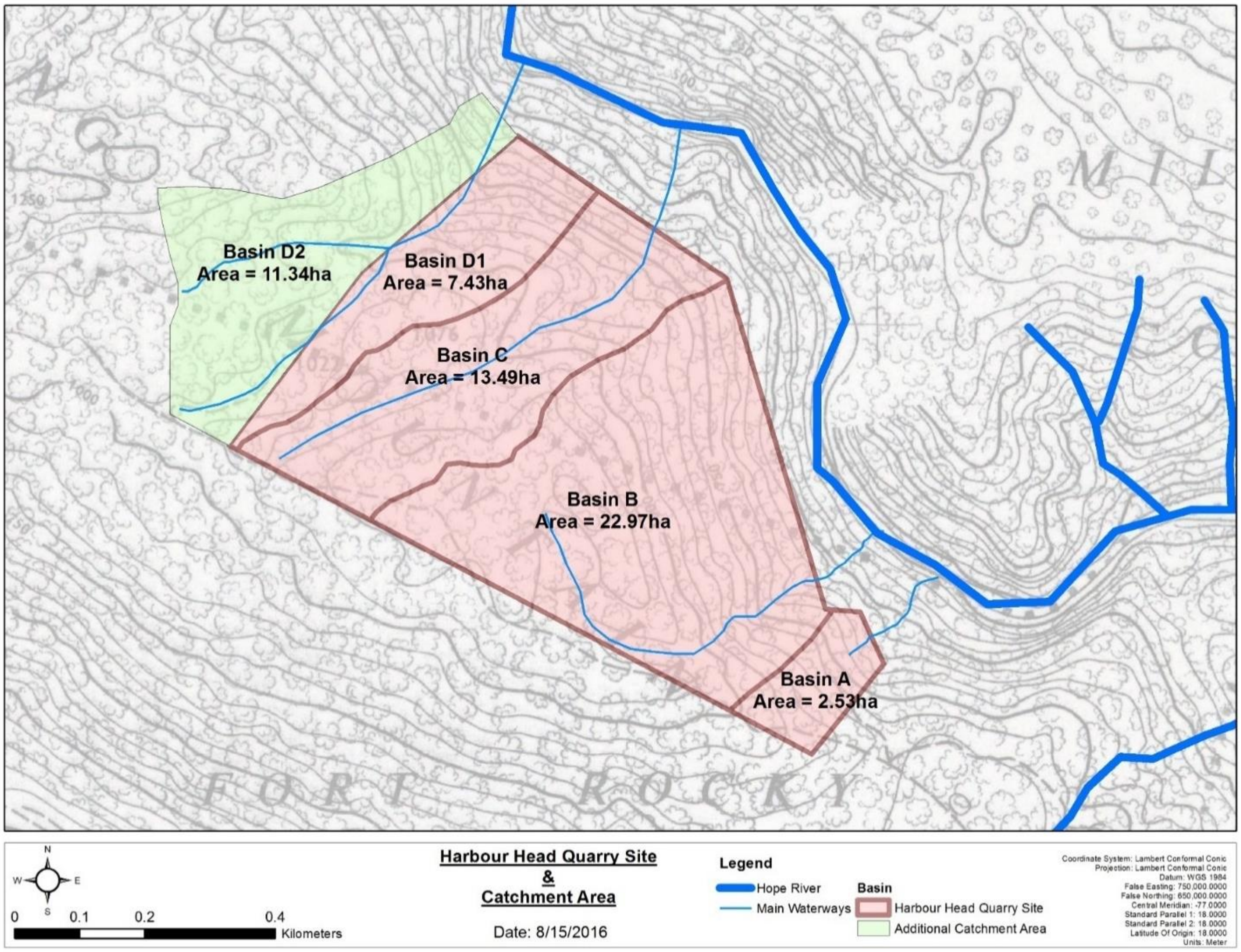


Figure 4.1.13: Harbour Head delineated catchment areas

4.1.6.4 Runoff Calculations

Based on the size of the catchment areas for the Project site which range from 2.53 to 22.97 hectares, the Rational Method was used to estimate the storm runoffs. The Norman Manley International Airport (NMIA) intensity duration frequency (IDF) curve (Appendix A) was used in the calculations.

The formula for the Rational Method is as follows:

$Q = 0.0028CiA$

Where:

Q = peak storm water runoff (m3/s)

C = runoff coefficient

i = rainfall intensity (mm/hr)

A = drainage area (ha)

The Velocity Method was used to estimate the time of concentration used in the Rational Method. The Velocity was estimated based on the TR-55 velocity versus slope for shallow concentrated flow diagram (Appendix B) and that runoff is conveyed above ground in the natural waterways. It was assumed that the watershed slopes would be reduced by approximately 30% during mining operations due to excavation and benching.

The rainfall intensity (i) is determined by the time of concentration which is the time it takes for runoff to travel from the farthest point of the catchment to the outlet. A minimum time of concentration of 10 minutes was used in keeping with the NWA design guidelines which states that for time of concentration of less than 10 minutes, a time of concentration of 10 minutes shall be used.

Values for the runoff coefficient are presented in Appendix C.

The 10-year design storm was used in in the analysis. The computed peak discharges are presented in Table 4.1.4 below.

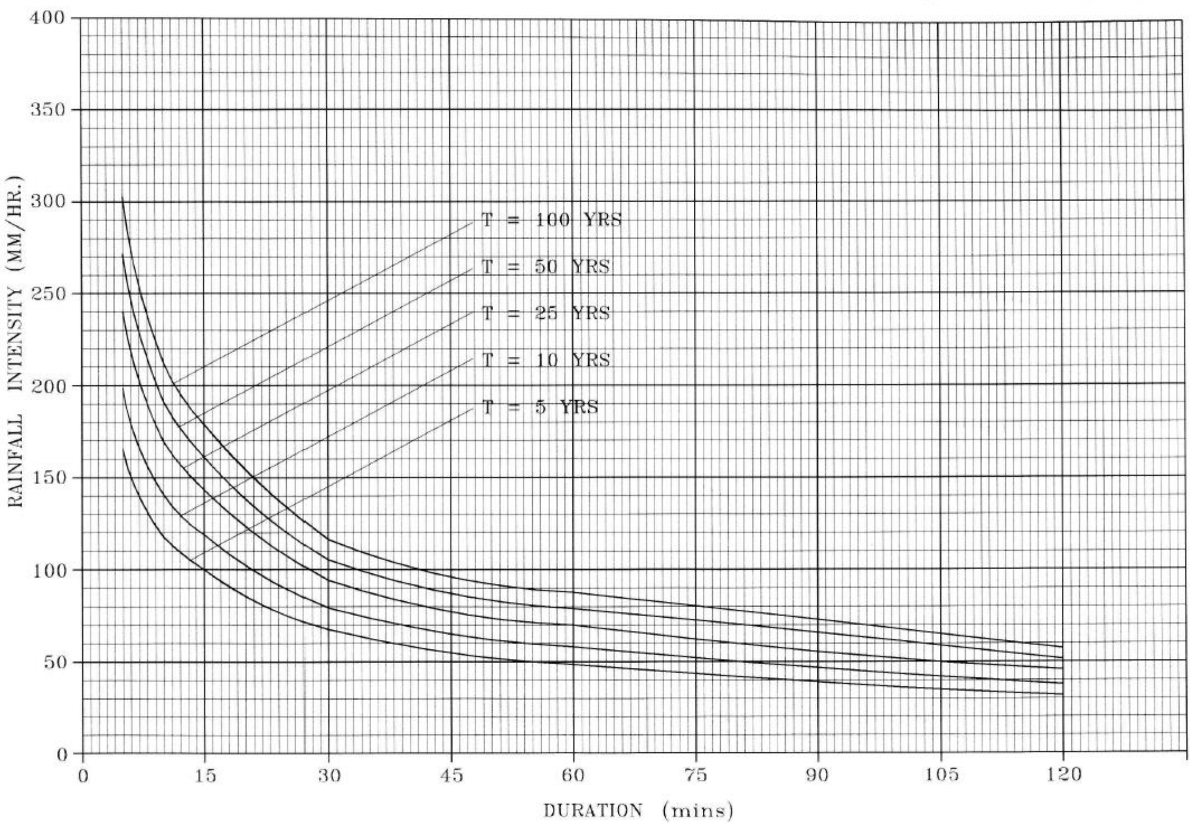
Table 4.1.4: Harbour Head computed peak discharges

Catchment Area	Area	Watershed Slope	Runoff Coeff.	Runoff Coeff Surface Type Description	Shallow Concentrated Flow Velocity	Water Course Length	Time of Conc	Intensity	Design Discharge *
	(ha)	(m/m)		Table 2, HEC 12	(m/s)	(m)	(mins)	(mm/hr)	(cms)
Pre-Development 10 Year Storm									
Basin A	2.53	0.75648	0.20	Woods	0.667	223	5.6	140	0.20
Basin B	22.97	0.37465	0.15	Woods	0.469	578	20.5	100	0.96
Basin C	13.49	0.27494	0.15	Woods	0.402	695	28.8	80	0.45
Basin D1	7.43	0.32528	0.15	Woods	0.437	668	25.5	88	0.27
Basin D1 & D2	18.77	0.32528	0.15	Woods	0.437	668	25.5	88	0.69
Mining Conditions 10 Year Storm									
Basin A	2.53	0.52953	0.60	Cut, Fill Slopes	0.558	223	6.7	140	0.60
Basin B	22.97	0.26226	0.50	Cut, Fill Slopes	0.393	578	24.5	90	2.89
Basin C	13.49	0.19246	0.50	Cut, Fill Slopes	0.336	695	34.5	75	1.42
Basin D1	7.43	0.22770	0.50	Cut, Fill Slopes	0.366	668	30.4	80	0.83
Basin D1 & D2	18.77	0.22770	0.50	Cut, Fill Slopes	0.366	668	30.4	80	2.10

Conclusions and Recommendations

Based on the computed peak flows, surface runoff is likely to increase by approximately 200% during mining operations. Erosion and the transportation of sediment toward the Hope River will also increase. Settling basins are not practical because of the generally steep slope toward the Hope River. The use of check dams and solutions at the toe of the slope such as silt fencing are recommended. Energy dissipation measures should be included in the check dam design to reduce scour and erosion of the hillside.

FIG. 1 NORMAN MANLEY INTERNATIONAL AIRPORT, KINGSTON , JAMAICA
RAINFALL INTENSITY – DURATION – FREQUENCY CURVES (tc = 5 – 120mins)



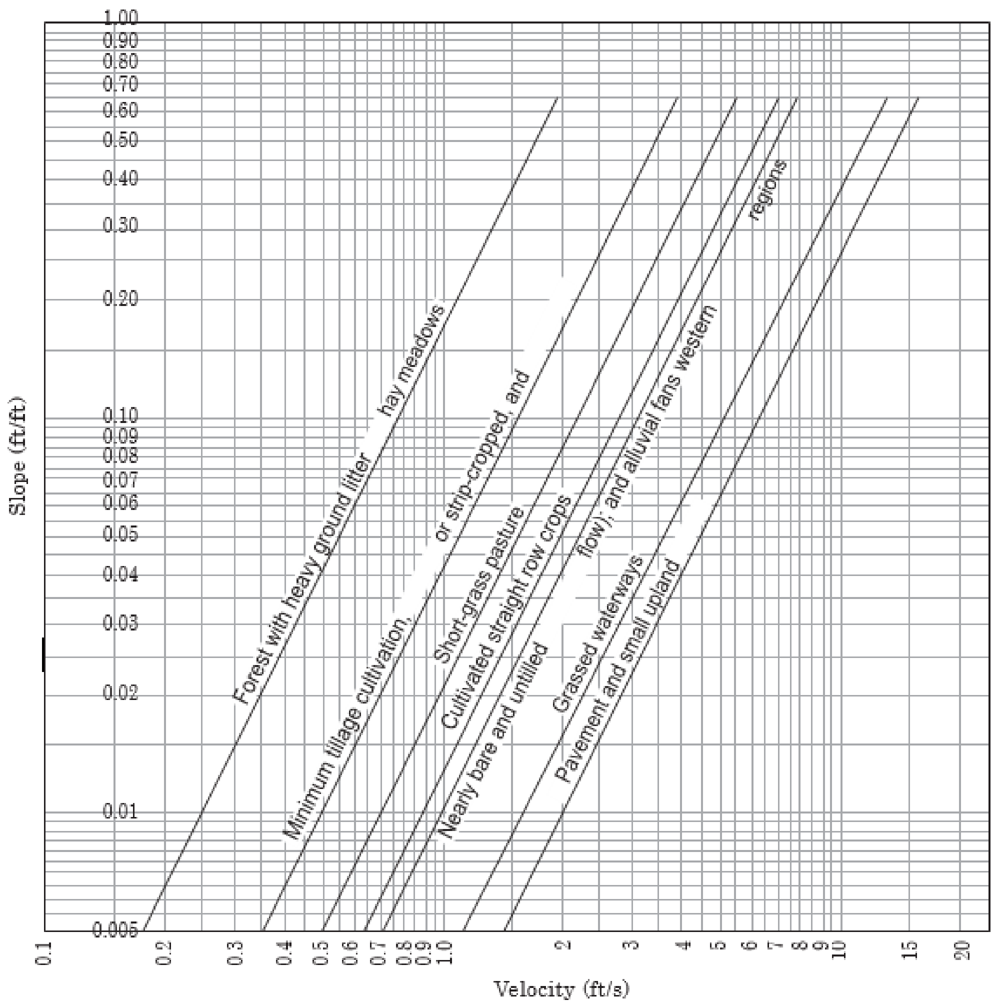


Table 15–3 Equations and assumptions developed from figure 15–4

Flow type	Depth (ft)	Manning's n	Velocity equation (ft/s)
Pavement and small upland gullies	0.2	0.025	$V = 20.328(s)^{0.5}$
Grassed waterways	0.4	0.050	$V=16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans in western mountain regions	0.2	0.051	$V=9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V=8.762(s)^{0.5}$
Short-grass pasture	0.2	0.073	$V=6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V=5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V=2.516(s)^{0.5}$

15–8 (210–VI–NEH, May 2010)

4.2 Halberstadt

4.2.1 Project Location

The Halberstadt Quarry is located towards the eastern boundary of the parish of St. Andrew, less than 1 km west of the parish of St. Thomas. It is situated approximately 1.5 km north of Salt Spring, St. Andrew and 1.2 km northeast of Bito, St. Andrew on faulted mountains at a height of between 500 metres and 600 metres above sea level overlooking the valley of Bull Park River (Figures 4.2.1). The area consists of a rugged terrain, characterized by steep slopes, high ridges and narrow gullies.

Figure 4.2.1: Location of the Halberstadt Quarry (Source: 1: 50,000 metric Kingston Topographic-Sheet 18)

4.2.2 Background

The total size of the Halberstadt property is approximately 13 hectares, of which 6.7 hectares is covered by deposits of gypsum and anhydrite. An estimated 1 hectare of the 6.7 hectares was approved for mining following the granting of a mining licence by the

Mines and Geology Division (MGD) in 2013. The 1 hectare was mined to a depth where it became challenging a apply proper mining practices as some consequence mining activities were suspended and an application made for a permit for an extension by an additional 1 hectare to the west of the present mining area. The permit for the expansion has recently been approved by the Agency (NEPA).

The Halberstadt Quarry was reopened in October 2013 by Caribbean Cement Company Limited (CCCL), through its subsidiary Jamaica Gypsum and Quarries Limited (JGQ) after being dormant for over 40 years. At that time, it was considered to be the only economical reserve of gypsum remaining which is required to supply the cement plant in the manufacture of Ordinary Portland and Blended Cements. JGQ has sought to determine with respect to Halberstadt:

i) the quantities of gypsum/anhydrite the company has in its possession;
ii) the quality of this material;
iii) What must be done to reduce or mitigate the environmental impacts using best environmental practices.

The company is involved in the mining of gypsum and anhydrite, both of which are shipped to countries such as Colombia, Venezuela, Trinidad and Barbados and is also used locally by Caribbean Cement Company Ltd. in the final stage of cement processing. Gypsum, ($CaSO_4.H_2O$) or hydrous calcium sulphate, is a soft mineral that is primarily used in the manufacturing of building materials such as sheet rock, laths and tiles. It is also used in the paint and paper industry as filler, in cement manufacturing and as a fertilizer in agriculture. Anhydrite ($CaSO_4$) is the anhydrous form of calcium sulphate and is harder and denser. This mineral is an industrial raw material in cement, sulphuric acid and fertilizer.

4.2.3 Current Status of Halberstadt Gypsum Mine

Mining of the 1 hectare of gypsum at Halberstadt, which was approved by the MGD in 2013 has ceased and it is the intention of JGQ to conduct mining of an additional 6.7 hectares that is contiguous with the existing mine (Plate4.2.1). Further extraction of the floor and face of the existing quarry bench is expected to continue following approval of the additional 6.7 hectares. The major infrastructure works are already in place including haul road to the quarry site and a detention pond which collects storm water and sediments from the Halberstadt mining area. As the mine progresses, additional haul roads as well as changes to alignment of existing haul roads close to the mining area may be required.

Thick overburden has to be removed in order to reach the gypsum deposits for mining. During the mining of the 1 hectare, the overburden material was hauled to the disused Bito Quarry where it was disposed of and spread over the area and stored for future use (Plate 5.2.2).

Plate 4.2.2: Section of benched face of 1-hectare Halberstadt mine and adjoining land for mining

Plate 4.2.1: Section of benched face of 1-hectare Halberstadt mine and adjoining land for mining

4.2.4 Reserve Estimates

NHL Engineers Ltd conducted a subsurface geological survey based on drilling of boreholes, to determine the reserve capacity of the gypsum deposits at the Halberstadt quarry. Information from the drill holes indicated the following:

- Clays, sand and gravel to depths ranging from 0-15m
- Clayey shales, Sandstone of variable depth
- Gypsum/anhydrite at depths ranging from 10m-60m

Results of laboratory analysis for the gypsum showed an average percentage gypsum of approximately 50% with a high of 90%. The reserve estimation was obtained by a simplified representative cross-sectional area of the deposit which varies from 5,625m^2 to 3600m^2. The presumptive profile indicates that the effective depth of length of gypsum deposit is about 450m. A conservative volumetric estimate of the deposit is 2,586,500m^3.

The average content of the gypsum is approximately 52% based on laboratory test which therefore gives a volumetric reserve estimate of 1,350,804m^3. In applying the in-situ densities (bulk densities) of gypsum and anhydrite (2.33t/m^3 and 2.9t/m^3 respectively), it gives a reserve estimate of 3,147,373 tonnes of gypsum and 3,586,418 tonnes of anhydrite. This compares favourably with CCCL's internal reserve estimate of 6.3 million tonnes.

4.2.5 Mining Life Cycle

The life of the gypsum/anhydrite deposit in the Halberstadt Quarry will vary depending on the rate at which gypsum and anhydrite are extracted. The rate of extraction of the reserves will be a result of the following:

- The demand for the gypsum and anhydrite
- The ability of the established quarry to meet the demands and estimated targets. This will largely be affected by the availability and reliability of the mobile equipment.
- Whims of the weather. Though mining will take place mainly during the dry season, un-anticipated wet weather will negatively affect production rates.

The mining sequence will therefore be determined by the quantity requirements and the required stipulations for proper benching. Based on the mining sequence, the mine life cycle for the next 5 years, accounts for over 1,000,000 metric tons of local gypsum, as detailed in Tables 4.2.1 and 4.2.2).

Table 4.2.1: The Estimated Recovery tonnage expected across the next 5 years

YEAR	2015	2016	2017	2018	2019	Total
Halberstadt Gypsum	200,000	200,000	200,000	200,000	200,000	1,000,000

Table 4.2.2: Production budget for 2015

2015	Production
Jan	4002
Feb	3577
March	4205
April	3614
May	3733
June	3760
July	3596
August	3264
September	3059
October	3143
November	3432
December	3157
Total	**42,541**

4.2.6 Pit Design

4.2.6.1Bench Plan

The bench design for the Halberstadt Quarry will feature several benches that allows for the efficient mining across the 6.7 hectares. Currently mining has only occurred across one bench within the initial hectare, shown in Figure 4.2.2 below. This is attributed to the fact that the reserves are generally homogenous and such mining is dictated by quantity and quality requirements of the company. With the extent of the mine area being 6.7 hectares, the bench plan will be in continuous progress, to allow for increased efficiency and safety thus ensuring best mining practice.

Consequently, it will allow the development of well-defined benches, made possible by the chosen methods of extraction and engineering methodologies applied to the mining process. The latter will allow mining in the Halberstadt Quarry to take place in a sustainable manner thereby allowing material extraction to take place simultaneously with the other active forms of land use in the area.

Benching within the quarry will progress generally in a NE-SW direction with the benches orientated in a northeast to southwesterly direction. Figures 4.2.3 – 4.2.7 illustrates the progressive bench plan. With one bench already established mining will progress until the reserves are depleted and a new bench will be prepared to access remaining reserves. Following a system of ensuring a minimum required “strip lead”, where overburden is removed as necessary to facilitate mining instead of in a gross extensive manner, benches will be created throughout the life span of the mine. As the mining progresses the floor of the quarry will extend simultaneously as bench widths decrease, (see Figure 4.2.7).

Figure 4.2.2: Illustrating the initial phase of extraction going into the second Hectare

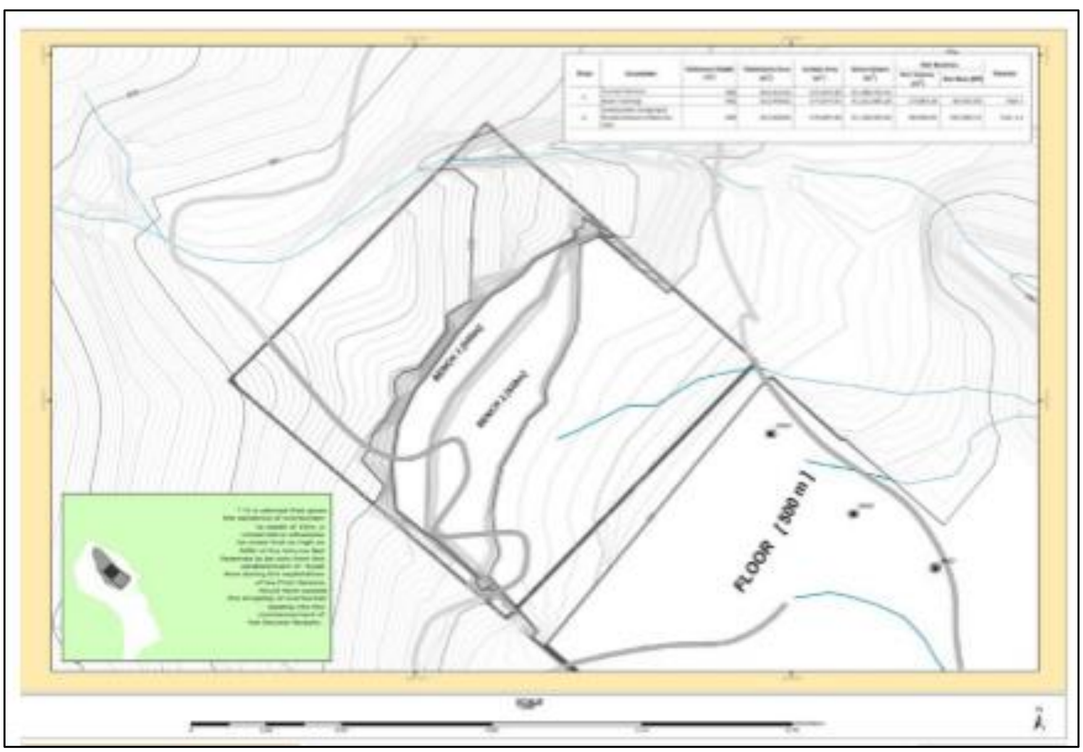


Figure 4.2.3: Illustrating the creation of bench 3 as more overburden is removed.

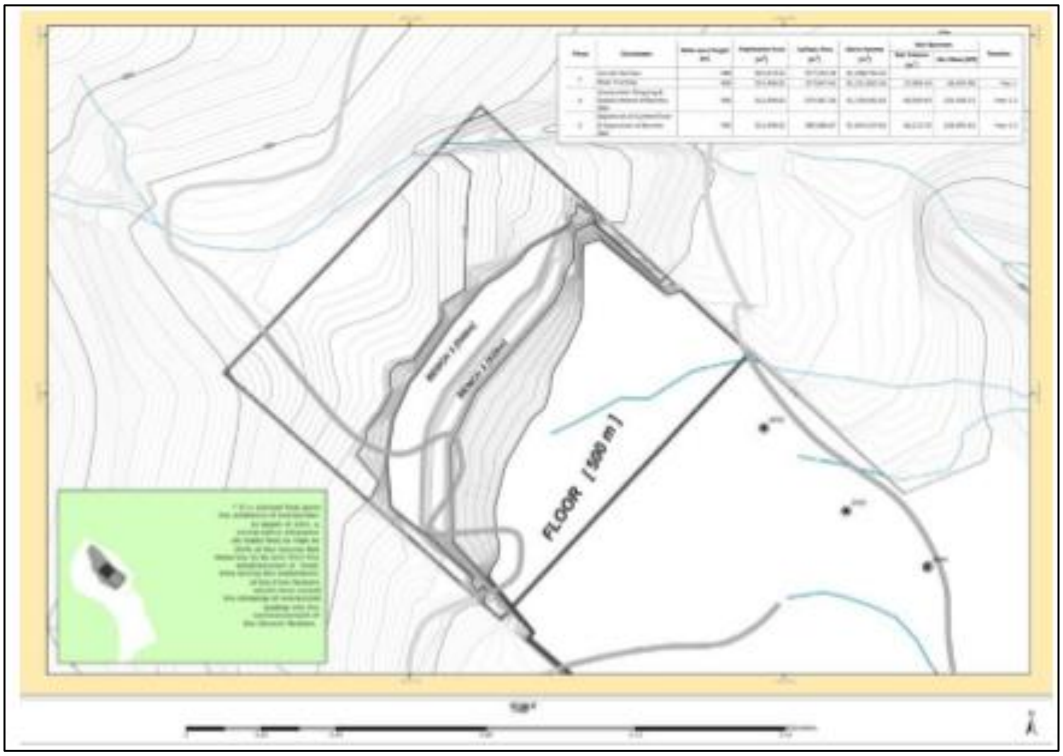


Figure 4.2.4: Illustrating the expansion of the quarry floor as bench 2 is depleted.

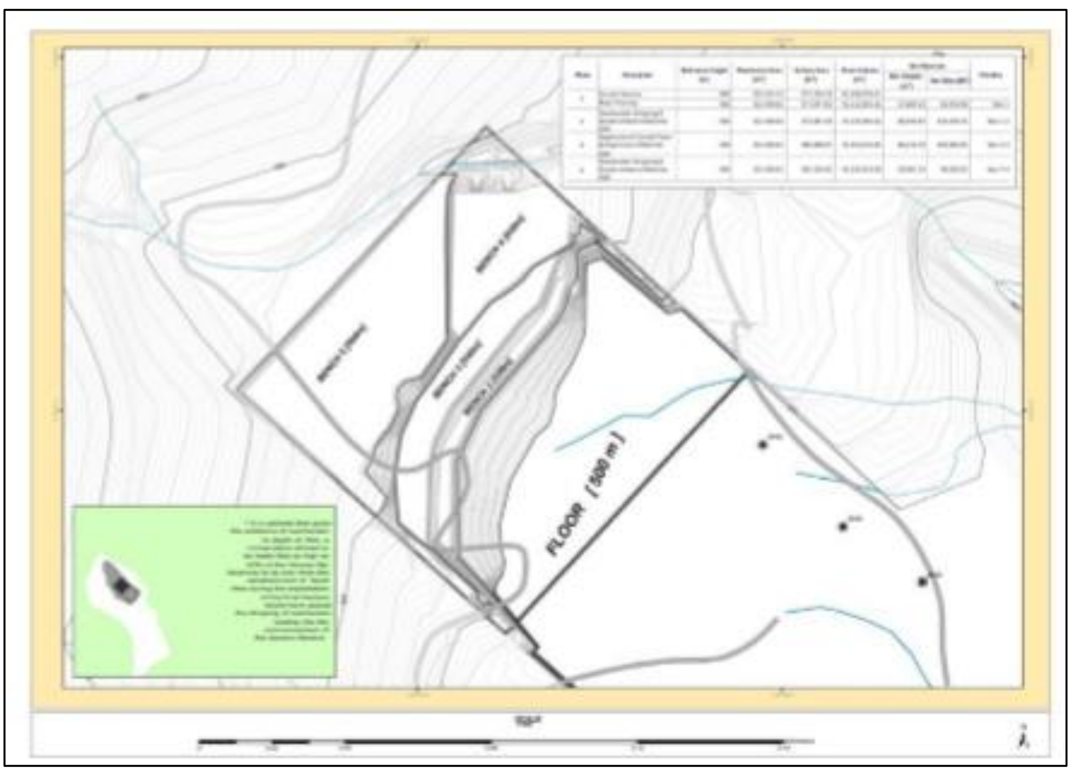


Figure 4.2.5: Illustrating the creation of benches 4 & 5 as more overburden is removed.

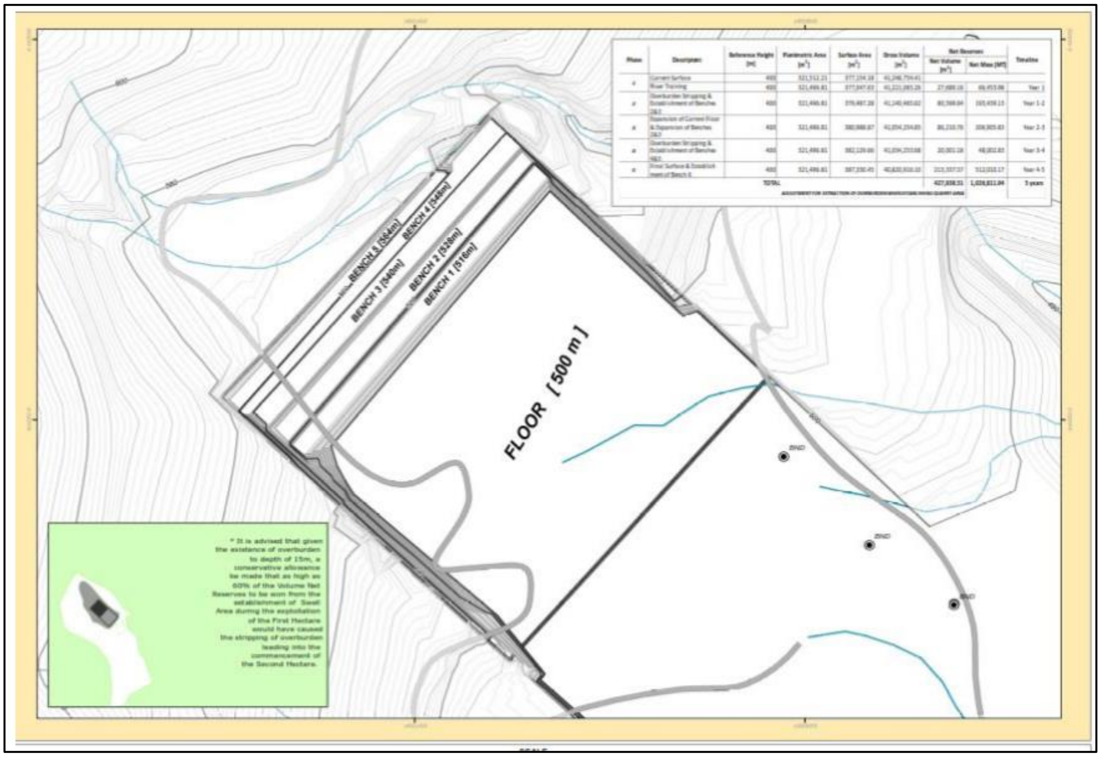


Figure 4.2.6: Illustrating the final 6 possible benches and the extension of the quarry floor.

4.2.7 Quarry Development

4.2.7.1 General Comments

The development of the quarry is controlled by CCCL's Mining Engineer who issues work instructions to Contractors. Control is maintained by daily site inspections by CCCL's Quarry Supervisors and weekly visits by the Quarry Management.

The initial quarry programme was limited to the one (1) hectare of land as approved by NEPA but will now encompass on a progressive basis a potential 6.7 hectare. The programme that was established will be maintained throughout the 6.7 hectares and thus will result in an area at the end of the mine operations that conforms to all environmental regulations. As executed, it will also facilitate the extraction of products required for use in the manufacture of cement.

Overburden is stripped using a D9 CAT bulldozer from benches and pushed to the floor into piles. At present the Contractor utilizes one (1) screen, one (1) dozer, one (1) loader, and 25tons road trucks to transport material from the quarry to the plant and the JGQ pier.

4.2.7.2 Extraction (Drilling and Blasting)

The extraction of gypsum and anhydrite will be facilitated primarily by drilling and blasting thus creating muck piles. Drilling and blasting will be done by qualified contactors with many years of experience.

4.2.7.3 Crushing and Screening.

Crushing and screening will be done by using a mobile crusher with a built-in screen in order to attain a n output size of 2" maximum as is required by CCCL screen at the edge of the bench face. A track mounted, fully mobile crusher and screen is preferred as the equipment of choice. The rated capacity for this crusher will be 500-800tph. During this process, the fines are separated and stockpiled for delivery to the Bito Quarry where this rejected material is stored for future quarry rehabilitation. The quality assurance is facilitated by grab samples taken from crushed piles, and then tested by CCCL's Laboratory.

4.2.7.4 Stockpiling, Loading and Hauling

Stockpiling, loading and hauling of the finished product is done using a 980C CAT front-end loader and a 345 excavator. The latter is used to load haul trucks (capacity 25 tons) for transport to the JGQ pier where it is stored prior to delivery to customers.

4.2.8 Rehabilitation

Jamaica Gypsum will implement a progressive rehabilitation plan for the Halberstadt quarry. The rehabilitation will start with the restoration of the mined-out bench at the end of mining road #1, which was abandoned by the previous operator. The bench will be backfilled with the overburden that will be removed from the new benches once approval for the re-opening of the quarry has been obtained. The final slope angle of the backfill will be determined based on the geotechnical characteristic of the overburden. Based on experience with the overburden material in other sections of the quarry a slope angle of at least of 50% (26o) should be safe. A narrow service strip can be maintained along the outer edge of bench area for easy maintenance and a safety margin.

The toe of the backfilled slope will be protected as needed where an appropriate geotechnical solution such as boulders, stepped gabions, etc. may be employed. Fast growing vegetation as outlined in Table 4.2.3 will be planted in front of the toe of the backfilled slope to help to stabilize the toe area. These plants will be obtained from a pre-established nursery within which the species necessary for post-mining rehabilitation will be housed (outlined further, below).

Table 4.2.3: Fast growing plant currently growing in the Halberstadt area

Herbs	
Alternanthera ficoidea	Crab Withe
Catharanthus roseus	Periwinkle
Leonotis nepetifolia	Christmas Candlestick
Panicum maximum	Guinea Grass
Pluchea carolinensis	Wild Tobacco
Shrubs	
Chromolaena odorata	Christmas Bush
Ricinus communis	Castor Oil Plant
Trees	
Acacia farnesiana	Cassie Flower
Guazuma ulmifolia	Bastard Cedar
Leucaena leucocephala	Lead Tree
Piscidia piscipula	Dogwood

French drains or other suitable internal drainage solution will be constructed in areas where water is seeping or suspected from seeping out the bench wall during wet season. Where surface drainage traverses the backfilled slope, an appropriate stabilized surface drain will be installed and maintained. As the backfill of the slope is completed the surface will be stabilized according to an active planting program. The establishment of a ground cover would be of priority and would include planting the herbs listed in Table 4.2.3 as well as endemic species such as Agave sp., Croton humilis var. adenophyllus, Notoptera hirsute and Piper amalago. Their progress will be assisted with the deployment of erosion control blankets and appropriate mulch as necessary. Fast growing shrubs and trees will be planted after the ground cover is established (again as

outlined in Table 4.2.3). In the final phase hardwood trees, such as Bursera simaruba (Red Birch), Simarouba glauca (Bitter Damson), and Trichiliahirta (Wild Mahogany) can/will be planted.

A plant nursery will be setup to ensure that sufficient, suitable plant material is available to allow a timely re-vegetation of the site. The nursery will primarily facilitate the care of commonly occurring, native, and endemic plants currently found in the area. This rehabilitation process will be repeated for each bench area that has been mined out. The rehabilitation plan for Halberstadt quarry which was developed and is submitted as a part of the 2013 EIS documentation will be used to guide the quarry rehabilitation activities.

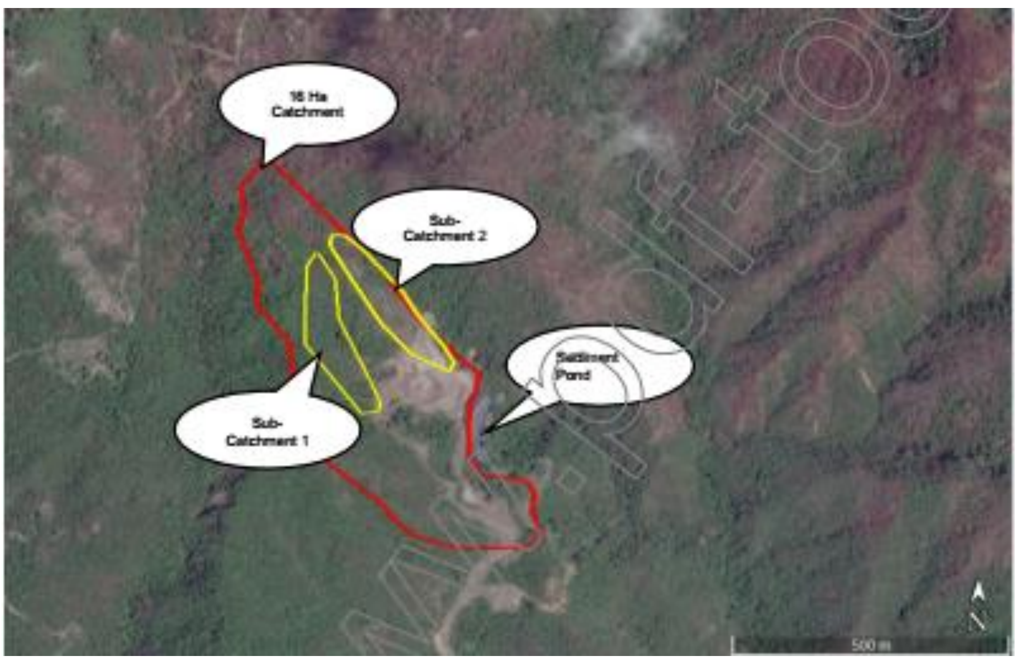
4.2.9 Drainage Assessment

The proposed quarry expansion will extend to the northwest of the original 1-hectare section. The topography suggests the expanded area will drain to the previously designed system. As such it will be necessary to expand the existing drains in a northerly direction along the northern and western boundaries of the 6.7-hectare. These drains will be extended as the quarry development advances from the south to the north. The lower sections the drain is to be upgraded as necessary to accommodate the increased flows. Similarly, the sediment pond may be extended where necessary to accommodate the additional runoffs.

4.2.9.1 Catchments and Runoff Estimation

Existing topographic data from Google SRTM data as well as the survey department 1:12500 map series indicate the site boundaries fall within a catchment area of approximately 16.8 hectares. The runoff from the catchment enters small swales, some of which crosses the site along existing constructed roads. The runoff from this catchment is at present directed to a detention system.

The project area was delineated into one (1) major catchment area that measured 16.8 Hectares. Within it, contained two (2) sub-catchment areas that measured 1.67 Hectares and 1.57 Hectares that were used to determine the size of the drains needed in the area of the proposed quarry expansion. These minor drains would be connected to the existing drainage system in original development and will convey run-off water from the area proposed for the expansion of the quarry to the existing drainage network.



4.2.9.2 Existing and Post Development Conditions

The estimated peak runoffs were generated for the Halberstadt site catchment using the SCS method as described above. The peak runoffs ranged from 0.75 cubic metres per second to just below 7 (6.53) cubic metres per second for the 2-years to 100-year return periods under existing conditions.

The post development conditions show increases in runoff across the site catchment as a result of the clearing of vegetation and mining of the land surface; as the mining surface increases, so does the surface runoff. The increases in peak runoffs that are estimated to occur are in the range of 0.18% to 1.03% for the 2-year to 100-year return periods under existing conditions.

The corresponding 50-year return period peak runoffs are 5.39 cubic metres per second and 8.97 cubic metres per second under both existing and post development conditions respectively.

Hydrology	Units	Return Period					
		1:2yr	1:5yr	1:10yr	1:25yr	1:50yr	1:100yr
Catchment area	HA	16.8	16.8	16.8	16.8	16.8	16.8
Catchment slope	%	14.01%	14.01%	14.01%	14.01%	14.01%	14.01%
Tc	hr	0.89	0.89	0.89	0.89	0.89	0.89
Peak runoff							
Existing Conditions	m^3/sec	0.86	1.62	2.90	4.28	5.39	6.53
Post Development	m^3/sec	3.41	3.91	6.18	7.77	8.97	10.18
Difference	%	2.97	1.41	1.13	0.81	0.66	0.56

4.2.9.3 Hydraulic Assessment

The existing drainage features were designed to accommodate a one in fifty (1:50) year storm event for the previously proposed quarry. The design specifications are as follows with all the drains having a slope of 5%.

Parameter	Minor Drain	Major Drain	Units
0DQQLQJ¶V——&RHIILFLHQ t	0.035	0.035	
Side slope	1.5	1.5	
Width of channel (at top)	3.00	3.70	m
Flow Depth	0.60	0.80	m
Depth + freeboard	0.75	1.00	m
Width of channel (at base)	0.75	0.70	m
R	0.4	0.6	m
P	3.45	3.58	m
A	1.41	2.20	m^2
Flow	4.94	10.15	m^3/sec

The expected post development flow rate is expected to be 8.97 cubic meters per second for a 50-year storm event. According to the analysis, the major drainage feature with a top width of 3.70 m, bottom width of 0.70 meters and a flow depth of 0.80 meters remains sufficiently designed to accommodate the flow of the expected run-off.

The minor drainage feature will not be sufficient to accommodate the expected design flow and needs to be upgraded.

4.2.9.4 Drains

The sub-catchment areas located in the area of interest have approximate values of 16713.29 square meters and 15782.61 square meters, with surface flow values of 0.87 cubic meters per second and 0.83 cubic meters per second respectively for two sub-catchments. The design for the channel was according to a fifty (50) year storm event. The slope of the drains will remain at 5%

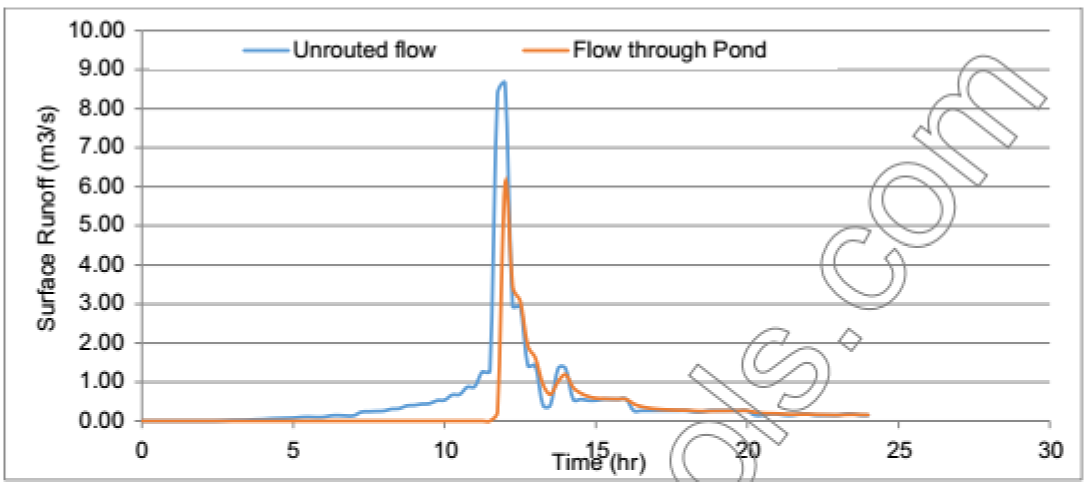
Parameter	Sub Catchment One Drainage	Sub Catchment Two Drainage	Main Drainage Feature	Ford Crossing	Units
0DQQLQJ¶V——&RHIILF	0.035	0.035	0.035	0.035	
Side slope	1.5	1.5	1.5	5	
Width of channel (at top)	3.30	3.30	3.70	8	m
Flow Depth	0.60	0.60	0.80	0.10	m
Depth + freeboard	0.75	0.75	1.00	0.13	m
Width of channel (at base)	1.05	1.05	0.70	6.75	m
R	0.5	0.5	0.6	0.1	m
P	3.21	3.21	3.58	7.11	m
A	1.63	1.63	2.20	0.92	m^2
Flow	6.63	6.63	10.15	0.95	m^3/sec

Therefore, the proposed drain geometry is sufficient enough to control the run-off from the sub catchment areas. Ford crossings will be used across road ways and will be designed to appropriately accommodate the flow in the sub-catchment basins that they will be located in. These ford crossing will be used in lieu of the concrete culverts.

4.2.9.5 Detention Pond

The detention pond was designed to detain the run-off water from the original 1 hectare quarry. It was designed to accommodate a twenty-five (25) storm event and reduce the run-off from the quarry by 42%: reducing it from 8.64 cubic meters per second to an estimated 6.07 cubic meters per second. The design dimensions for the detention pond are as follow:

Detention Pond (Routed)		
Parameter	Value	Unit
Required		
Top surface area	0.5	Ha
Base surface area	0.45	Ha
Pond Depth	4	m
Output		
Length of outlet Weir	3	m
Max water depth above Weir	1.34	m
Peak unrouted flow	8.64	m3/s
Peak routed flow	6.07	m3/s



The pond has an estimated surface area of approximately two thousand six hundred and eighty-six (2686) square meters, depth of four (4) meters and the three (3) meter exit weir was not observed upon inspection. The analysis of the estimated as built condition of the pond was done and it was observed that the pond would need to be re-sized to accommodate the run-off from the catchment. Even though the original development was 1 hectare, the overall area draining to the pond is 16.8Ha. The design for the original pond considered the future expansion of the entire catchment and as such it was designed to accommodate the 16.8Ha. It is recommended therefore that the pond be constructed to the originally proposed dimensions.

According to the analysis of the expected run-off from the catchment area. It is recommended that the minor drains should be resized to have dimensions equal in measurement to that of the major drains. Therefore, they should have a top width of 3.70 meters, a depth that includes the freeboard of 1 meter, and bottom width of 0.70 meters. The existing pond should be enlarged to the original design specifications in order to accommodate the twenty-five (25) year flow it was intended.

4.2.9.6 Proposed Modification to Existing Infrastructure

The drainage network that is being considered for the proposed expansion of the quarry will consist of earthen drains of trapezoidal cross sections. These drains will be located at the perimeter of the quarry. The best option for conveying run off from the quarry is to construct the earthen drains in stages, as the excavation and mining progresses.

Due to the nature of the work that will be performed on site, the perimeter drains will extend into the mining area as more of the existing hill is excavated. The floor of the quarry should be graded in such a manner that the surface run-off flows in the perimeter drains on either side of the work area. It is proposed that there be a high point going down the centre of the quarry floor and the ground should be sloped at a 2% grade leading into the channels.

Channels that will be located at the edge of the hill will have berms at the side that is facing the precipice. These berms are designed to prevent any run-off that may overflow from the channel, preventing it from flowing down hill and causing any potential flooding incidents.

4.2.9.7 Conclusions

The designed catchment area was 16.8 Hectares and the estimated post development run-off flow was determined to be 8.97 cubic meters per second. Two (2) sub-catchments were also delineated in the area of expansion, these were measured to be 1.67 Hectares and 1.57 Hectares and the run-off flow rates were 0.87 cubic meters per second and 0.83 cubic meters per second respectively.

The measure drains were sized to accommodate the fifty (50) year post development run-off and will have a top width of 3.70 meters, total depth of one meter and a base of 0.70 meters.

The minor drains for sub-catchment one and two will have the following dimensions: top width of 3.30 meters, total depth of 0.75 meters and a base of 1.05 meters. These dimensions are sufficiently sized to accommodate the fifty (50) year post development return period.

The ford crossings will have the following dimensions: top width of eight (8) meters, total depth of 0.13 meters and a base of 6.75 meters.

It was determined that the existing pond would need to be resized. The pond would need to adhere to the dimension specifications of the original design.

The previously designed minor drains should be resized to accommodate the estimated fifty (50) year return period. These should be resized to the follow specifications: top width of 3.70 meters, total depth of one meter and a base of 0.70 meters.

It is to be noted the changes may need to be made to the proposed drainage modification based on actual field conditions encountered as the mining progress.

5 DESCRIPTION OF THE ENVIRONMENT

5.1 Harbour Head

5.1.1 Physical Environment

5.1.1.1 Regional Geomorphology

The proposed Harbour Head Quarry site is located north-west of the existing quarry (Plate 5.1.1). The Mountain Range rises to a height of 451m, but gradually decreases in elevation in the NW and SE. Towards the southern half of the ridge, elevation reaches a maximum of 378m and then decreases gradually in a SE direction, ending close to the coastline.

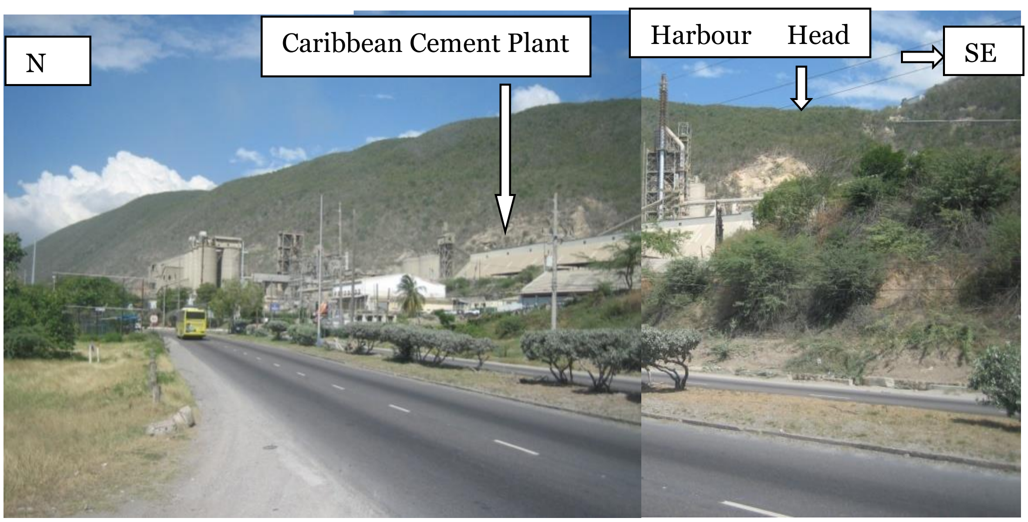


Plate 5.1.1: A view of the south-eastern side of the proposed site. The Caribbean Cement Company plant is at the foot of the hill.

The Hope River forms the eastern boundary of the ridge for a distance of 3.5km and is aligned with the ridge trending in a NW – SE direction. Regionally, the Dallas Mountain to the east of the project site is morphologically related and has similar geomorphic features and is thought to be formed by the same geologic and tectonic processes (Figure 5.1.1).

The areas surrounding the project site is typically uniform with respect to slope and terrain characteristics. However, there is a gradual change in morphology near the south-eastern end of the ridge where erosion features appear to increase in intensity especially in the vicinity of the existing CCCL quarry.

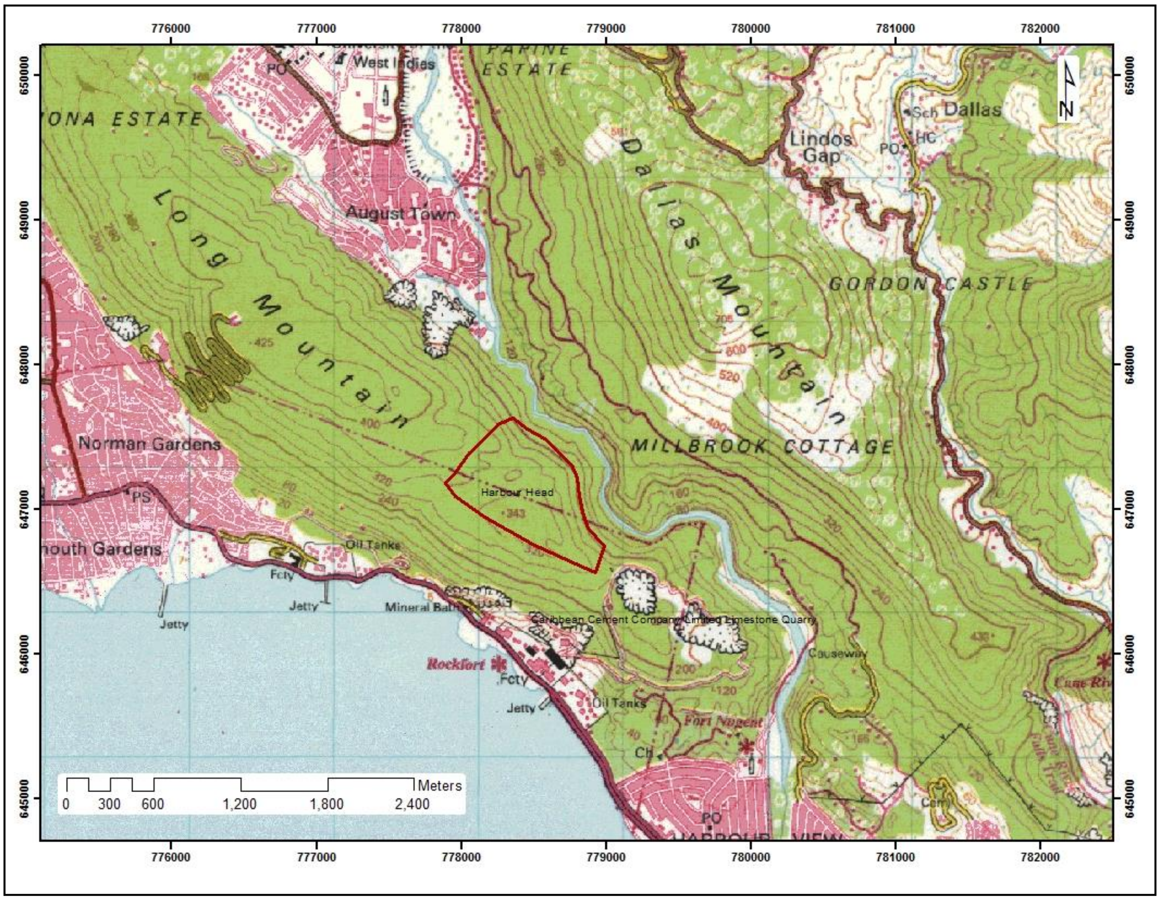


Figure 5.1.1: Topographical Map of the project site and surrounding regions (1:50,000 metric topographic map)

5.1.1.2 Geomorphology

A small plateau is located on top of the ridge where the CCCL quarry is to be sited (Plate 2.2). The property is approximately 50 hectares in size, with approximately half of this acreage situated on the plateau, while the other section of the property situated on sloping terrain overlooking the Hope River and Dallas Mountain. The slope located on the NE descends steeply (Plate 2.3) over a distance of 280 m-350 m towards the Hope River.

Occasional undulating features and small narrow valleys are also observed along the plateau area of the site (Plates 5.1.2 & 5.1.3).

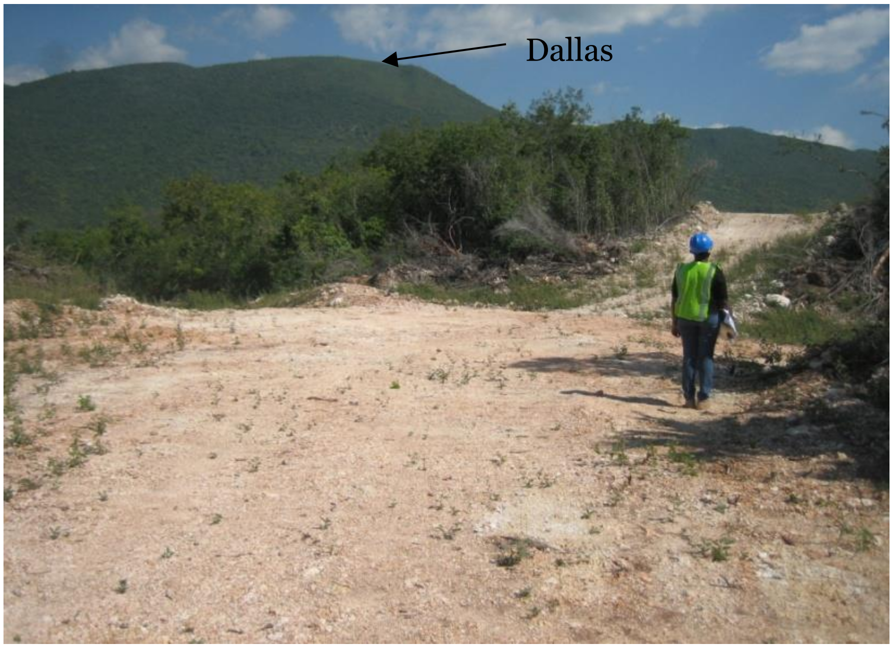


Plate 5.1.2: A section of the project site, looking east with the Dallas Mountain in the background

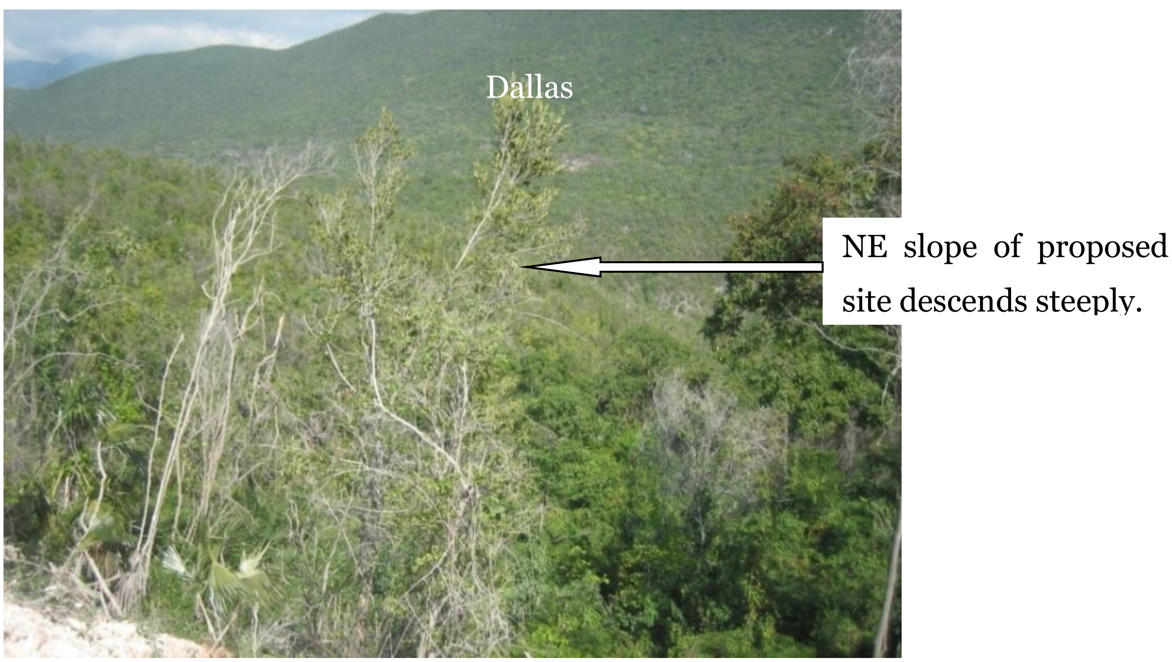


Plate 5.1.3: NE slope of proposed site descends steeply towards Hope River

Plate 5.1.4: Another view of slightly undulating land on the small plateau within the proposed project site

Plate 5.1.5: Shallow valley within the small plateau area within the proposed site

Two major erosion gully features are found on the property; the most northerly drains at or near the north-western boundary of the project site and the other gully drains through the NW of the property. The gullies drain in a north easterly direction on the site, but then changes to a northerly direction as it drains away from the project site and into the Hope River.

Karst features that are typical of limestone geomorphology were not identified from remote sensing imagery nor were they observed in the field. However, large limestone cavities were observed outside of the project site during field survey conducted in the Hope River. These were, however infrequent.

5.1.1.3 Geology

5.1.1.3.1 Methodology

The information presented in this section is based on:

- **a.** Extensive field work,
- **b.** aerial photographic interpretation and
- **c.** review of geology maps and technical reports relevant to the area.

The main access road as well as newly excavated tracks perpendicular to the access route provided adequate coverage for a detailed survey particularly for the north-western half of the site. The Hope River traverse was done to compliment the survey for the south-eastern side of the project site as access to that area from the top of the ride was extremely challenging

5.1.1.3.2 Regional Geology

The regional geology of the Harbour Head site and surrounding areas is associated with tectonic activities such as folding, faulting and up-thrusting, leading to the formation of mountain ranges and other features during the Pliocene to form the Long and Dallas Mountains. The mountain ranges have a young evolutionary history relative to the Wag Water Belt that makes up a large portion of the geology of NE and E St. Andrew. The long axis of the Long and Dallas Mountains are aligned with a NW – SE anti-clinal axis (Figure 5.1.2). The area has been folded and faulted during the Pliocene, giving rise to anti-clinal structures and a less distinct synclinal structure on the lower section of the Mountain Range.

The lower reaches of the Hope River also form a part of the regional geology and is associated with tectonic movement during the Pliocene Period. A traverse through the Hope River between the Long and Dallas Mountains reveal localized folded structures as well as vertical bedding structures normally associated with fault movement.

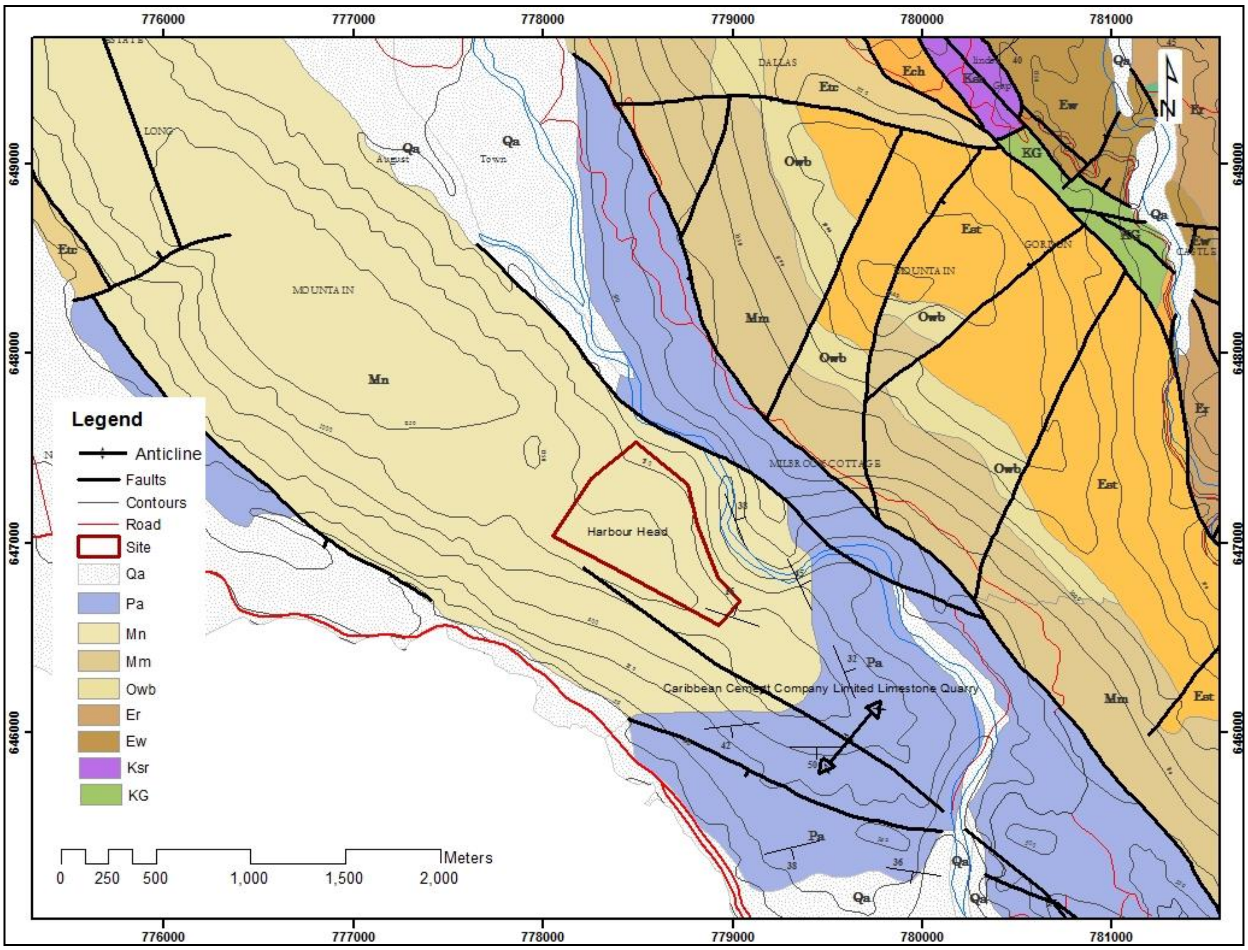


Figure 5.1.2: Geology of Project site and surrounding areas (Taken from Mines and Geology Division's 1:50,00 metric geology Series, Kingston Geology Sheet 13 – Updated Draft)

5.1.1.3.3 Lithology

Two geological Formations dominate the Harbour Head quarry site and surrounding areas. These are: the Newport Formation (Mn) of the White Limestone Group and the younger August Town Formation (Pa) of the Coastal Limestone Group (See Figure 5.1.3).

The *Newport Limestone* is a white to buff colour, partly recrystallized bioclastic limestone with subordinate micrites (Plate 5.1.4). Imprints of coralline and mulloscs fossils were observed in this formation. A pinkish variety was also observed in the northern section of the project site as well as in the Hope River close to the site (Plate 5.1.6). Other areas expose soft, marly to nodular limestone which is easily removed by a geological hammer (Plate 5.1.7). The Newport limestone dominates the Harbour Head quarry site.

Plate 5.1.6: Newport Limestone exposed on access road to proposed Harbour Head site

Plate 5.1.7: Newport Limestone exhibiting pinkish tinge in the Hope River Valley

Plate 5.1.8: White, soft marly and nodular limestone of the Newport Formation

Plate 5.1.9: Another exposure of the rubbly and marly characteristics of the Newport Limestone near the t south eastern end of the project site

The exposed outcrops in many instances are extensively fractured, giving rise to cobble and small to large boulder - size limestone material. Weathering is also observed to slight to moderate, but confined to the top layer in the limestone. Typically, the rock fractures are stained with reddish brown lateritic soil due to percolation of storm water into open fractures.

The strength of the rock is variable; where there is recrystallization, the limestone is hard and may require blasting for excavation. In other areas, particularly towards the SW and centre, the limestone is soft, marly and rubbly and can easily be ripped by mechanical means.

The *August Town Formation* can be described as a soft, light yellowish brown calcareous sand and marly and rubbly limestone (Plate 5.1.10). This formation occurs just south of the project site and is the material currently being quarried by CCCL. There is an erosional unconformity between the Younger Coastal Limestone and the Newport limestone; however, this was not readily identified in the field, probably due to extensive mining activity in the area.

Plate 5.1.10: Yellowish brown calcareous sand and marly limestone of the August Town Formation

5.1.1.3.4 Geological Structure

Tectonic movement has also resulted in extensive rock fracturing, overturned beds and localized folding in the Newport Limestone which were observed on the project site as well as in the Hope River (Plates 2.10 and 2.11).

Plate 5.1.11: Mossaic showing folded structure in the Newport Limestone in the Hope River Valley

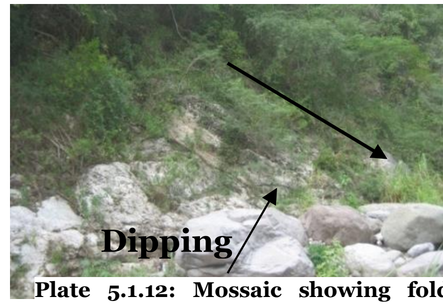


Plate 5.1.12: Mossaic showing folded structure in the Newport Limestone in the Hope River Valley

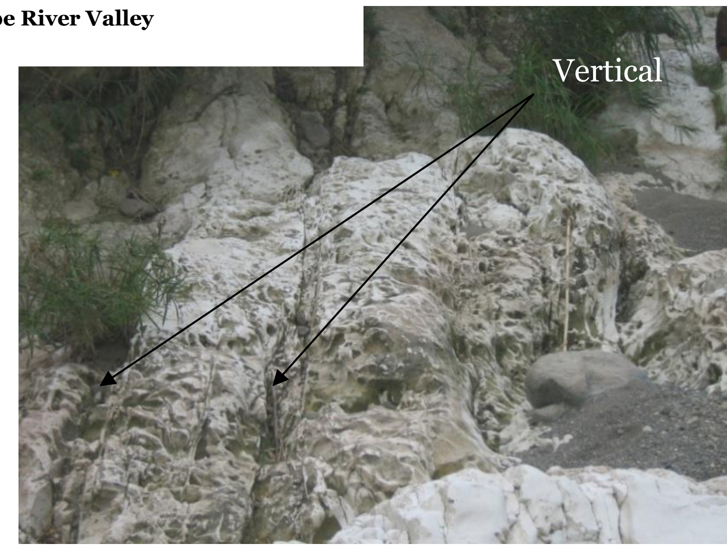


Plate 5.1.13: Vertical beds in the Newport Limestone -(Hope River Valley)

5.1.1.4 Soils

The description of soils is based on on-site observation from a geology/geomorphic viewpoint as well as from an agricultural soil description developed by the Rural Agricultural Development Agency (RADA).

Soil cover is typically thin at the top of the ridge, not exceeding 6cm in thickness. However, where there are shallow valleys, the thickness of the soil increases. The typical soil can be described as reddish brown lateritic clayey silt. Below the soil is a weathered mantle of reddish brown soil intermixed with limestone cobbles, pebble stones and occasional boulders. A review of the soil map provided by the Rural Physical Planning

Unit of the Ministry of Agriculture shows that the dominant soil is the Bonnygate Stony Loam (Figure 5.1.3). The soil is characterized by gravelly, loamy texture with high erodability, very low moisture content and very rapid internal drainage.

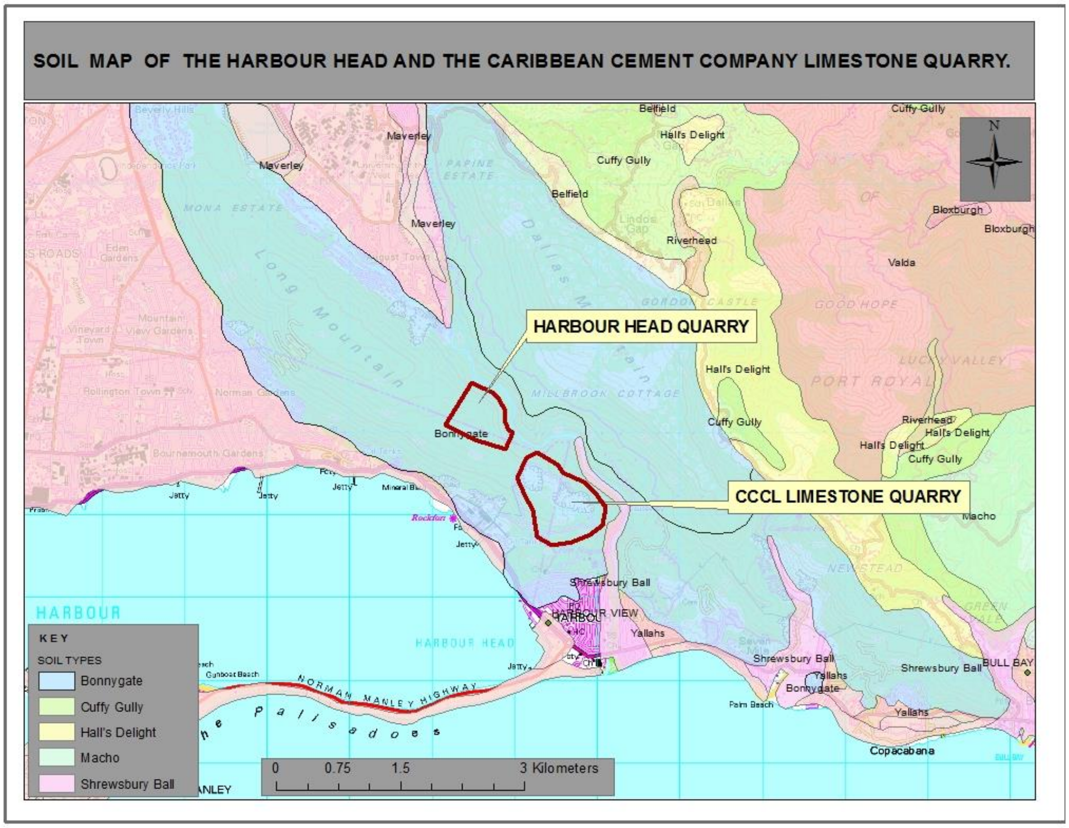


Figure 5.1.3: Soil Map for the Harbour Head Limestone Quarry (Source: Rural Physical Planning Unit, Ministry of Agriculture)

5.1.1.5 Hydrogeology

5.1.1.5.1 Hydro-Stratigraphy

The site lies atop two hydrostratigraphic units: Newport Limestone Formation classified as Limestone aquifer (southern western and central sections); and deposits comprised of Coastal Limestone Group (August Town Formation) classified as Coastal Aquiclude noted at the northern and eastern sections (Water Resources Authority Hydrological Database: http://webmapjam.dyndns.pro/). The Newport Formation typically comprises of white chalky marl with irregular areas of compact limestone which allows movement and storage of groundwater within the unit. The August Town Formation is a low permeability limestone which does not support the development of wells (Figure 5.1.4).

The quarry area lies within Hope River Watershed Management Unit (Hope River WMU) of the Kingston Hydrological Basin (Water Resources Authority Hydrological Database: http://webmapjam.dyndns. pro/). The elevation of the site is above 335m with steeply sloping section located to the northern and north-eastern section of the site contiguous with the Hope River Valley. Groundwater contours indicate groundwater elevation of 20m above mean sea level, which is expected to be over 300m deep at the site. Exploration drilling done at selected points within the boundary of the site, to a depth of 150 ft to 175ft (45.7m - 53.3m) encountered no groundwater.

From the geological map, the area lies between two fault systems; the Enriquillo Plantain Garden Fault Zone to the south of the site and the north of the site directing the flows within the Hope River (WD Wiggins-Grandison December 2005, Jamaican Seismology with reference to other Islands in the Greater Antilles). Faults are generally zones along which increased permeability occurs and groundwater may also occur along these zones. The Draft Water Resources Development Master Plan (2005) prepared by the Water Resources Authority (WRA) gives the safe water yield within the Hope River WMU as $23m^3$/year.

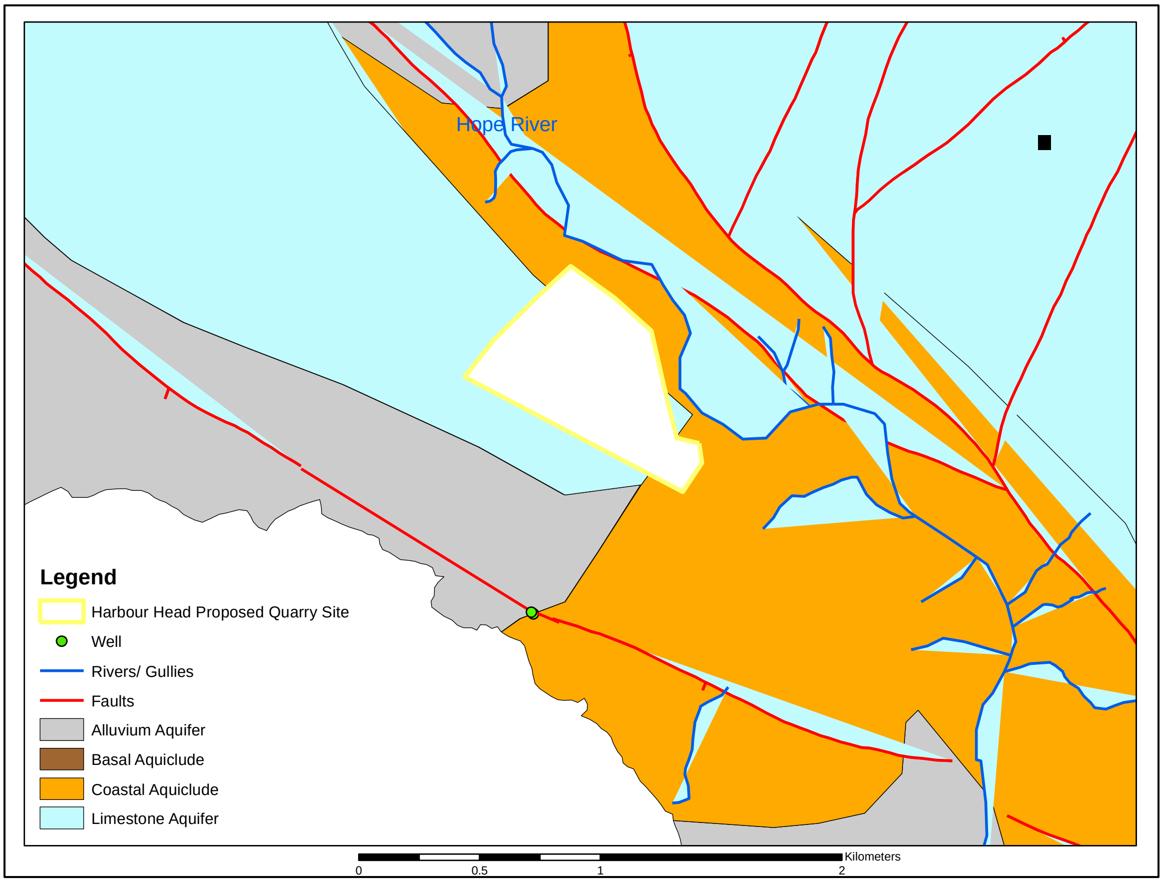


Figure 5.1.4: Hydro-Stratigraphic Map of Harbour Head and Surrounding areas

5.1.1.5.2 Ground Water Abstraction

Data received from the WRA has indicated that a well was completed at Cement Company in March 2014, Rock Spring #2R (A20014/44), to replace the previously drilled Rock Spring #1R. The Rock Spring #1R well taps the Limestone Formation and the replacement Rock Spring #2R taps the Alluvium Aquifer of the Liguanea Formation within the Enriquillo Plantation Garden Fault Zone. The Rock Spring 1R well was licensed in September 2008 (A2008/51) to abstract and use 3,500m3/day of water for industrial purposes in the production of cement with a static water level of 0.5mbgl. The Rock Spring #1R well is a moderate-high producer with specific capacities ranging from 2,712.28 m3/day/m at lowest pumping rate to 1,235.12m3/day/m at highest pumping rate. An increase in abstraction rate was granted in June 2013 (A2023/39) for an additional 200m3/day, taking the abstraction rate from 300m3/day to 3700m3/day. The replacement well Rock Spring #2R is licenced to abstract and use water at the rate of

1920m³/day. The well performance test indicates that the well is a medium to high producer with specific capacities ranging from 704m³/day at the lowest pumping rate to 547.53m³/day at the highest rate. The drilling data has indicated water was struck at 8.5mbgl with a static water level on completion of 0.7mbgl.

*CCCL drilled and tested a replacement well (A2008/57) for the Rock Spring deep well (leased from the National Water Commission) in July-August 2008, and was licensed to abstract and use water totaling 3,500m³/day. CCCL had experienced 'serious security challenges' at the Rock Spring deep well site and has decided to drill a well within their property close to the south-western boundary C2011/03. A consent for drilling is valid for a period of **twelve months** from the date of issue based on the provisions of the Water Resources Act and the regulations. CCCL did not act on the permit within the specified time and had to reapply in 2013 for a permit to drill C2013/06. The replacement well Rock Spring #2R is licenced to abstract and use water at the rate of 1920m³/day. The well performance test indicates that the well is a medium to high producer with a specific capacity (m3/d/m) ranging from 704m³/day at the lowest pumping rate to 547.53m³/day at the highest rate. The drilling data has indicated water was struck at 8.5m below ground with a static water level on completion of 0.7 mbgl.*

An increase in abstraction rate was requested and granted in June 2013 (A2013/39) for an additional 200m³/day, taking the abstraction rate from 3500m³/day to 3700m³/day.

5.1.1.6 Hydrology

The site is located in the watershed drained by the Hope River which is approximately 19.6km in length. The site is located within the Hope River Watershed Management Unit of the Kingston Hydrological Basin (Water Resources Authority Hydrological Database: http://webmapjam.dyndns.pro/). Site assessment along with topographical maps have shown that the site is drained by one gully feature which is primarily seasonal characterized by high flows in short duration during rainfall events which drains toward the Hope River Valley (Figure 5.1.5). The site is located along the lower reach of the river and the river valley is contiguous with the northern and north-eastern boundary of the site. Site investigation conducted January 28 2016 showed the sinking of the Hope River underground at JAD 2001 coordinate point 778258.755 648048.089 (Figure 5.1.6 and Plate 5.1.14).

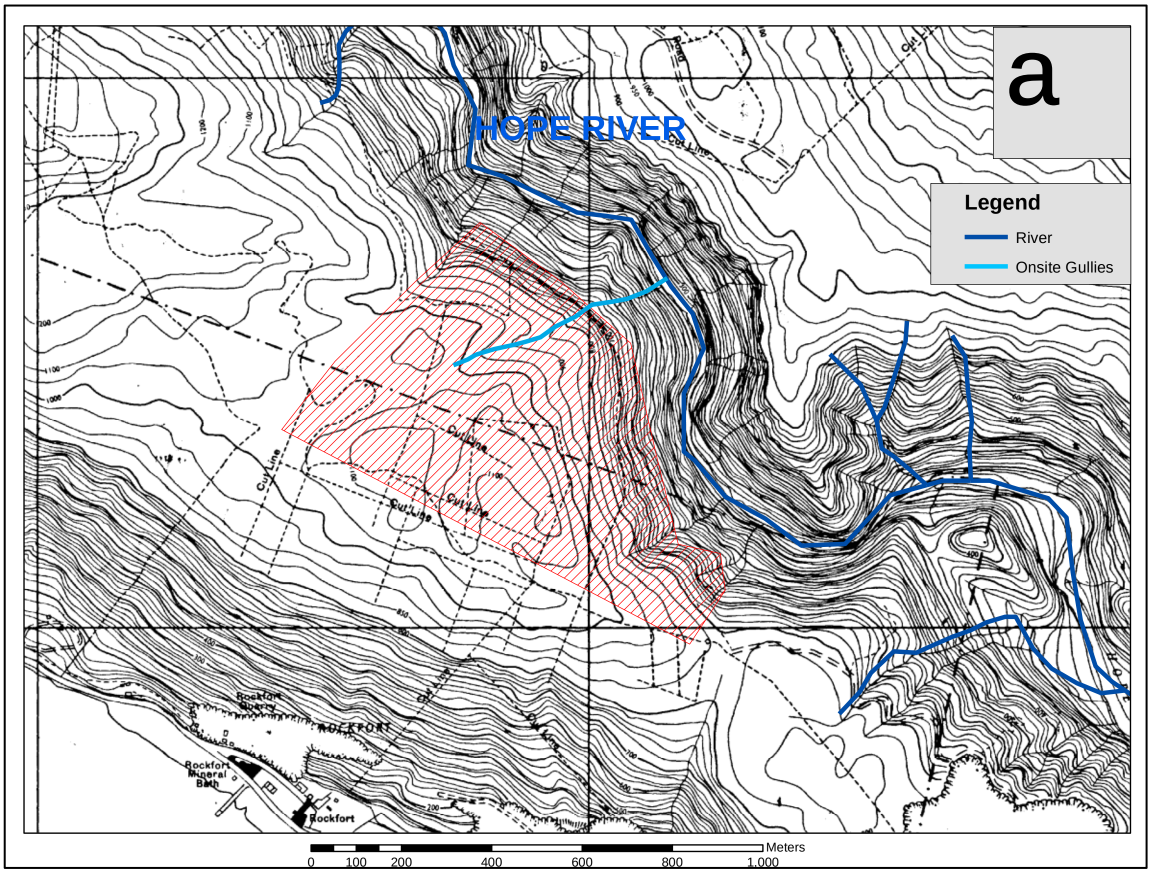


Figure 5.1.5: Drainage Map of Harbour Head site and Surrounding areas (Source: 1:12,500 Imperial Topographic 106A)

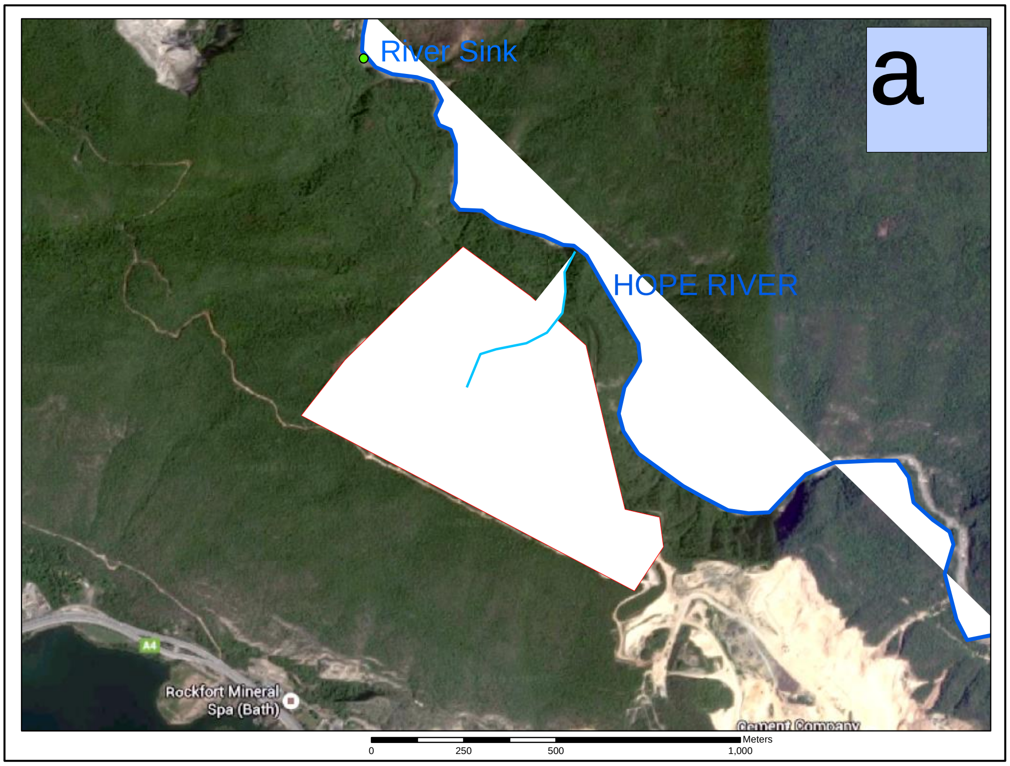


Figure 5.1.6: Google Map showing location where water in the Hope River sinks underground (Google Image 2015)

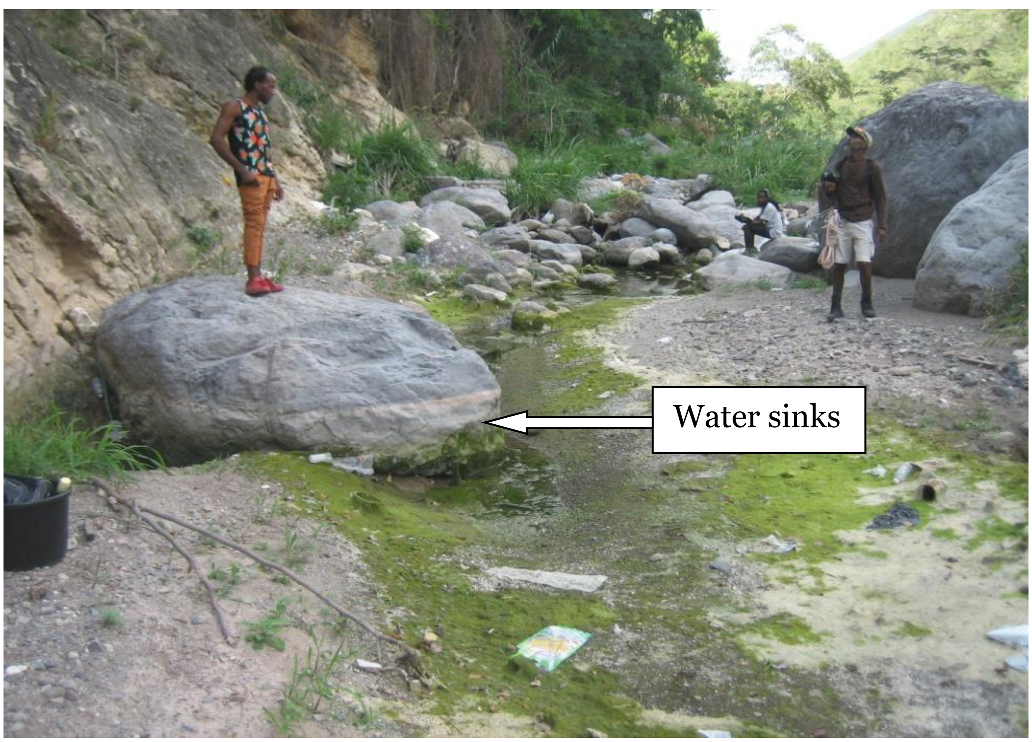


Plate 5.1.14: Water in the Hope River sinks underground

5.1.1.7 Water Quality

Baseline water quality samplings were conducted on January 28, 2016 at two sites for this project: Hope River (surface water; Plate 5.1.15) and the CCCL well (groundwater water; Plate 2.14)). Surface water quality sampling was conducted on the Hope River up-gradient of the project site before the river sinks underground (location JAD 2001 coordinate point 778258.755N 648048.089E). The closest well to the project site is the Cement Company well located on the Cement Company Plant. Samples were collected in pre-sterilized bottles acquired from the laboratory, stored on ice and taken to the Scientific Research Council Laboratory for analysis of all parameters. Table 5.1.1 below lists the coordinates and water quality test results.

Parameters tested for the surface water (Hope River) are Total Phosphate, Total Suspended Solids, Total Dissolved Solids, Nitrate, Dissolved Oxygen, FOG, Turbidity Faecal Coliform and pH in keeping with approved TOR by the National Environment and Planning Agency (NEPA).

Parameters tested for the groundwater (well) are: Total Phosphate, Total Suspended Solids, Total Dissolved Solids, Nitrate, Dissolved Oxygen, FOG, Turbidity Faecal Coliform, Sulphate, Chloride, Sodium and pH in keeping with approved TOR.

Results are compared with the NRCA Ambient Water Quality Standard, I-Jam Drinking Water Standard and the World Health Organization Drinking Water standard.

Table 5.1.1: Water Quality Test Results for Hope River and CCCL Well

Parameter	Hope River Coordinate JAD 2001: 778227.67N 648256.57E	NRCA Ambient Standard	Well Coordinate JAD 2001: 778370.422N 648093.094E	I-JAM Standard	WHO Standard
Total Phosphate mg/L	0.14	0.01 – 0.8	0.09	-	-
Total Suspended Solids mg/L	<2	-	8	-	-
Total Dissolved Solids mg/L	370	120 – 300	1994	-	600 - 1000
Nitrate mg/L	22	0.10 – 7.5	8.36	45	-
Dissolved Oxygen mg/L	13.7	-	7.3	-	-
FOG mg/L	2.25+/-0.12	-	2.41+/- 0.13	-	-
Turbidity NTU	0.51	-	0.71	5	4
Faecal Coliform MPN/100mL	350	-	<1.8	-	
pH	8.7	7.00 – 8.4	7.4	-	-
Sodium mg/L	^	4.50 – 12.0	269	-	200
Chloride mg/L	^	5.00 – 20.0	951	250	200 - 300
Sulphate mg/L	^	3.00 – 10.0	192	250	500

^ Indicates that no analysis was conducted for these parameters.

Surface water

The water quality within the Hope River has indicated pH, TDS, and Nitrate levels elevated above ambient standard. The river has indicated faecal contamination with faecal coliform levels of 350mg/L. A comparison of pre-quarry water quality with the water quality during quarry operation would not be possible because the Hope River under normal flow does not contain water adjacent to, or down-gradient of the site. This is due to the fact that water in the river sinks underground up-gradient of the project site.

Well water

The Carib Cement well has indicated TDS (1994mg/L), Chloride (951 mg/l) and sodium (951mg/L) levels elevated above the WHO drinking water guidelines. Well water quality has indicated seawater intrusion within the alluvium aquifer due to its proximity to marine environment. Sulphate is elevated above the ambient standard but is within the I-JAM and WHO drinking water standards. The well water is currently used for industrial purposes.

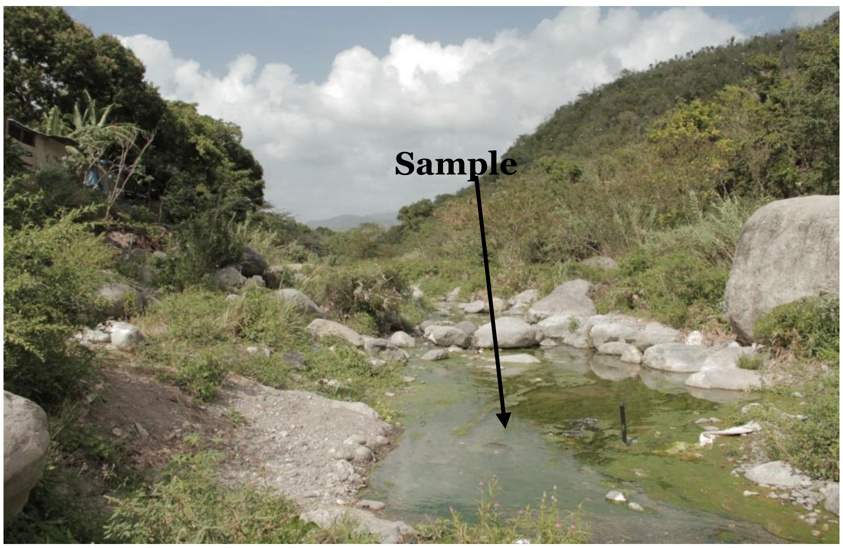


Plate 5.1.15: Location of the Sample Site looking upstream of the Hope River

Plate 5.1.16: Well located on the Caribbean Cement Company Plant Site

5.1.1.8 Climate

Since local and regional climatic conditions affect the dispersion of pollutants, an understanding of the prevailing long-term climatic patterns and the short term, site-specific meteorological conditions will help to assess the likely impact of emissions from the quarries on local air quality. The site is only approximately 6 km southwest of the meteorological station at Norman Manley International Airport (NMIA) and there are no intervening topographical features that would result in differences in meteorology between NMIA and the site. Meteorological data from NMIA will therefore be representative of the site and can be considered site-specific.

Table 5.1.2 summarizes the temperature, rainfall, and humidity values recorded between 1951 and 1980 and this data is indicative of the conditions that have existed at the site. The minimum temperature ranges from 22.3 °C to 25.6 °C with highest temperatures in July and August and the maximum daily temperature ranges from 29.6 °C to 31.9 °C. The relatively narrow range in temperature reflects the moderating influence of the sea. Highest monthly average rainfall occurs between May and October and the annual mean rainfall is 62.1 mm. October has the highest average monthly rainfall (167 mm) and days with rain (10 days).

The main regional scale weather features that affect the island are upper level pressure troughs (an elongated area of low atmospheric pressure at high altitude), tropical waves and incipient storms and cold fronts. Upper level troughs occur year-round but are more frequent in the winter when there are more frequent temperate latitude low-pressure systems and fronts. During the winter months, cold fronts associated with low-pressure systems that form over the south central United States can reach Jamaica although the still warm water in the Gulf of Mexico and the Caribbean moderates them. These fronts can be stationary and produce much rainfall over the northern areas of Jamaica. The summer troughs are fewer but can be more persistent. The troughs sometimes interact with the easterly waves (a wavelike disturbance in the tropical easterly winds that usually moves from east to west) and tropical storms to produce intense rainfall. Tropical waves and incipient storms occur in the summer and move from east to west and are good rainfall producers. A tropical wave is a kink or bend in the normally straight flow of surface air in the tropics that form a low-pressure trough, or pressure boundary, and showers and thunderstorms. It can develop into a tropical cyclone.

Table 5.1.2: Monthly Mean and Annual Mean Values for Selected Meteorological

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Mean
Maximum Temp. (°C)	29.8	29.6	29.8	30.3	30.8	31.2	31.7	31.9	31.7	31.3	31.1	30.5	30.8
Minimum Temp. (°C)	22.3	22.3	22.9	22.6	24.7	25.3	25.6	25.3	25.3	24.8	24.1	23.1	24.0
Rainfall (mm)	18	16	14	27	100	83	40	81	107	167	61	31	62.1
No. of rain days	4	4	3	5	5	6	4	6	8	10	6	4	5.4
Rel. Hum. 7am (%)	80	78	77	77	76	73	76	76	78	80	79	78	77.3
Rel. Hum. 1pm (%)	61	62	64	60	66	65	65	68	68	65	65	64	64.4
Sunshine (Hours)	8.3	8.6	8.5	8.7	8.2	7.7	8.2	8	7.2	7.4	7.8	7.8	8.0

The dominant winds over Jamaica are the northeast trade winds whose strength is governed by the strength and location of the Azores-Bermuda sub tropic high-pressure cell. During the summer months, the high-pressure cell is weaker and farther north (than in summer) and consequently the trade winds are broad, persistent and extend further south. In the winter months, the central pressure of the cell is higher and further south and the winter trade winds are weaker and have a more northerly component.

The wind data for the period 1981 to 1990 show that the most predominant wind directions are from the east and east-southeast, (Table 5.1.3, Figure 5.1.7). These are the prevailing sea-breeze directions and reflect the effects of the mountains that lie along an east- west axis. The mountains deflect the dominant northeasterly trade winds and provide the easterly component to the winds. The mean wind speed over the period was 10.3 knots (19.1 km/h). Winds from the south had the highest wind speeds (19.5 knots (kt)) followed by the south-southwest. Winds from the ESE had the lowest average wind speeds. Calm winds were reported 14.7% of the time and wind speeds of 1 to 3 kt were reported 4.2% of the time. For the 2002 NMIA wind data (see Figure 5.1.7), it was revealed that the predominant wind direction was from the southeast, followed by the south-south-easterly winds. This is consistent with the historic patterns as reported.

Table 5.1.3: Wind Speed and Direction Data from Norman Manley International

	WIND DIRECTION																
Wind speed (Knots)	NNE 020-030	NE 040-050	ENE 060–070	E 080–100	ESE 110-120	SE 130-140	SSE 150-160	S 170-190	SSW 200-210	SW 220-230	WSW 240-250	W 260-280	WNW 290-300	NW 310-320	NNW 330-340	N 350-010	All DIR
0																	12792
1 – 3	102	47	61	151	66	60	85	143	88	84	64	290	556	644	798	438	3677
4 – 6	373	194	346	796	431	371	545	1035	457	297	281	697	1435	2253	3486	2104	15101
7 – 10	536	311	857	2470	1434	1027	1093	1429	578	279	216	545	866	1801	3787	3020	20249
11 - 16	169	121	868	5520	3675	1714	751	257	87	59	31	79	96	255	809	930	15421
17 - 21	35	14	265	3734	3322	1475	327	45	10	4	2	6	8	53	108	97	9505
22 - 27	15	0	59	2786	3254	1509	238	12	3	1	1	3	5	54	51	70	8061
28 - 33	7	0	8	594	520	224	19	7	1	0	1	0	5	24	31	52	1493
34 - 40	0	0	0	7	8	10	3	3	0	0	1	0	1	15	0	13	61
41 - 47	0	0	1	1	0	1	4	0	0	0	0	0	0	0	0	0	7
48 - 55	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
56 - 63	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	3
>63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Average Speed	18.54	19.09	18.29	14.80	13.67	14.32	17.74	19.46	19.16	18.11	18.03	16.99	16.59	17.54	18.54	18.89	13.94

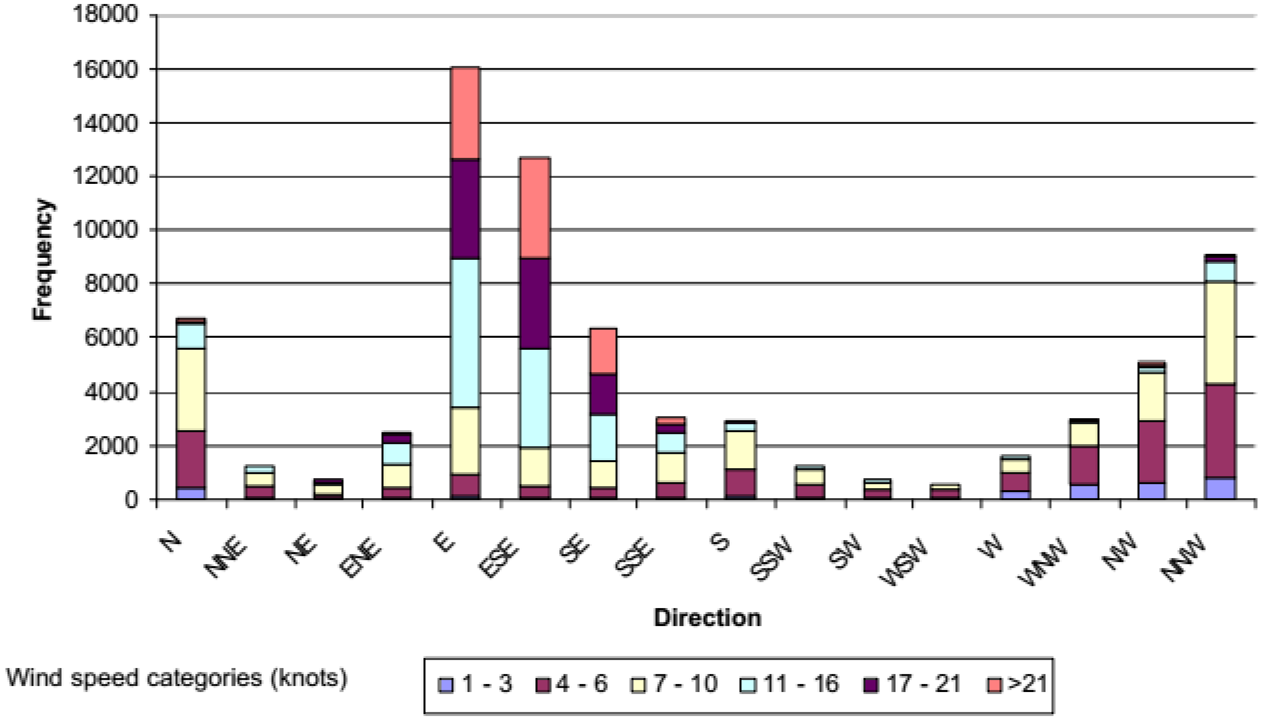


Figure 5.1.7: Wind Speed and Wind Direction Frequencies at Norman Manley International Airport, 1981 – 1990

5.1.1.9 Air Quality

An air dispersion modeling exercise involving the AERMOD air dispersion model was conducted by Air Quality Consultants Limited, to predict the impact of air emissions on ambient air quality from two proposed quarries to be located at Halberstadt and Harbour Head in St. Andrew, Jamaica. A summary of the findings for both locations is presented here and the full document presented separately as Appendix 6.

The proposed project involves the quarrying and mineral processing of gypsum and limestone at Halberstadt and Harbour Head, respectively. The operation at Halberstadt will process 200,000 tonnes per year of gypsum from 6.7 hectares of land, while that at Harbour Head will process 800,000 tonnes per year of limestone from 20 hectares of land. It is envisaged that each operation would involve activities such as drilling, blasting, material transport and stockpiling, as well as the crushing or processing of materials. The quarries are approximately 8.5 km apart and were modeled in a single model domain of

20 x 20 km, with its centre being the centroid of all air pollutant sources identified at both quarries.

Other sources that could contribute to the overall air quality impact within the air shed were considered in the air dispersion modeling analyses and they included sources at Jamaica Public Service Company (JPS) Rockfort Power Plant, Jamaica Private Power Company (JPPC), Jamaica Flour Mills (JFMills), Jamaica Gypsum and Quarries Port facility and Caribbean Cement Company (CCC) manufacturing facility.

The emission rates for the criteria pollutants of particulate matter (TSP and PM_{10}), sulphur dioxide (SO_2), nitrogen oxides (NO_X), and carbon monoxide (CO) that are being emitted from the proposed quarries were determined based on the use of USEPA AP42 emission factors and project data. Emission rates for the other facilities were obtained from the Air Dispersion Modeling Report for Caribbean Cement Company Limited dated September 2015, the Air Dispersion, Modeling Report for Halberstadt Gypsum Quarry dated October 2013, and the 2015 Annual Air Emissions Summary Reports for JFMills and CCC.

Building and terrain effects were also included as part of the modeling analyses, and the meteorological data set was defined using the 2011-2015 modeled data with the grid centre at the centroid of sources at both proposed Halberstadt and Harbour Head Quarries. The surface meteorological data was preprocessed, along with the upper air data using the AERMET software programme in order to generate the meteorological input files required by the AERMOD air dispersion model.

The receptor grid system was also determined using a multi-tier grid system that included a 100-meter grid within 3 km from the centroid of project sources (UTME 323110 and UTMN 1987820) and a 500-meter grid spacing between 3 and 10 km from the centroid of project sources. Special receptors inclusive of schools, churches, police stations, postal agencies, post offices, a football stadium, recreation areas, health centres and ambient air quality monitoring stations were also included as part of the receptor network.

With all the input files established, the air dispersion model was executed. The model was run using the rural option based on the Auer (1978) Land Use categories, and the Ozone Limiting Method (OLM) was applied for conversion of NO_X to NO_2 with a NO_2/NO_x ratio of 0.1. The 2012 annual average ozone concentration (27 µg/m³) for the Kingston area that was obtained at an ambient air quality monitoring station at Rockfort, was applied to the OLM.

Tables ES-1 to ES-3 show the results of the model runs for the proposed quarries and their comparisons with the national ambient air quality standards (NAAQS) and/or Guideline Concentrations (GCs), as well as the Significant Impact Concentrations (SICs).

Table 5.1.4: Summary of Model Results for Halberstadt Quarry

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Gypsum Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	34.4	325210	1988120
	Annual	20	60	20	2.9	324710	1987720
PM_{10}	24-hr	9	150	80	22.6	325210	1988120
	Annual	20	50	20	1.5	324710	1987720
NO_2	1-hr	0	400	N/A	2.4	324810	1988020
	24-hr	0	N/A	80	0.34	324750	1987877
	Annual	0	100	20	0.1	324710	1987720
SO_2	1-hr	0	700	N/A	169.0	324810	1988020
	24-hr	0	280	80	23.8	324750	1987877
	Annual	0	60	20	7.4	324710	1987720
CO	1-hr	0	40000	2000	0.34	324810	1988020
	8-hr	0	10000	500	0.13	324610	1988120

Table 5.1.5: Summary of Model Results for Harbour Head Quarry

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Limestone Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	84.3	316142	1988285
	Annual	20	60	20	8.6	316277	1988292
PM_{10}	24-hr	9	150	80	37.2	316142	1988285
	Annual	20	50	20	3.8	316277	1988292
NO_2	1-hr	0	400	N/A	1.4	315610	1988820
	24-hr	0	N/A	80	0.36	316277	1988292
	Annual	0	100	20	0.04	316110	1988320
SO_2	1-hr	0	700	N/A	98.7	315610	1988820
	24-hr	0	280	80	25.8	316277	1988292
	Annual	0	60	20	2.7	316110	1988320
CO	1-hr	0	40000	2000	0.2	315610	1988820
	8-hr	0	10000	500	0.085	316277	1988292

Table 5.1.6: Summary of Model Results for Quarries

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Gypsum & Limestone Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	84.4	316142	1988285
	Annual	20	60	20	8.6	316277	1988292
PM_{10}	24-hr	9	150	80	37.2	316142	1988285
	Annual	20	50	20	3.8	316277	1988292

NO_2	1-hr	0	400	N/A	2.4	324810	1988020
	24-hr	0	N/A	80	0.36	316277	1988292
	Annual	0	100	20	0.1	324710	1987720
SO_2	1-hr	0	700	N/A	169.0	324810	1988020
	24-hr	0	280	80	25.8	316277	1988292
	Annual	0	60	20	7.4	324710	1987720
CO	1-hr	0	40000	2000	0.34	324810	1988020
	8-hr	0	10000	500	0.13	324610	1988120

The maximum ambient model predictions for the quarries, both separately and in combination, revealed total compliance for all averaging periods for the various pollutants analyzed. There was also compliance with all applicable significant impact concentrations, except the 24h TSP for the Harbour Head quarry and both quarries together. Notwithstanding this exceedance, the 75% threshold of the applicable standard was not exceeded after the recommended background concentration was added to the predicted concentration.

OPERATIONS OF PROPOSED QUARRIES

It is envisaged that the proposed quarries would involve activities such as drilling, blasting, material transport and stockpiling, as well as the crushing or processing of materials. These activities are expected to be generated by bulldozers, excavators, front end loaders and haul trucks. Table 5.1.7 highlight the spread of equipment to be utilized by the quarries.

Table 5.1.7: Quarry Equipment

Equipment	Halberstadt Quarry	Harbour Head Quarry
Bulldozer	1	1
Excavator	1	1
Front End Loader	1	2
Screen	1	1

Vibrating Grizzly & Hopper	1	1
Crusher	1	1
Haul Truck	4	12
Diesel Generator	1	1

POTENTIAL AIR EMISSIONS

A critical step for conducting the air dispersion modeling is to quantify the emissions from the air pollutant sources at the proposed quarries. The emission rates for the sources identified were derived from the use of USEPA AP42 emission factors and project data and these are displayed in Tables 3.1.4 to 3.1.6.

Source information data for the other air pollutant sources are shown in Tables 5.1.5 through 5.1.6. Emission rates for the other facilities were obtained from the Air Dispersion Modeling Report for Caribbean Cement Company Limited dated September 2015, the Air Dispersion, Modeling Report for Halberstadt Gypsum Quarry dated October 2013, and the 2014 Annual Air Emissions Summary Reports for JFMills and CCC.

The main air pollutants being emitted from the proposed quarry facilities include criteria pollutants such as TSP, PM_{10}, NO_X, SO_2, and CO. It should also be observed that air emissions from the vehicular activities on the proposed quarries were not considered as part of the air dispersion modelling exercises.

HISTORICAL AMBIENT AIR QUALITY MONITORING DATA

Historical ambient air quality monitoring data in the vicinity of the proposed quarries were available at four locations where PM_{10} is measured. Table 5.1.8 shows data for years 2011 to 2014 and indicates the first and second high 24h average concentrations, as well as the annual mean concentrations for each year.

The data revealed that the PM_{10} standards for both 24h and annual averages were exceeded every year throughout the period 2011 to 2014 at the Mineral Spa location. Compliance with the standards was achieved for each year at all other locations.

Table 5.1.8: Historical PM10 Ambient Air Quality Monitoring Data

Location	Year	Highest 24-h mean, µg/m³	2nd Highest 24-h mean, µg/m³	Annual Mean, µg/m³
College Commons	2011	56.1	44.3	21.6
	2012	54.0	50.4	24.7
	2013	49.6	34.4	17.4
	2014*	80.1	62.6	35.3
Mineral Bath	2011	**228.8**	**215.5**	**73.9**
	2012	**348.9**	**227.5**	**78.7**
	2013	**218.2**	**205.9**	**80.9**
	2014*	**167.2**	**158.2**	**79.4**
Harbour View	2011	67.7	56.0	31.2
	2012	84.5	67.0	34.9
	2013	71.6	61.5	30.0
	2014*	122.3	90.0	44.1
NEPA	Standard	150	150	50

Bold type indicates exceedence above the standard
*** Only 6 months of 2014 data were available**

5.1.1.9.1 Modelling Approach

The assessment methodology for the air dispersion modeling exercise follows the guidance specified in the Natural Resources Conservation Authority (NRCA) Ambient Air Quality Guideline Document of 2006.

The detailed model recommended in the Ambient Air Quality Guideline Document is AERMOD. The model of selection was the commercially available AERMOD View air dispersion model (version 9.1) that is developed by Lakes Environmental, and is based on modifications as recommended by the United States Environmental Protection Agency (USEPA) that was released in May 2014. This model is used extensively to assess pollution concentration and deposition from a wide variety of sources. AERMOD View is a true, native Microsoft Windows application and runs in Windows applications. The **A**MS/**E**PA **R**egulatory **Mod**el (AERMOD) was specially designed to support the EPA's regulatory modeling programs. AERMOD is a regulatory steady-state plume modeling system with three separate components: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD Terrain Preprocessor), and AERMET (AERMOD Meteorological Preprocessor). The AERMOD model includes a wide range of options for modeling air quality impacts of pollution sources, making it a popular choice among the modeling community for a variety of applications. Some of the modeling capabilities of AERMOD include the following:

- The model may be used to analyze primary pollutants and continuous releases of toxic and hazardous waste pollutants.
- Source emission rates can be treated as constant or may be varied by month, season, hour-of-day, or other optional periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources. For this project all emission rates were treated as constant.
- The model can account for the effects of aerodynamic downwash due to buildings that are nearby point source emissions.
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system.
- For applications involving elevated terrain, the U.S. EPA AERMAP terrain preprocessing program is incorporated into the model to generate hill height scales as well as terrain elevations for all receptor locations.
- The model contains algorithms for modeling the effects of settling and removal (through dry and wet deposition) of large particulates and for modeling the effects of precipitation scavenging for gases or particulates.
- AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are provided by the U.S. EPA AERMET meteorological preprocessor programme.

Emission Sources

A critical step for conducting the air dispersion modeling is to quantify the emissions from the air pollutant sources at the proposed quarries (see Figures 3-1 and 3-2). The emission rates for the sources identified were derived from the use of USEPA AP42 emission factors and project data and these are displayed in Tables 3-1 to 3-3.

Source information data for the other air pollutant sources are shown in Tables 3-4 through 3-10. Emission rates for the other facilities were obtained from the Air Dispersion Modeling Report for Caribbean Cement Company Limited dated September 2015, the Air Dispersion, Modeling Report for Halberstadt Gypsum Quarry dated October 2013, and the 2014 Annual Air Emissions Summary Reports for JFMills and CCC.

Table 3-7: Emission rates for Jamaica Flour Mills

Source ID	Description	TSP, g/s	PM_{10}, g/s	SO_2, g/s	NO_X, g/s	CO, g/s
EP01	Shaker Filter SM13	0.1038	0.1038			
EP02	General Suction Filter	0.1038	0.1038			
EP03	Lower Dust Filter #1	0.1038	0.1038			
EP04	Lower Dust Filter #2	0.1038	0.1038			
EP05	Rice Mill Polishing Filter	0.0047	0.0047			
EP06	Rice Mill Filter CM915	0.0095	0.0095			
EP07	A-Mill Polishing Filter	0.0047	0.0047			
EP08	A-Mill Screen Cleaning	0.0438	0.0438			
EP09	A-Mill Filter AM95	0.0155	0.0155			
EP10	A-Mill Floor Bins Filter	0.0324	0.0324			
EP11	B-Mill Screen Cleaning	0.0155	0.0155			
EP12	B-Mill Filter BM119	0.0155	0.0155			
EP13	B-Mill Filter BM120	0.0155	0.0155			
EP14	B-Mill Filter BM121	0.0155	0.0155			
EP15	B-Mill Filter BM122	0.0155	0.0155			
EP16	B-Mill Expansion Filter	0.0533	0.0533			
EP18	Flour Packing Filter	0.0125	0.0125			
EP19	Packing Vacuum Filter	0.0125	0.0125			
EP20	Feed Mill Vacuum Filter	0.0074	0.0074			
EP21	Feed Mill Bin Filters	0.0233	0.0233			
EP22	Pellet Cooler Cyclone #1	0.0654	0.0327			
EP23	Pellet Cooler Cyclone #2	0.0654	0.0327			
EP24	Bulk Flour Loadout	0.0006	0.0001			
EP25	Warehouse Filter AM116	0.0049	0.0049			
EP26	Boiler	0.0005	0.0003	0.0147	0.0052	0.0013
F01	Grain Receiving by Ship	0.4578	0.1160			
F02A	Feed Loadout #1	0.0006	0.0001			
F02B	Feed Loadout #2	0.0006	0.0001			
F03A	Feed Pellet Loadout #1	0.0014	0.0003			
F03B	Feed Pellet Loadout #2	0.0014	0.0003			
F04	Corn Loadout Spout	0.0167	0.0056			

Source: Annual Air Emissions Summary Report for JFMills dated November 2015

Table 3-8. Source Parameters and PM emissions for CCC's Point Sources

Source Description	Source ID	UTME (m)	UTMN (m)	Elev (m)	Stack Height (m)	Stack Dia. (m)	Stack Vel. (m/s)	Stack Temp. (K)	TSP/PM_{10} Emissions (g/s)
CCC Quarry Hammer Mill	QHM	317,783	1,987,119	212.1	15	2.26	0.1	303	0.0028
CCC Coal Pile A Vent	COALA	316,732	1,987,062	20.37	2.4	0.91	11.6	363	0.0002
CCC Coal Pile B Vent	COALB	316,746	1,987,074	22.2	2.4	0.91	11.6	363	0.0002
K4 ESP Discharge	K4EPDIS	316,675	1,987,089	18.33	39.6	0.34	25	303	0
Kiln 4 Homogenizing Silo Vent	4HOMSLV	316,645	1,987,187	27.26	26	0.91	33	303	0
Kiln 4 Homogenizing Silo Discharge	4HOMSLD	316,637	1,987,196	29.08	4.5	0.34	21	303	0
Coal Mill A Cages	CAGES	316,733	1,987,069	20.95	14	1.38	3.2	303	0.0002
Clinker Storage Silos (Top)	CSSTOP	316,742	1,987,180	32.58	41	1.38	2.2	303	0.1442
CCC Gypsum Hammer Mill	GYPHM	316,591	1,987,043	7.09	2	0.2	12	303	0.0013
Clinker Storage Silos (bottom) belts	CSSBOTM	316,756	1,987,164	34.35	12.5	0.2	13	303	0.0368
Cement Mill 4 Separator Vent	CMIL4SV	316,711	1,986,916	12.57	14.6	1.38	5	333	0
Cement Silo 1-4	CSIL124	316,725	1,986,905	12.67	36.5	1.03	3	303	0.2288
Cement Silo 5-8	CSIL528	316,735	1,986,893	12.6	36.5	1.03	3	303	0.2288
Cement Silo 9 vent	CEMENT9	316,627	1,986,846	5.92	36.5	1.03	3	303	0.2288
Cement Silo 10 vent	CEMEN10	316,638	1,986,834	5.2	36.5	1.03	3	303	0.2288
Distribution Bin	DISTBIN	316,620	1,986,859	6.63	36.5	1.03	3	303	0.2288
Transfer Station	XFERSTN	316,717	1,986,898	12.17	36.5	1.03	3	303	0.2288
Big Bag Loading	BAGLOAD	316,622	1,986,786	4.13	10.5	1.03	5	303	0.1135
Packer 4	PACK4	316,618	1,986,868	6.87	10.5	0.91	5	303	0.1135
Packer 5	PACK5	316,609	1,986,859	6.4	10.5	0.91	5	303	0.1153
Cement Silo 9 and 10 Discharge	CS9&10D	316,635	1,986,842	5.53	10.5	0.91	5	333	0.0711
Raw Mill Bin Feed Belt vent	K5RMFB20	316,902	1,987,022	36.17	3	0.25	14	303	0.0159
Raw Mill Bin Feed Belt vent	K5RMFB30	316,809	1,987,089	30.28	10	0.25	14	303	0.0159
Raw Mill Bins	K5RMBINS	317,045	1,987,022	67.72	30	0.4	15	303	0.0414
Raw Mill Feed Belt	5RMBEL91	317,040	1,987,026	66.2	10	0.4	14	303	0.0398
Raw Mill Feed Belt	5RMBEL97	316,975	1,987,071	51.33	24	0.3	17	303	0.0265
Raw Mill System Fugitive	5RMSYSFG	316,966	1,987,082	49.93	10	0.4	14	303	0.0393
Raw Mill Cyclone Fugitive	5RMCYCFG	316,968	1,987,075	50	10	0.3	16	303	0.0255
Kiln 5 Homogenizing Silo vent	5HOMSILV	316,931	1,987,135	50.86	34	0.45	15	303	0.0531
Kiln 5 Homogenizing Silo Discharge	5HOMSILD	316,935	1,987,137	52.45	10	0.45	15	303	0.0531
Kiln 5 Feed vent	K5FEEDV	316,928	1,987,133	49.66	95	0.4	14	303	0.0407
Kiln 5 Clinker Cooler	CLC5	316,858	1,987,151	50.77	29	1.8	13	394	0.887
New CSBELTS	CSBELNEW	316,760	1,987,189	39.08	14	1.38	3.2	303	0.0368
Cement Mill 3	CMILL3	316,703	1,986,921	12.23	10.7	1.38	6	363	0
Cement Mill 4	CMILL4	316,709	1,986,911	12.3	20	1.38	7	363	0
Kiln 5 Stack	CCK5	316,910	1,987,098	43.13	117.5	2.65	20.6	393.1	1.08
Coal Mill Possimetric Surge Bins	CMSBINS	316,737	1,987,072	21.34	14	1.03	3	303	0.0004
Cement Mill 5	CMILL5	316,687	1,987,143	21.18	20	1.5	4.7	375.1	0.2288
Cement Mill 5 Separator Vent	CMILL5SV	316,687	1,987,155	23.08	15	1.5	5	333	0.6816

CCC Shale Hammer Mill	SHM	316,597	1,987,035	7.58	2	0.2	12	303	0.0009

Source: Annual Air Emissions Summary Report for CCC dated June 2015

Table 3-9. Area Source Locations and PM Emissions for the CCC Facility

Source Description	Source ID	UTME (m)	UTMN (m)	Elevation (m)	Release Height (m)	TSP/PM_{10} Emissions (g/s)	Area (m^2)
CCC Quarry	QUARRY	317,164	1,987,320	203	6	3.14848	606,840
Coal Yard	COALYARD	316,200	1,987,116	6.0	6	0.00426	52,500
Gypsum Yard	GY	316,645	1,987,020	11.3	6	0.03763	294.5
Clinker Storage Yard	CSY	317,092	1,986,888	40.04	6	0.42332	2,209
Playfield	PLAYFIELD	317,169	1,986,881	48.1	6	0.15735	5,720

Source: Annual Air Emissions Summary Report for CCC dated June 2015

Table 3-10. Other Emissions for the CCC Kiln 5 Stack

Source Description	Source ID	UTME (m)	UTMN (m)	SO_2 (g/s)	NO_x (g/s)	CO (g/s)
Kiln 5 Stack	CCK5	316,910	1,987,098	6	60.3	111.9

Source: Annual Air Emissions Summary Report for CCC dated June 2015

Figure 3-1: Map showing Halberstadt's Air Pollutant Sources

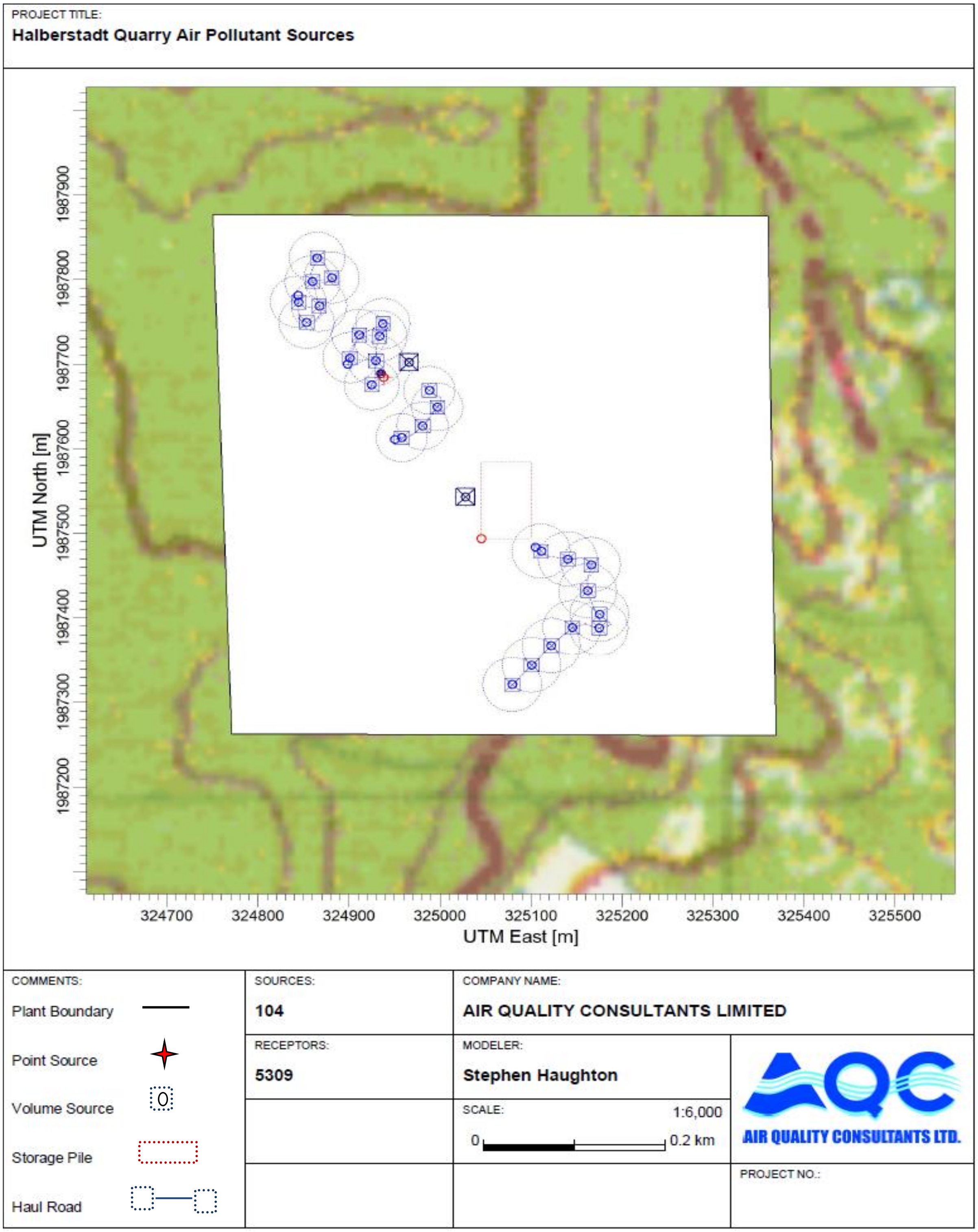
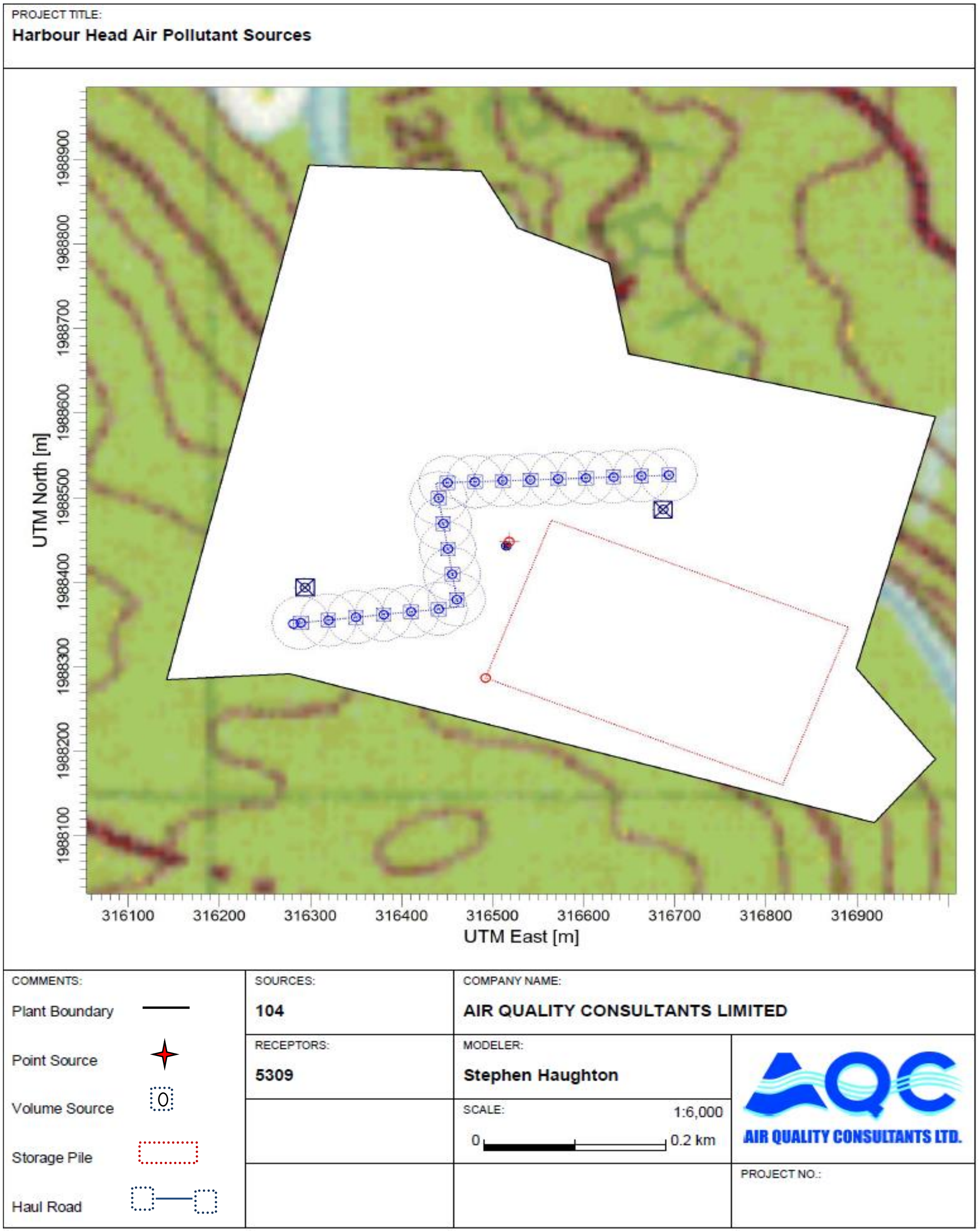


Figure 3-2: Map showing Harbour Head's Air Pollutant Sources



Comparison of Proposed Quarry Emission Rates with Emission Standards

According to the Natural Resources Conservation Authority (Air Quality) Regulations, there are no specific mass-based emission limits for quarry operations (including a diesel generator with less than 2 MW capacity). Hence, no direct comparison can be made with the emission rates for the proposed quarry operations at Halberstadt and Harbour Head.

Building Downwash Effects

Buildings located close to point sources (see Figure 3-3) at the facility may significantly affect the dispersion of the pollutants from the source. If the point source is relatively low, the air pollutants released may be trapped in the wake zone of nearby obstructions (structures or terrain features) and may be brought down to ground level in the immediate vicinity of the release point (down-wash). It is therefore necessary to determine if such effects are present for each point source.

The "Good Engineering Practice" (GEP) height is defined as the height necessary to ensure that point source emissions do not result in excessive pollutant concentrations in the immediate vicinity of the source. These excessive concentrations may be the result of atmospheric downwash, eddies, or wakes that may be created by the source itself, nearby structures, or nearby terrain obstacles. If a point source is below the GEP height, then the plume entrainment must be taken into account by modifying certain dispersion parameters used in the dispersion model. However, if the point source height meets GEP, then entrainment within the wake of nearby obstructions is unlikely and need not be considered in the modeling.

The GEP height formula is: $Hg = H + 1.5*L$ where Hg is the GEP height measured from ground level elevation at the base of the point source, H is the height of nearby structure(s) measured from the ground level elevation at the base of the point source, and L is the lesser dimension, height or projected width, of the nearby structure(s). This definition will allow the consideration of all stacks up to a height of 65 m.

A building or structure is considered sufficiently close to a point source to cause wake effects when the minimum distance between the point source and the building is less than or equal to five times the lesser of the height or projected width of the building (5L). This distance is commonly referred to as the building's "region of influence." If the source is located near to more than one building, each building and point source configuration would have to be assessed separately. If a building's projected width is used to determine 5L, then the apparent width of the building must be determined. The apparent width is the width as seen from the source looking toward either the wind direction or the direction of interest. For example, for short-term modeling, the AERMOD model requires the apparent building widths (and also heights) for every 10 degrees of azimuth around each source. The AERMOD model also contains algorithms for determining the impact of downwash on ambient concentration and was used for determining predicted maximum estimates.

There are a number of buildings nearby the point sources that were identified in the modeling project and these are sufficiently close to cause wake effects for the plumes. The dimensions of the various buildings as well as the parameters for the various point sources were inputted into the Building Profile Input Program (BPIP) to generate the necessary building heights and widths.

The USEPA BPIP was designed to incorporate the concepts and procedures expressed in the GEP technical support document (EPA, 1985), the Building Downwash guidance (Tikvart 1988, Tikvart 1989, and Lee 1993), and other related documents into a program that correctly calculates building heights (BHs) and projected building widths (PBWs). The BPIP model is divided into two parts.

Part one (based on the GEP technical support document) is designed to determine whether or not a stack is subject to wake effects from a structure or structures. Values are calculated for GEP stack height and GEP-related BHs and PBWs. Indication is given to which stacks are being affected by which structure wake effect. Part two calculates building downwash BHs and PBWs values based on references Tikvart, 1988, Tikvart

1989, and Lee 1993, which can be different from those calculated in part one. Part two only performs the calculations if structure wake effects are influencing a particular stack.

No building downwash effect was considered for the proposed quarries since the only point source that exist at each proposed location is not isolated, but attached to the crusher-hopper-screen device. Nevertheless, it is envisaged that no downwash would be created in a vicinity of a site building as the expected location will exceed the building's "region of influence".

Meteorological Data

The AERMOD model requires hourly surface data values for wind speed, wind direction, temperature,

rainfall, relative humidity, pressure, cloud cover and ceiling height and solar radiation and at least once daily mixing height data. Both surface and upper air data were obtained as modeled meteorological data for years 2011 through 2015 based on a mesoscale numerical weather prediction model (see Appendix for further details).

These data were submitted directly into the AERMET meteorological preprocessor programme, which uses three stages to process the data. The first stage extracts meteorological data and assesses data quality through a series of quality assessment checks. The second stage merges all data available for 24-hour periods and writes these data together in a single intermediate file. The third and final stage reads the merged meteorological data and estimates the necessary boundary layer parameters for dispersion calculations by AERMOD.

The surface parameters within a 3-km radius around the centre of the modeling domain that were applied to the AERMET processor are listed in Table 3-11.

The preprocessed modeled meteorological data was used to determine its corresponding Wind Rose plot (see Figure 3-3). The Wind rose show that the most predominant wind direction blows from the southeast, with the secondary wind direction being from the east-southeast. This means that the emissions plume will be dispersed mainly in the northwestern direction, and secondarily in the west-northwestern direction from the Red Stripe facility. For the five years' data that were modeled, the average wind speed was determined to be 4.26 m/s.

Table 3-11: Surface Parameters for AERMET Processor

Sector (angle from north)	Land Use	Albedo	Bowen Ratio	Surface Roughness
0 – 140°	Deciduous Forest	0.215	0.875	0.9
140 – 160°	Urban	0.2075	1.625	1
160 – 180°	Deciduous Forest	0.215	0.875	0.9
180 – 230°	Urban	0.2075	1.625	1
230 – 360°	Deciduous Forest	0.215	0.875	0.9

Model Domain, Receptor Network and Terrain Considerations

The selected model domain was 10 km in the north-south direction and 10 km in the east-west direction, with the centre of the domain being the centroid of project sources at (UTME 323110 and UTMN 1987820). Figure 3-4 shows part of the model domain with the receptor grid and the plant boundary. The model domain is overlain on a Jamaica Metric Grid 1:50,000 topographic map.

Receptor Network

The selection and location of the receptor network are important in determining the maximum impact from a source and the area where there is significant air quality impact. Impacts were assessed at locations beyond the facility fence line. Consequently, the receptor locations were selected as a multi-tier grid that is defined by discrete Cartesian receptors, square in shape, and with origin at the centroid of the project sources. Certain special receptor locations were also defined, including schools, churches, police stations, postal agencies, post offices, a football stadium, recreation areas, health centres and ambient air quality monitoring stations were also included as part of the receptor network.

The entire receptor network locations include the following:

- A 100-meter spaced grid within 3 km from the subject source;
- A 500-meter spaced grid between 3 and 10 km of the subject source;
- A total of 34 special receptors that include schools, churches, police stations, postal agencies, post offices, a football stadium, recreation areas, health centres and ambient air quality monitoring stations (see Table 3-12); and
- A total of 88 plant boundary receptors

A total of 5,309 receptors were considered, and some of these are graphically depicted in Figure 3-4.

Figure 3-3: Wind Rose Plot – 2011-2015 Modeled Met Data for Project Site

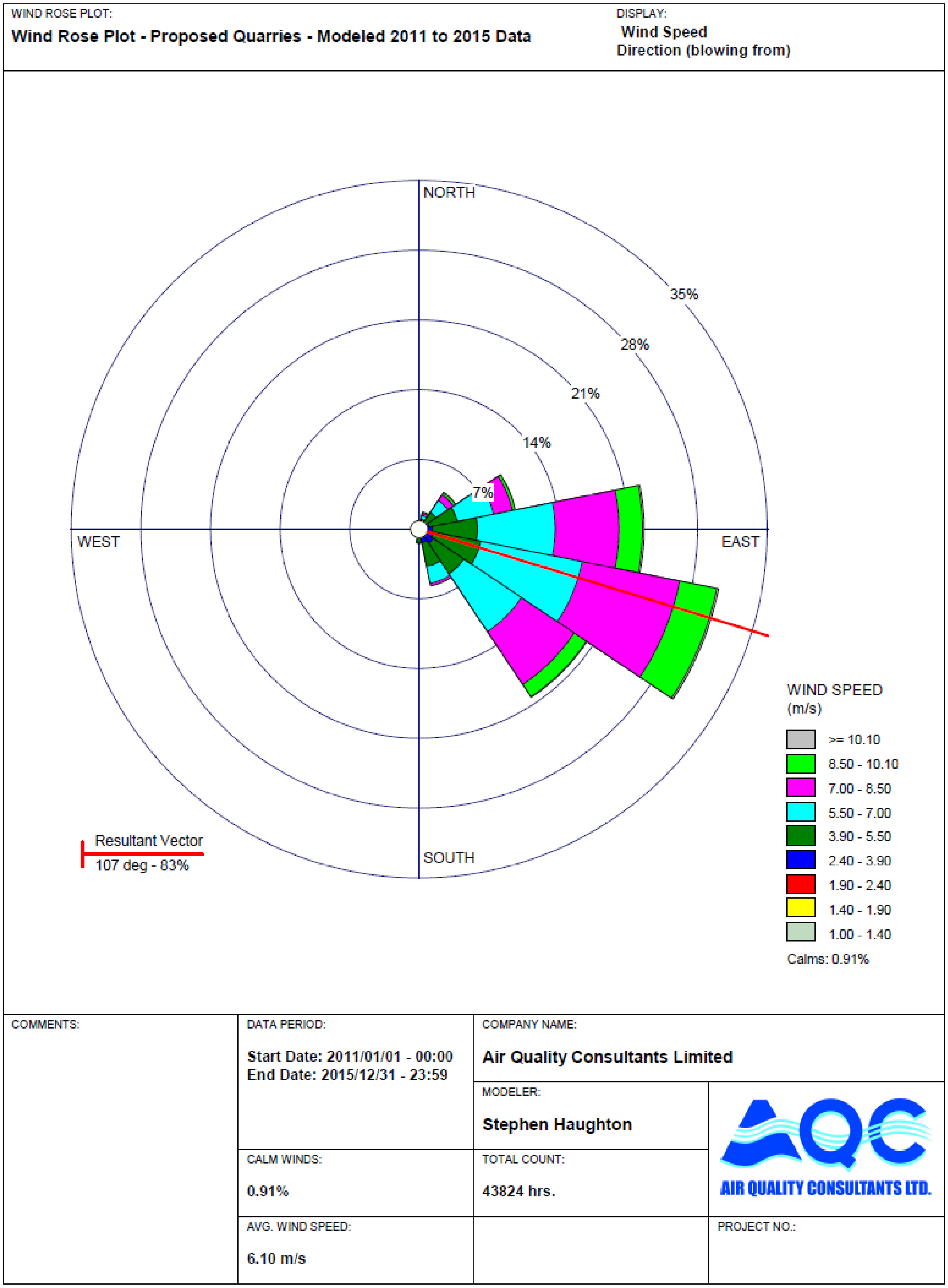
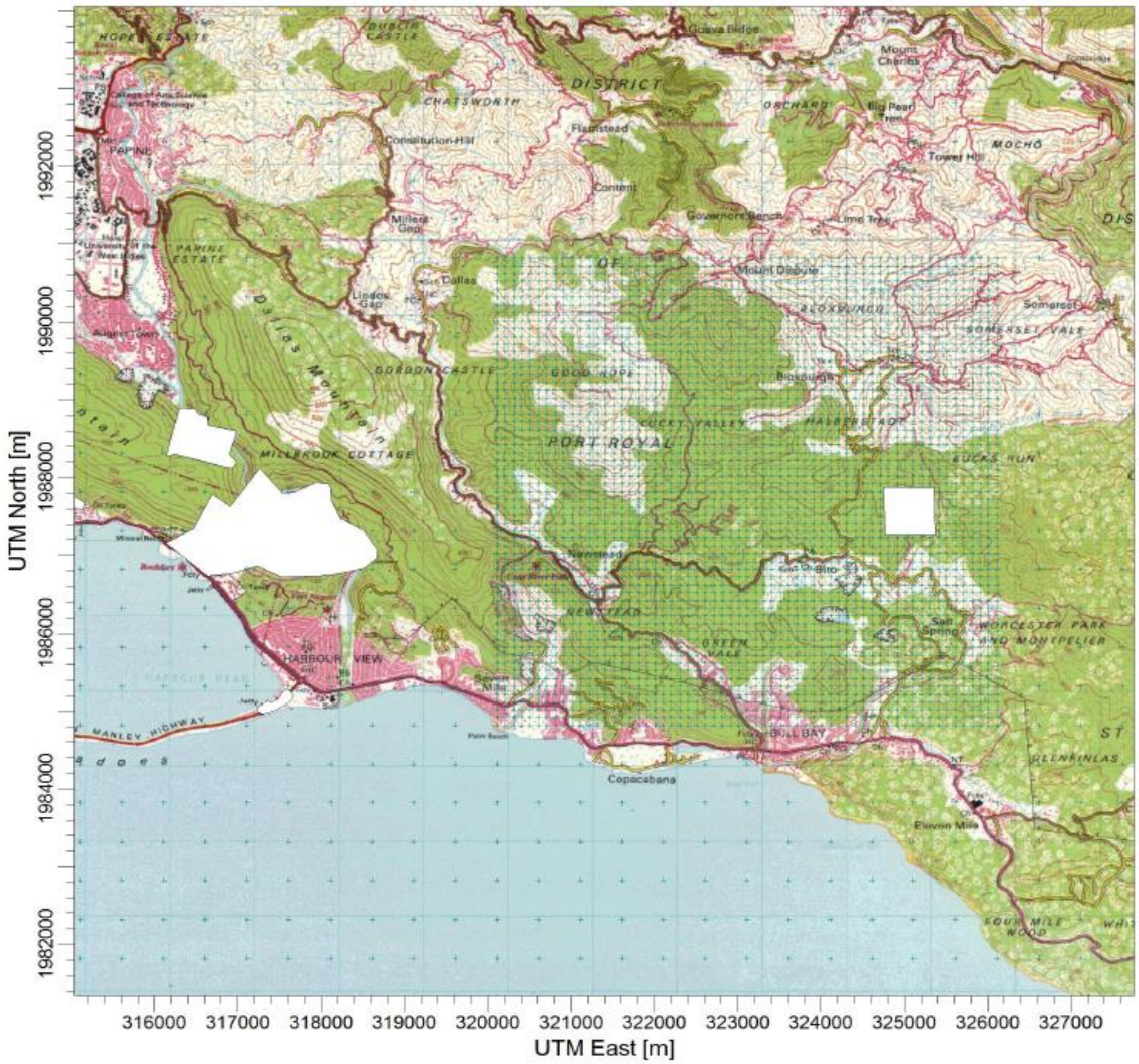


Figure 3-4: Model Domain showing the Receptor Grid

PROJECT TITLE:

Partial Model Domain Showing Receptors



COMMENTS:	SOURCES:	COMPANY NAME:	
Receptors	104	**AIR QUALITY CONSULTANTS LIMITED**	
Plant Boundary	RECEPTORS: 5309	MODELER: **Stephen Haughton**	AIR QUALITY CONSULTANTS LTD.
		SCALE: 1:80,000 (0 – 3 km)	
			PROJECT NO.:

Table 3-12: Special Receptors

Description	X Coordinate, m	Y Coordinate, m	Elevation, m
Bull Bay Police Station	323181	1984543	32.03
Bull Bay Health Centre	323337	1984723	27.04
Church at Bull Bay	324574	1984741	49.37
Bull Bay All Age School	324604	1984934	60.34
Bull Bay Post Office	324214	1984615	30.7
Church at Cocoa Walk	329907	1986423	161.18
Woburn Lawn Primary School	329967	1991696	630.72
Somerset All Age & Infant School	327463	1990218	388.18
Church at Somerset	327619	1990056	345.83
Tower Hill Postal Agency	325199	1992260	886.3
Tower Hill Primary School	324971	1991984	883.88
Church at Lime Tree	324040	1991263	957.1
Bloxburgh Primary & Infant School	325001	1989588	910.5
Church at Bloxburgh	324935	1989540	900.33
Bito Primary &Infant School	323764	1986903	385.46
Church at Bito	323818	1986975	388.37
Bito Postal Agency	323896	1987047	414.3
Cane River Falls	320647	1986921	239.32
Church at Newstead	321379	1986453	187.01
St. Benedict's Primary School	321572	1986069	182.03
Church near Donald Quarrie High School	318203	1985211	7.77
Harbour View Health Centre	317838	1985574	15.28
Harbour View Police Station	318265	1985480	10.06
Harbour View Post Office	317884	1985804	18.53
Harbour View Church	317537	1986264	31.92
Mineral Bath	316348	1987314	13.85
Mountain View Police Station	313421	1988895	37.55
Norman Gardens Primary & Junior High School	313559	1988795	39.27
Harbour View Mini Football Stadium	318152	1986207	26.96
Aqua Park	318093	1985442	13.94
Donald Quarrie Comprehensive High School	318204	1985194	7.8
College Commons PM_{10} Monitoring Site	314660	1991124	173.27
Harbour View PM_{10} Monitoring Site	317810	1985898	17.67
Mineral Bath PM_{10} Monitoring Site	316203	1987347	8.9

Terrain Considerations

The classification of the land use in the vicinity of the proposed facilities was needed for the model runs because dispersion rates differ between urban and rural areas. In general, urban areas cause greater rates of dispersion because of increased turbulent and buoyancy-induced mixing. This is due to the combination of greater surface roughness caused by more buildings and structures and greater amounts of heat released from concrete and similar surfaces. The USEPA guidance provides two procedures to determine whether the character of an area is predominantly urban or rural. One procedure is based on land-use type, and the other is based on population density. Both procedures require an evaluation of characteristics within a 3-km radius from the subject source, but the land-use methodology is considered more accurate. Hence, this method was applied and it was determined that the urban dispersion coefficient be selected for this modeling project.

According to the land-use type methodology, a 3 km radius circle was circumscribed about the boiler B1 stack. Then using the Auer land use types, about 25% (less than the 50% threshold) of the 3-km radius area around the project site matches the urban zones of I1, I2, C1, and R2 (see Figure 3-5), and hence the rural option was selected.

Figure 3-5: Land Use Categories

Auer Land Use Categories I1, I2, C1, & R2 (Auer 1978)

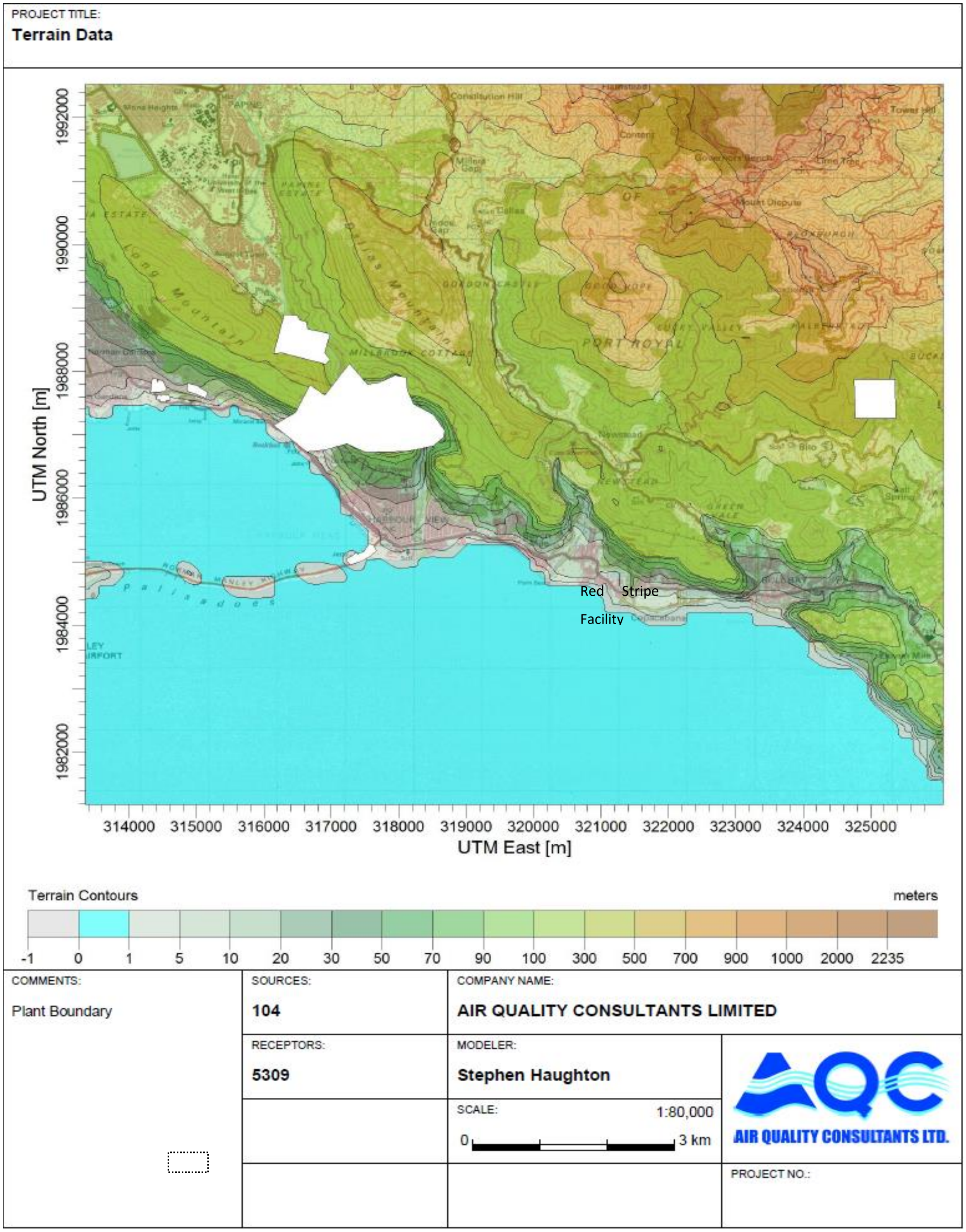
Type	Use and Structure	Vegetation
I1	Heavy Industrial	Grass and tree growth extremely rare; <5% vegetation
	Major chemical, steel and fabrication industries; generally, 3-5 story buildings, flat roofs	
I2	Light-moderate industrial	Very limited grass, trees almost totally absent; <5% vegetation
	Rail yards, truck depots, warehouse, industrial parks, minor fabrications; generally, 1-3 story buildings, flat roofs	
C1	Commercial	Limited grass and trees; <15% vegetation
	Office and apartment buildings, hotels; >10 story heights, flat roofs	
R2	Compact Residential	
	Single, some multiple, family dwelling with close spacing; generally, <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn sizes and shade trees; <30% vegetation

Source: Auer, A. H. 1978. Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology, 17:636-643

Additionally, the topography in the region of the proposed quarries is defined as either simple terrain (terrain lying below the stack top elevation) or complex terrain (terrain above the top of release heights). Measurements of the terrain in the area surrounding the facility were obtained using Shuttle Radar Topography Mission terrain data files.

It was determined that the topographic area generally range from 0m to about 2235m in terrain elevation (see Figure 3-6). Therefore, since some terrain elevations extend above the greatest release heights, complex terrain algorithms were included as part of the air dispersion modeling analyses.

Figure 3-6: Terrain Data for the project area



Model Results

With the various sources identified, a model domain established of 10 km in the east-west direction and 10 km in north-south direction with its centre at the centroid of project sources, and the necessary input files created, model predictions were made for the pollutants SO_2, NO_2, TSP, PM_{10}, and CO for averaging periods for which there are JNAAQS or GC. Model runs were conducted for the proposed air pollutant sources alone at each quarry site, as well as the cumulative air quality impact in combination with the other defined sources within the air shed.

During the NO_X model runs, the Ozone Limiting Method (OLM) was applied to convert NO_X to NO_2. The in-stack NO_2/NO_X ratio of 0.1 was utilized in the OLM and this was applied to the 2012 average annual ozone concentration (27 $\mu g/m^3$) that was obtained at an ambient air quality monitoring station located at Rockfort in Kingston.

Proposed Quarry Impacts

Tables 4-1 to 4-3 summarize the maximum predicted concentrations for the proposed quarry air pollutant sources, as well as their comparison with the JNAAQS, SIC and GC.

The results revealed total compliance with the JNAAQS and GC for all averaging periods for the various pollutants analyzed. There was also compliance with all applicable SICs, except the 24h TSP for the Harbour Head quarry and both quarries together, that only demonstrated a marginal exceedance of 5.5%. Notwithstanding this exceedance, the 75% threshold of the applicable standard was not exceeded after the recommended background concentration was added to the predicted concentration.

Table 4-1: Model Results – Halberstadt Quarry

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Gypsum Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	34.4	325210	1988120
	Annual	20	60	20	2.9	324710	1987720
PM_{10}	24-hr	9	150	80	22.6	325210	1988120
	Annual	20	50	20	1.5	324710	1987720
NO_2	1-hr	0	400	N/A	2.4	324810	1988020
	24-hr	0	N/A	80	0.34	324750	1987877
	Annual	0	100	20	0.1	324710	1987720
SO_2	1-hr	0	700	N/A	169.0	324810	1988020
	24-hr	0	280	80	23.8	324750	1987877
	Annual	0	60	20	7.4	324710	1987720
CO	1-hr	0	40000	2000	0.34	324810	1988020
	8-hr	0	10000	500	0.13	324610	1988120

Table 4-2: Model Results for Harbour Head Quarry

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Limestone Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	84.3	316142	1988285
	Annual	20	60	20	8.6	316277	1988292
PM_{10}	24-hr	9	150	80	37.2	316142	1988285
	Annual	20	50	20	3.8	316277	1988292
NO_2	1-hr	0	400	N/A	1.4	315610	1988820
	24-hr	0	N/A	80	0.36	316277	1988292
	Annual	0	100	20	0.04	316110	1988320
SO_2	1-hr	0	700	N/A	98.7	315610	1988820
	24-hr	0	280	80	25.8	316277	1988292
	Annual	0	60	20	2.7	316110	1988320
CO	1-hr	0	40000	2000	0.2	315610	1988820
	8-hr	0	10000	500	0.085	316277	1988292

Table 4-3: Model Results for Quarries

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Significant Impact Concentration (µg/m³)	Gypsum & Limestone Quarry Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	80	84.4	316142	1988285
	Annual	20	60	20	8.6	316277	1988292
PM_{10}	24-hr	9	150	80	37.2	316142	1988285
	Annual	20	50	20	3.8	316277	1988292
NO_2	1-hr	0	400	N/A	2.4	324810	1988020
	24-hr	0	N/A	80	0.36	316277	1988292
	Annual	0	100	20	0.1	324710	1987720
SO_2	1-hr	0	700	N/A	169.0	324810	1988020
	24-hr	0	280	80	25.8	316277	1988292
	Annual	0	60	20	7.4	324710	1987720
CO	1-hr	0	40000	2000	0.34	324810	1988020
	8-hr	0	10000	500	0.13	324610	1988120

Additionally, Tables 4-4 and 4-5 show the ten highest 24h TSP model predictions for the Harbour Head Quarry and both quarries combined, and they indicate that the second highest predicted 24h TSP concentration is less than the corresponding 24h SIC.

Table 4-4: Ten Highest 24h TSP Modeling Data – Harbour Head Quarry

Predicted Concentrations, µg/m³	X Coordinate, m	Y Coordinate, m
84.3	316142	1988285
72.6	316277	1988292
62.6	316110	1988320
60.4	316649	1988670
45.5	316628	1988778
40.6	316610	1988820
39.9	316527	1988819
31.1	316487	1988886
30.4	316986	1988596
30.4	317110	1988320

Table 4-5: Ten Highest 24h TSP Modeling Data – Proposed Quarries

Predicted Concentrations, µg/m³	X Coordinate, m	Y Coordinate, m
84.4	316142	1988285
72.7	316277	1988292
62.6	316110	1988320
60.6	316649	1988670
45.6	316628	1988778
40.8	316610	1988820
40.1	316527	1988819
34.4	325210	1988120
31.3	316487	1988886
30.5	316986	1988596

Figures 4-1 through 4-12 show the pollutant contour plot-files for TSP, PM_{10}, NO_2, SO_2, and CO for the proposed quarries. The plot files show the most impacted areas based on the predicted pollutant concentrations generated by the model runs. The colour coded scale in the figures indicates the various impact concentrations obtained up to the predicted maximum concentrations achieved.

Figure 4-1: Predicted 24-h TSP Concentrations – Proposed Quarries

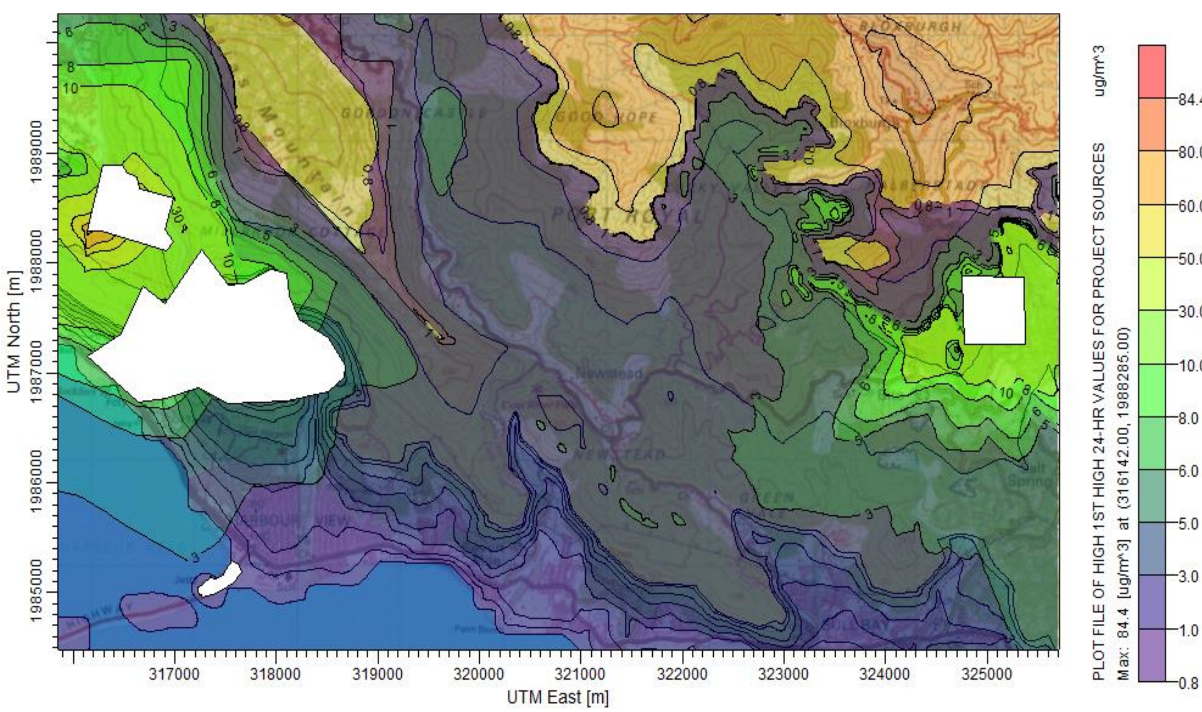


Figure 4-2: Predicted Annual TSP Concentrations – Proposed Quarries

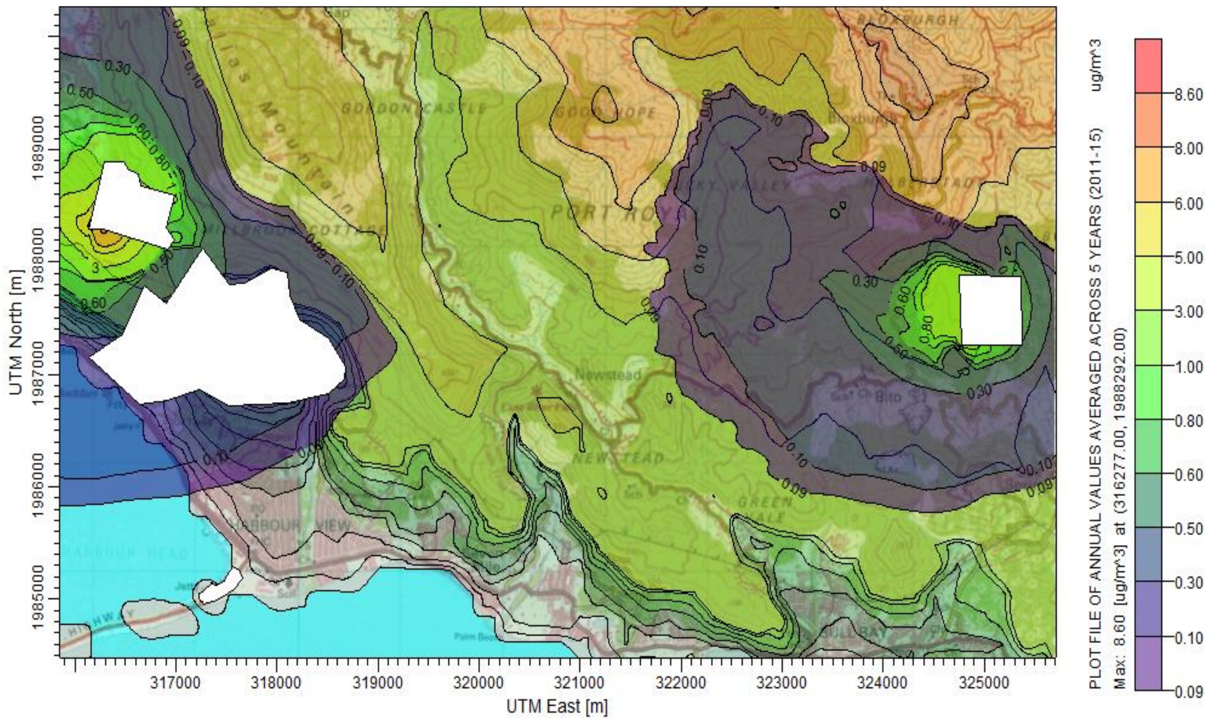


Figure 4-3: Predicted 24-h PM_{10} Concentrations – Proposed Quarries

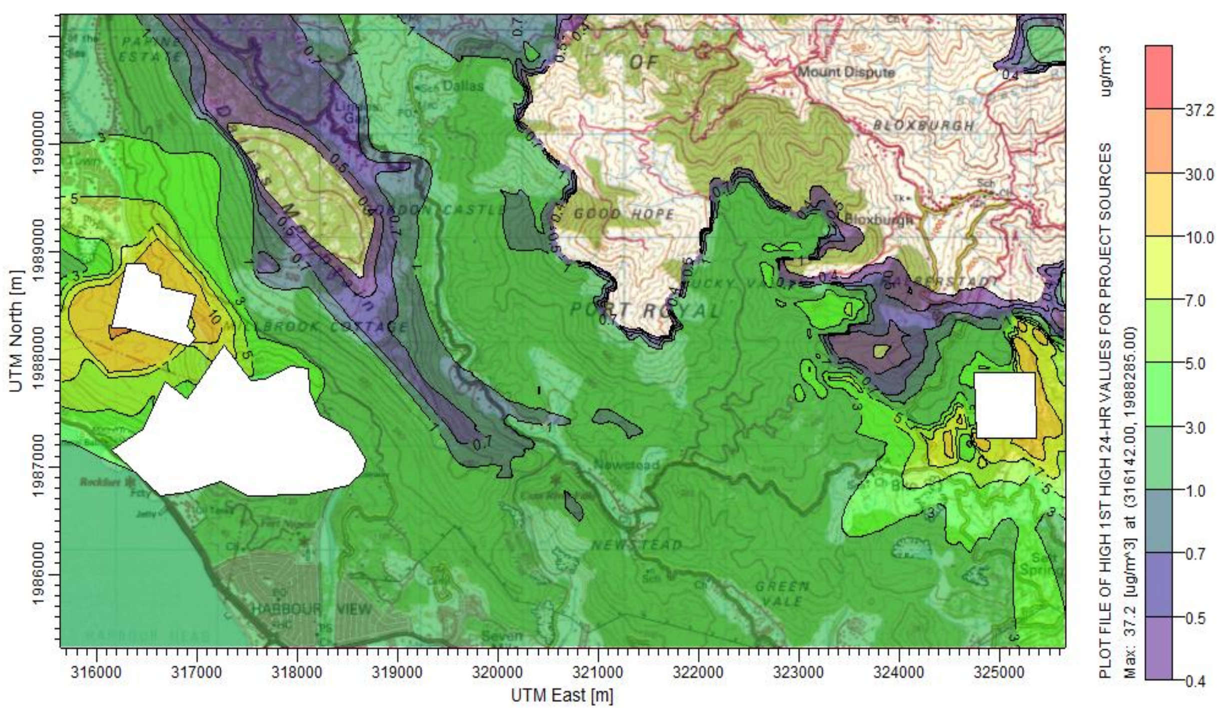


Figure 4-4: Predicted Annual PM_{10} Concentrations – Proposed Quarries

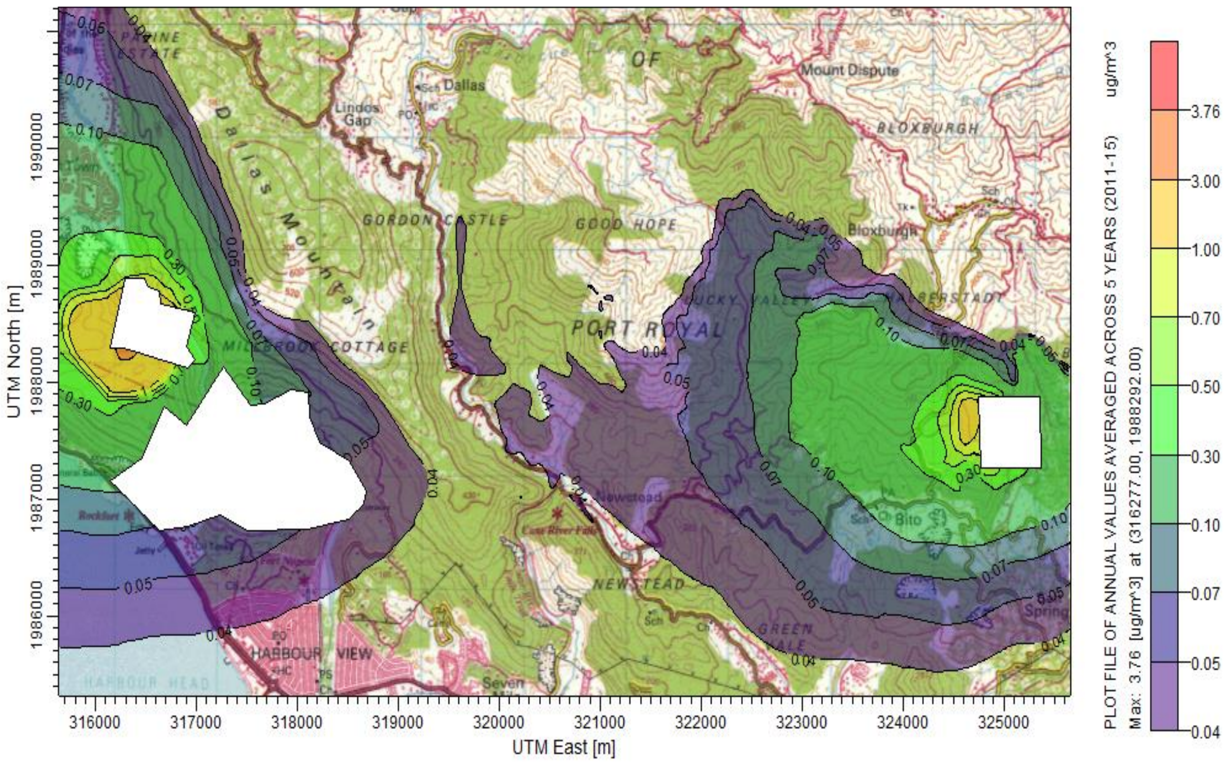


Figure 4-5: Predicted 1-h NO_2 Concentrations – Proposed Quarries

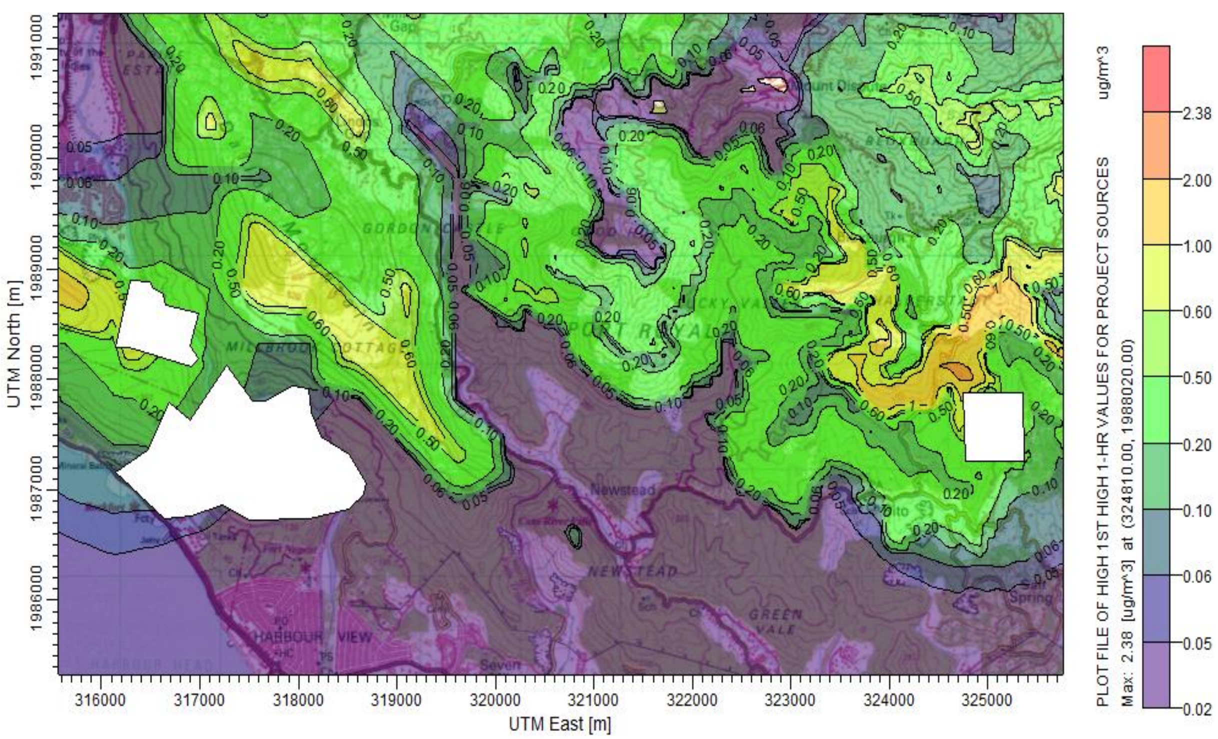


Figure 4-6: Predicted 24-h NO_2 Concentrations – Proposed Quarries

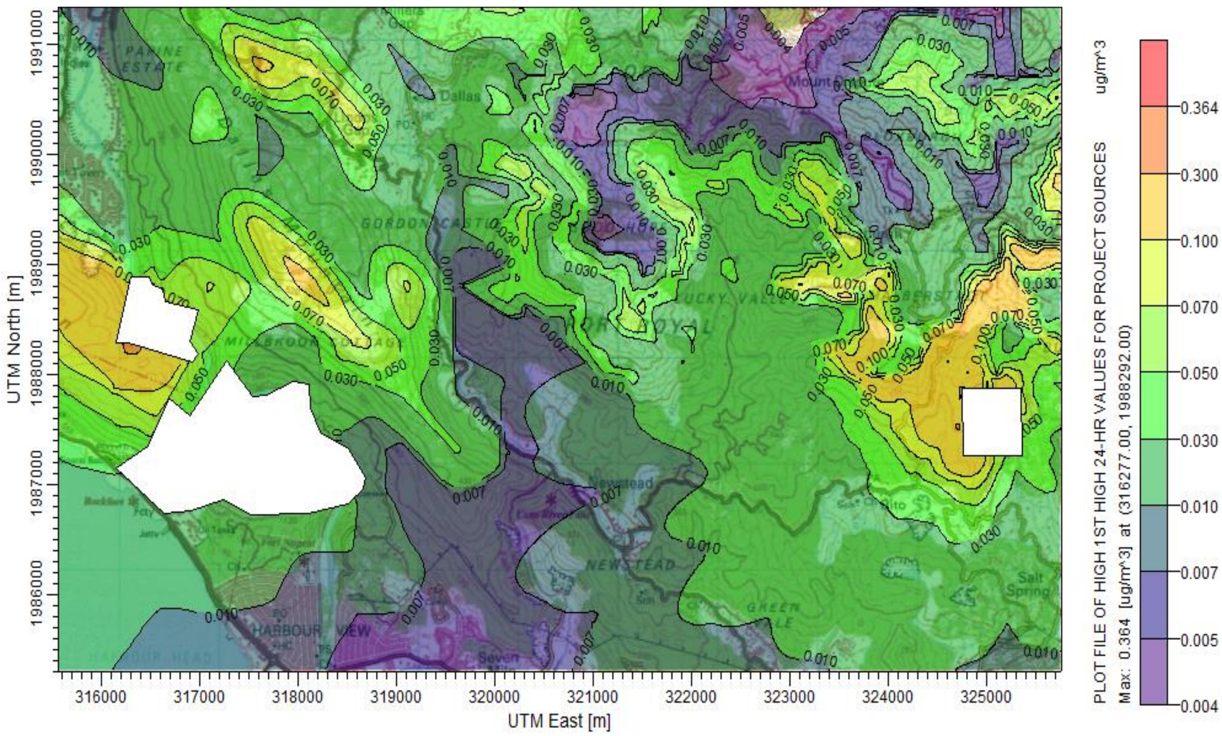


Figure 4-7: Predicted Annual NO_2 Concentrations – Proposed Quarries

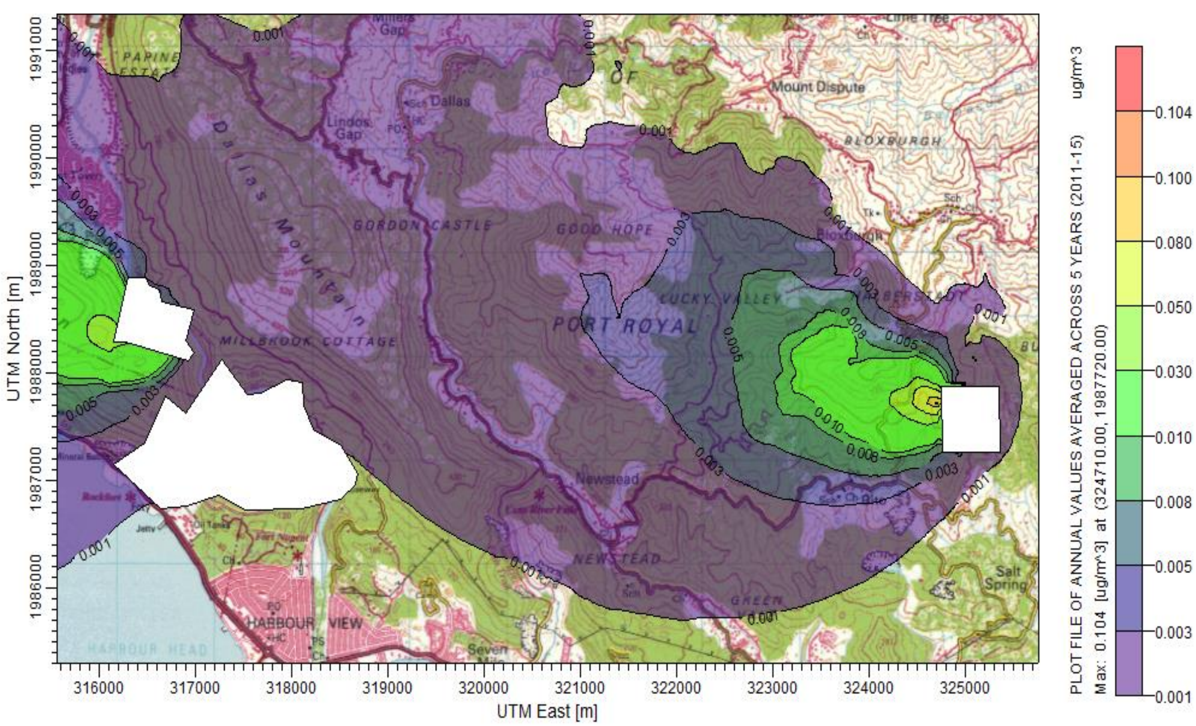


Figure 4-8: Predicted 1-h SO_2 Concentrations – Proposed Quarries

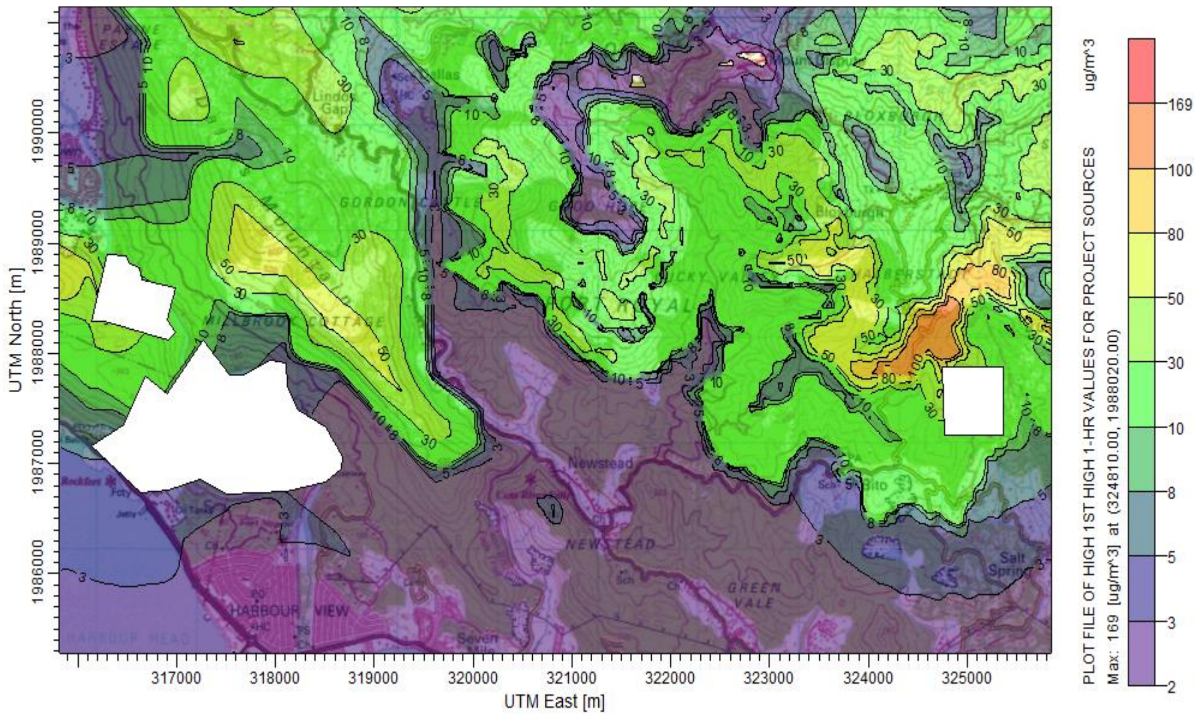


Figure 4-9: Predicted 24-h SO_2 Concentrations – Proposed Quarries

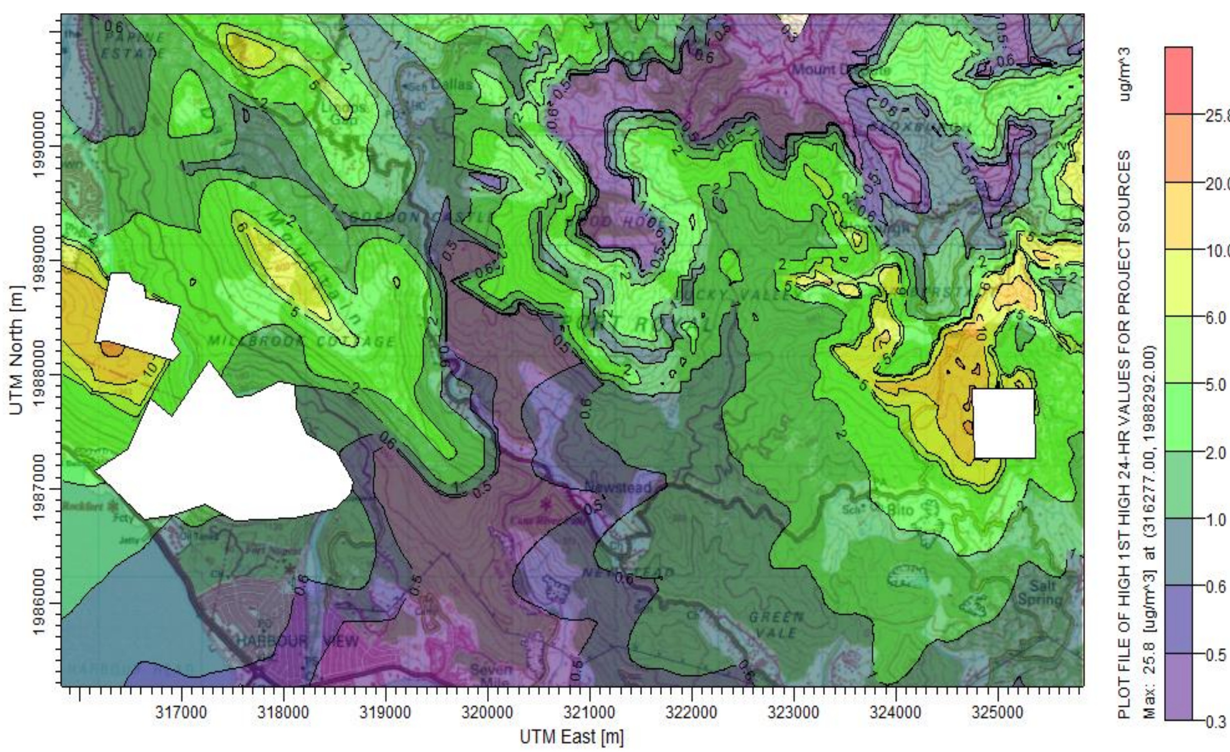


Figure 4-10: Predicted Annual SO_2 Concentrations – Proposed Quarries

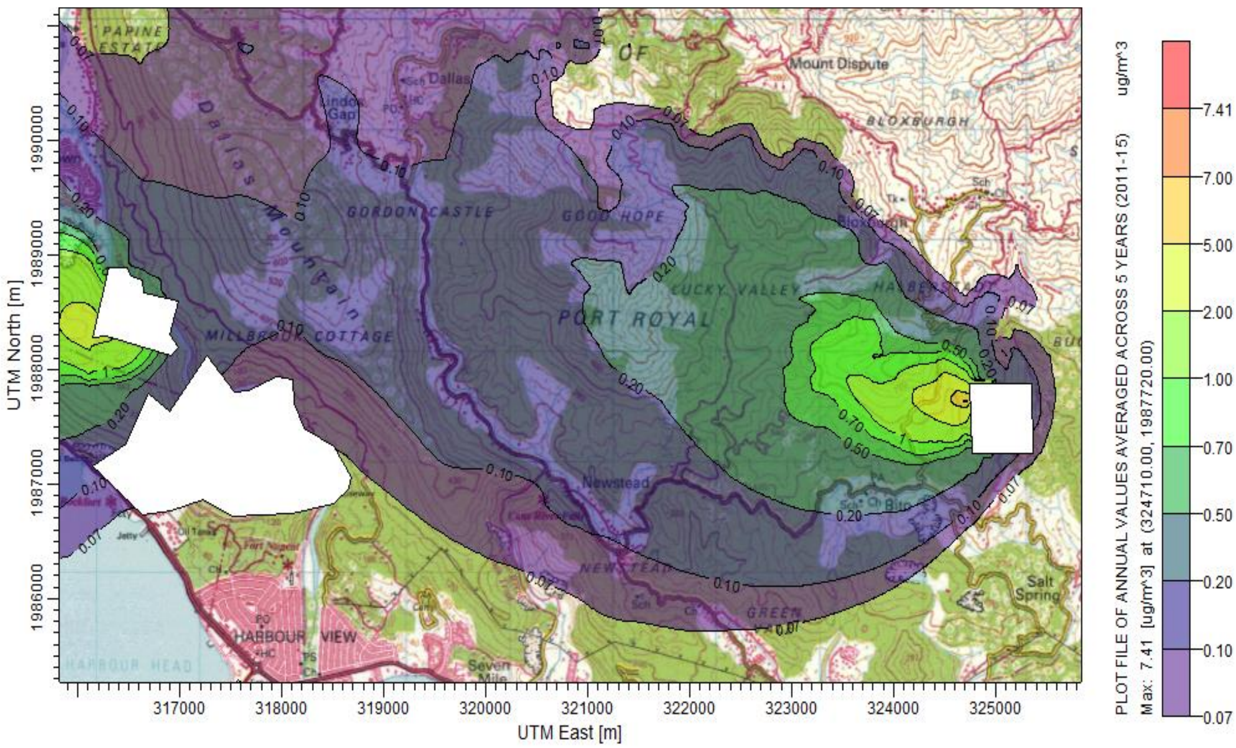


Figure 4-11: Predicted 1-h CO Concentrations – Proposed Quarries

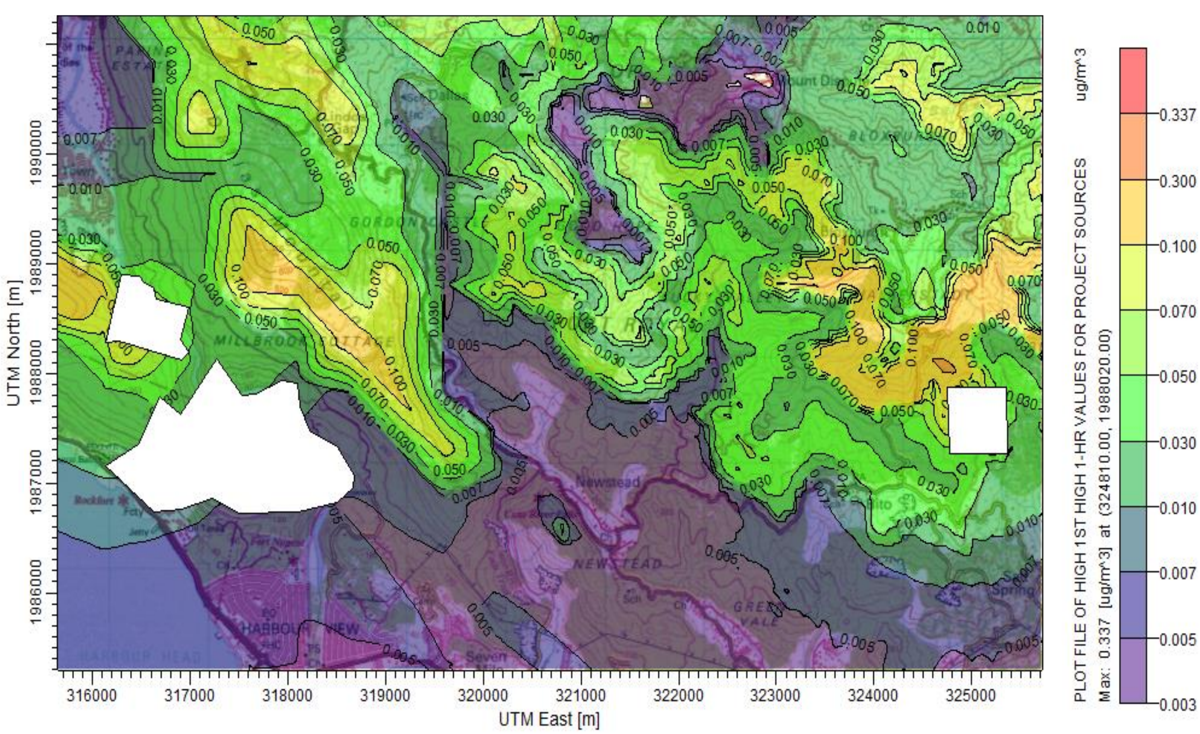
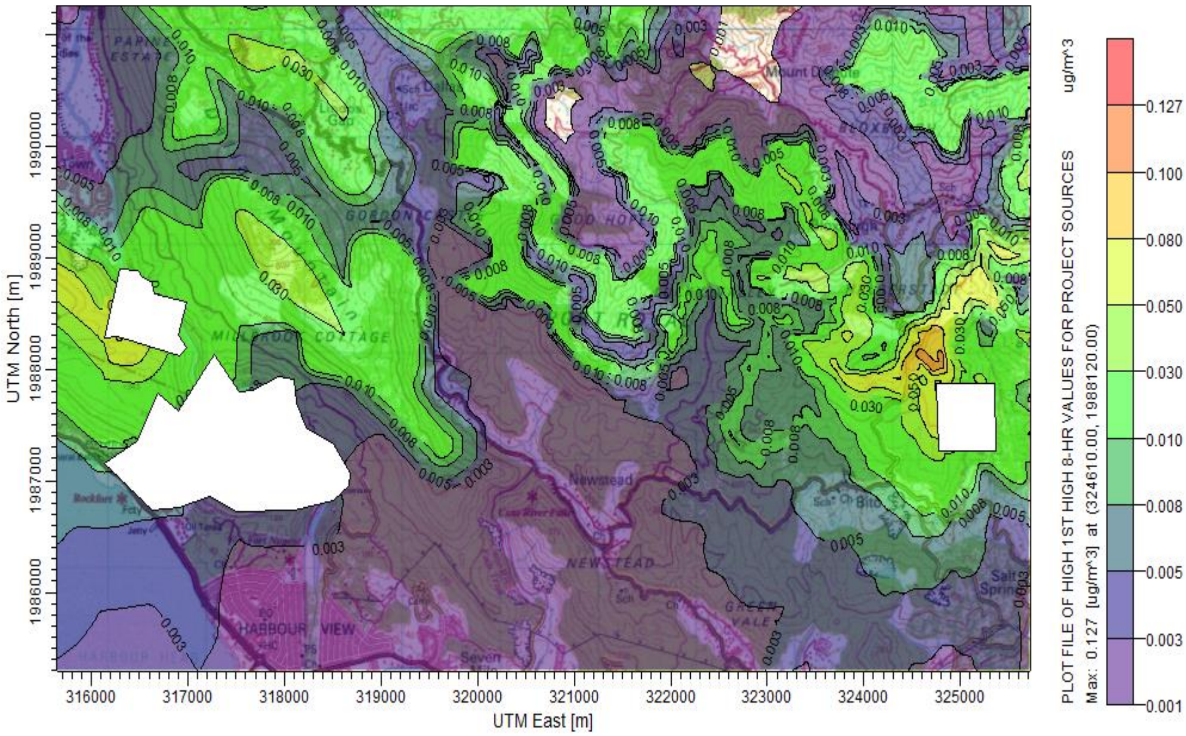


Figure 4-12: Predicted 8-h CO Concentrations – Proposed Quarries



Cumulative Impacts

As part of the air dispersion modeling analyses, a determination of the cumulative impact on ambient air quality of the nearby and the proposed quarry air pollutant sources was made.

Table 4-6 shows the model results for both Proposed Quarries and the All Sources category. The results for the All Sources category revealed maximum predicted concentrations that exceed the 1h SO_2 and NOx ambient air quality standards, 24h TSP and PM_{10}, as well as the annual TSP. A comparison of the maximum predicted concentrations for the Proposed Quarries and the All Sources category shows that the air emissions from the Proposed Quarries are not controlling the prevailing maximum predicted pollutant air quality impact within the air shed.

Table 4-6: Model Results – Proposed Quarries & All Sources

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Proposed Quarry Sources			All Sources		
				Max Conc (µg/m³)	UTME (m)	UTMN (m)	Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	84.4	316142	1988285	**435.8**	317399	1985124
	Annual	20	60	8.6	316277	1988292	**61.0**	317399	1985124
PM_{10}	24-hr	9	150	37.2	316142	1988285	**228.6**	318223	1987483
	Annual	20	50	3.8	316277	1988292	18.3	317399	1985124
NO_2	1-hr	0	400	2.4	324810	1988020	**725.8**	315110	1988320
	24-hr	0	N/A	0.36	316277	1988292	145.4	313610	1987820
	Annual	0	100	0.1	324710	1987720	66.9	313610	1987820
SO_2	1-hr	0	700	169.0	324810	1988020	**914.6**	315110	1988320
	24-hr	0	280	25.8	316277	1988292	110.3	315110	1988320
	Annual	0	60	7.4	324710	1987720	20.7	313610	1987820
CO	1-hr	0	40000	0.34	324810	1988020	3976.4	316902	1987629
	8-hr	0	10000	0.13	324610	1988120	1023.1	316688	1987791

Bold type indicates exceedance above the standard or Guideline Concentration

CONCLUSION

The following conclusions may be made as a result of the conduct of the air dispersion modeling analyses for the proposed Quarries:

1. ***There are no applicable air emission standards for the Proposed Quarries as stipulated by the National Environment & Planning Agency (NEPA).***
2. ***The maximum model predictions for the air pollutant sources at the proposed Quarries, both separately and in combination are all in compliance with their respective ambient air quality standards.***
3. ***The maximum model predictions for 24h exceeded the corresponding SIC, but when added to the recommended background 24h concentration, the overall 24h TSP concentration was less than 75%***

of the 24h TSP ambient standard. Additionally, the second highest 24h TSP model prediction was less than the corresponding 24h SIC.

4. ***Based on a comparison of the predicted maximum pollutant concentrations for the Proposed Quarries and the All Sources category, it was determined that the air emissions from the Proposed Quarries are not controlling the prevailing maximum predicted air quality impacts within the air shed.***

5.1.1.10 Fugitive Dust Emission Control Plan

Dust emanating from a quarry is a potential hazard and this can be detrimental to human beings. Dust can affect people in two ways: directly- by posing health risks (respiration problems) and indirectly, by causing damage to property (equipment and buildings). Inherently, dust from quarrying mineral is a common feature in any mining operation. CCCL is cognizant of this and therefore will place appropriate dust mitigation measures in place.

Dust is also one of the most complex pollutants to assess because of the infinite variation of sources, particle shapes, sizes, density and their resultant aerodynamic qualities. These qualities also determine the likelihood for a particle to be suspended by wind, transported and potentially deposited. Fugitive dust particles generated from materials handling typically range in diameter from 30 to 300 µm. The largest particles, because of their weight, generally travel only short distances and deposit near to the emission source. The smaller particle sizes however can travel further, especially during dry windy periods. The higher the wind speed the further a particle can be dispersed and the greater the size of particles that can be kept aloft.

The potential sources of dust at CCCL Quarries can most easily be classed by the size of the emission area. The loading of trucks in the quarry, for example, can be classed as a point source as dust has the potential to be generated in a defined location. Emissions from vehicles travelling to and from the mining area, in comparison, can be classed as line sources as emissions can occur along the entire route.

Vehicle movements associated with the access/haul roads have the highest potential for dust emission but roads will be conditioned with water to reduce potential emissions. Area sources soil handling during removal of over-burden and restoration will be managed carefully to ensure the risk of dust emissions is minimised. Stockpiles Storage of material in stockpiles can produce large areas of exposed dusty material subject to wind whipping.

Vehicle movements on the internal access/haul roads are likely to present the highest risk of dust nuisance as emissions can increase rapidly in proportion to vehicle speed and traffic volume but despite this risk, research has shown that the majority of 50 µm particles, typically produced from un-paved roads, deposit rapidly within 8m. For 20 µm particles a similar decline occurred at 30m. The movement of soil and the creation of bunds are also likely to present a high dust nuisance risk as this activity occurs outside the quarry void, often close to sensitive receivers when machinery movements can lift dust into the air. Disturbed soils, with no vegetation cover, can also become exposed to strong winds.

Dust Mitigation Measures

At CCCL Quarries the site manager is responsible for ensuring effective dust control and this relies on good site operational controls such as: • identifying and monitoring the intensity of potential dust generating activities; • monitoring weather conditions during dust sensitive periods; • responding to potential and actual dust problems; • planning contingency measures; • ceasing operations when major impacts cannot be avoided.

The Site Manager will have responsibility for ensuring that the risk of any potential dust nuisance arising from quarrying activities are minimised. The likelihood of failure of any dust prevention management techniques is likely to be low. A summary of the techniques which are utilised in the CCCL Quarry Dust Emission Control Plan are outlined in below. Should any problems arise action will be undertaken in accordance with the details in the Dust Management Plan. In response to the need to undertake any dust monitoring the Site Manager (or appropriate) shall undertake an immediate review of the management practices in order to identify and rectify potential problems.

General

- A high standard of housekeeping shall be maintained at all times.
- Exposed areas will be kept at a minimum as is practicable.
- All operatives receive formal training and instruction in relation to the control of the process and emissions to air.
- A daily log book is maintained.
- Visual dust assessments are made twice daily during operations by competent persons.

Soil Stripping and Handling

- Soil removal will be restricted to low risk meteorological periods.
- The duration of the activity will be minimal.
- Disturbed surfaces will be rehabilitated as soon as is practicable.
- Screening bunds will be created to provide protection from winds.

Extraction

- The material usually has a high moisture content when just excavated.
- The materials handled will be damp as needed where possible.
- Drop heights will be kept to a minimum wherever practicable.

• Loading and unloading will occur in areas protected from wind.

Access/Haul road

• Vehicle speeds will be restricted.

• Unpaved roads will we damped down when required using a water sprinkler.

• All vehicle loads will be sheeted and loads inspected to ensure no potential spillages.

• A water sprinkler will be available to moisten material if required.

Drilling Equipment

• All equipment shall be well maintained and serviced.

• Vehicle exhausts will be directed above the horizontal.

• All rock drilling equipment shall be fitted with dust suppression.

• Dusts collected by arrestment equipment shall be discharged into suitable containers that do not give rise to a secondary dust problem.

Stockpiles

• Stockpiles will be sprayed with water to maintain moisture content if required.

• Stockpiles will be located in areas protected from prevailing winds.

• The storage areas are located away from sensitive areas.

• Drop heights from tipping trucks will be kept to a minimum.

• Tipping will be undertaken as slowly as possible.

The results of all visual dust monitoring observations, along with remedial actions implemented and details of who carried out the monitoring is recorded. All personnel employed on-site are aware of and will undertake visual monitoring for dust throughout the working day. Daily monitoring in the form of a visual assessment is undertaken at the site.

Any problem observed, i.e. raised clouds of dust, is reported to the Site Manager (or the next level of management if they are unavailable), who is responsible for investigating the cause and implementing any necessary remedial action. All personnel who undertake particulate observations have received appropriate training, guidance and instruction in how to carry out the task.

Effective preventative maintenance is also undertaken on all plant and equipment concerned with the control of emissions to the air and spares and consumables are available at short notice in order to rectify breakdowns rapidly.

Plant personnel complete a daily site diary. This is kept on site, and is available for inspection. Daily comment is made about weather conditions on site when necessary. Daily checks are carried out to ensure that there are no visible emissions across the boundary.

5.1.1.11 Noise

The effect of noise is a concern to any quarrying operation. The noise in the quarry results from many different operations which include; ripping, and pushing operations, as well as from the use of heavy duty equipment, loaders, dozers, and trucks. Operators will be provided with personal protective equipment (PPE) for hearing protection. The general public and residents from the communities will be restricted in terms of ready access and therefore will not come in close contact with the noise from the quarry operations.

5.1.1.12 Ground Vibration

Ground vibration is expected to be confined to the quarry and being more than 1 km from the nearest community will not have any effect on the surrounding communities. There has not been any evidence of complaint/concern of ground vibration from the existing quarry.

5.1.2 Ecological Services

The plan is for CCCL to mine and rehabilitate progressively in the Harbour Head Quarry to ensure Mining best practices are not compromised. Mining will start adjacent to the exiting Limestone Quarry and will be limited to the first two benches (approximately 4 hectares). When material is exhausted in the first two benches rehabilitate will commence before proceeding to open up other areas. This progressive rehabilitation approach will ensure that disturbed areas is restricted to no more than 20 percent (4 hectares) at any given time.

It is therefore estimated that the maximum reduction in ecological services offered by the proposed project site will not be greater than 40 percent at any given time. At the end of mining activities all disturbed areas will be rehabilitated and thereby restoring and possible enhancing the ecological services to the pre-project level.

5.1.3 Natural Hazards

5.1.3.1 Landslide Hazard

An assessment of landslide hazard for the project site was based on the following:

a. Identification of landslides on natural and excavated slopes in the field
b. Examination of geological structures that could increase the risk of slope failure
c. Aerial photographic interpretation using black and white panchromatic (Ja55) photograph (1961) at a scale of 1:25,000
d. Review of Landslide Susceptibility Map for Kingston and St Andrew

Field Survey

Field survey was conducted during the period to identify landslide features at the Harbour Head site and surrounding areas that may have occurred in the past. Survey was conducted in all locations that were accessible by foot. Additionally, a number of vantage points were exploited where sections of the difficult terrain could be observed from a distance. There were no landslide features in the areas surveyed.

Detached Rock and Geological Structure

The steeply sloping areas towards the north east could not be thoroughly investigated in the field because of the thick vegetation and difficulty of access. It was however noted, that there are a number of extremely large detached boulders/rocks at the top of the ridge (Plate 3.1). These large blocks of detached limestone boulders could be the result of intersecting rock joints that caused the limestone blocks to be separated from the bedrock. The main concern is the existence and/or prevalence of large limestone blocks on the steep northeastern slope to cause rock fall hazards, especially during stripping of vegetation and other construction activity for quarry development.

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Plate 5.1.17: Large limestone boulder in the plateau area of the project site

Aerial Photographic Interpretation

Aerial photographic interpretation was conducted which indicate that landslide features were not present on the slopes within the general area of the project site. However, during operation phase of the quarry, excavation of benched quarry slopes will need to be designed to minimize slope failures.

Landslide Susceptibility Map

A Landslide Susceptibility Map for Kingston and St Andrew was prepared by the Unit for Disaster Studies at the University of the West Indies using a Bivariate Statistical Model developed by Brabb (1984). The landslide susceptibility map shows that the landslide susceptibility for the Halberstadt quarry site and surrounding areas has a landslide susceptibility ranging from low susceptibility on the top of the ridge to moderate susceptibility on the north-eastern slope (Figure 5.1.8).

The methodology used to develop the landslide susceptibility map does not incorporate rock falls as a slope movement parameter in the landslide analysis and does not include the risk or susceptibility of rock falls in the study area.

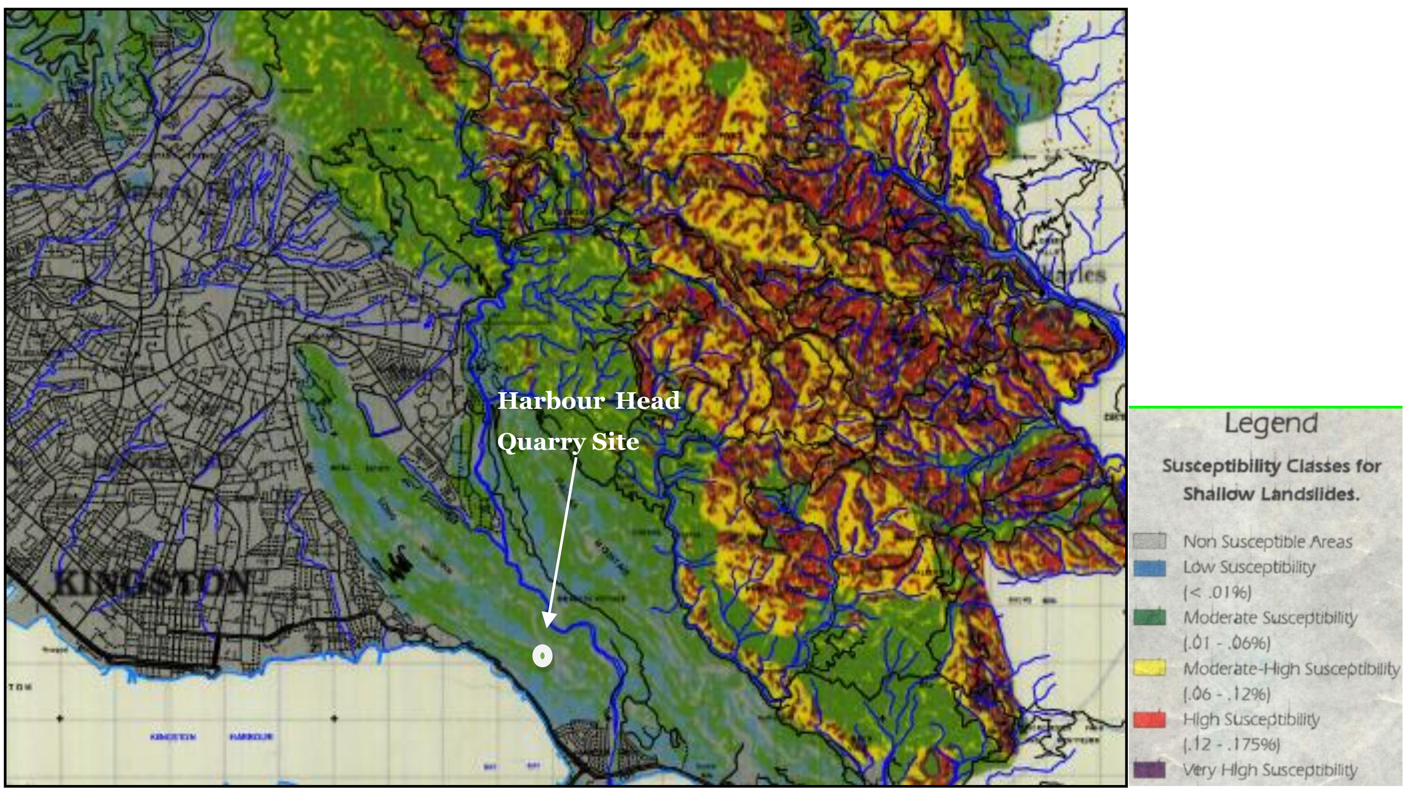

Figure 5.1.8: Landslide Susceptibility Map for Sections of St Kingston and St Andrew including the Harbour Head Quarry Site (Source: Unit for Disaster Studies, UWI-Mona)

Rock Fall Potential

The Yallahs pipeline which takes storm water from the Negro River in St Thomas to the Mona Reservoir in St Andrew is located on the steep terrain on the north-eastern boundary of the project site. The distance from the slope break on the steep NE slope to the Yallahs pipeline is approximately 150m and the length of the steeply sloping terrain to the Hope River is estimated to be from 280m -350 m. If the majority of the steep NE slope of the Harbour Head quarry site forms a part of the total footprint of the proposed quarry, then there would be concerns regarding the impact of quarry operations on slope stability and hence damage to the pipeline. Alternatively, if the footprint of the proposed quarry is the same as the delineated area for the quarry site, then the Yallahs pipeline would be under serious threat from the potential of rock falls.

Stability of Bench Slopes

Benched slopes will be created by blast excavation. The stability of the slopes will be dependent on bench design, blasting technique and monitoring of the excavated slopes. Excavation will take place in limestone of variable strengths, from moderately strong rock to weak-very weak marls and nodular limestone. Shallow slumps are likely to occur in the weak marls and may not necessarily be a major concern, but could be more of a nuisance value. However, large, loose boulders and poorly detached rock could be easily mobilized during extraction of the limestone which could impact safety of workers in the quarry pit.

Excavation of benched slopes by blasting, if not properly conducted, could cause further instability based on poor blast hole designs. It therefore implies that special attention should be paid to the selection and hiring of experienced blasting contractors for conducting blasting operations in establishing safe quarry benches.

5.1.3.2 Earthquake Hazard

Regional Seismicity

From a regional perspective, Jamaica is located in the north-central Caribbean on the Gonave Microplate, a tectonic sub-block of the Caribbean plate. The Gonave Micro plate has a spreading rate of 13mm/year of plate motion. It consists of the Oriental Fracture Zone (OFZ) which is located to the north, the Cayman Spreading Zone or Trench (CT) to the west and the Enriquillo Fracture Zone also known as the Enriquillo –Plantain Garden Fault passes through the eastern part of Jamaica. Earthquakes which are generated along these major fault zones tend to generate moderate to large earthquakes in the Caribbean (Figure 5.1.9). An example is the Haiti Earthquake of January 2010 which had its source on the Eriquillo –Plantain Garden Fault and generated a Magnitude 7 Category earthquake, resulting severe economic losses to the country and accounted for the loss of over 230,000 lives.

Local Seismicity

The project site is located in an area that has a history of seismic activity. However, most of the earthquakes that do generate seismic motion and occur frequently are generally of low intensity and not likely to cause significant structural damage. However, there are on-land source zones that have the potential to generate moderate as these are closest to the project site. These would include among others, the Enriquillo-Plantain Garden Fault, Blue Mountain Fault and the Wagwater Fault.

Figure 3.3 provides data on a century of historical seismicity from 1899-1998 for on-land and off-shore earthquakes around Jamaica which shows the larger earthquakes occurring offshore, particularly along the Caymanas Trough. Studies by Grandison (1994) have shown that there are on-land source zones that are capable of generating moderate earthquakes of magnitude 6.

An updated catalogue of Local regional seismicity for the period from 1998 to 2010 (Figure 5.1.10), shows a concentration of seismicity in the parishes of St Andrew, Western St Thomas and Portland. The vast majority are of magnitude 4 or less, not considered as damaging earthquakes.

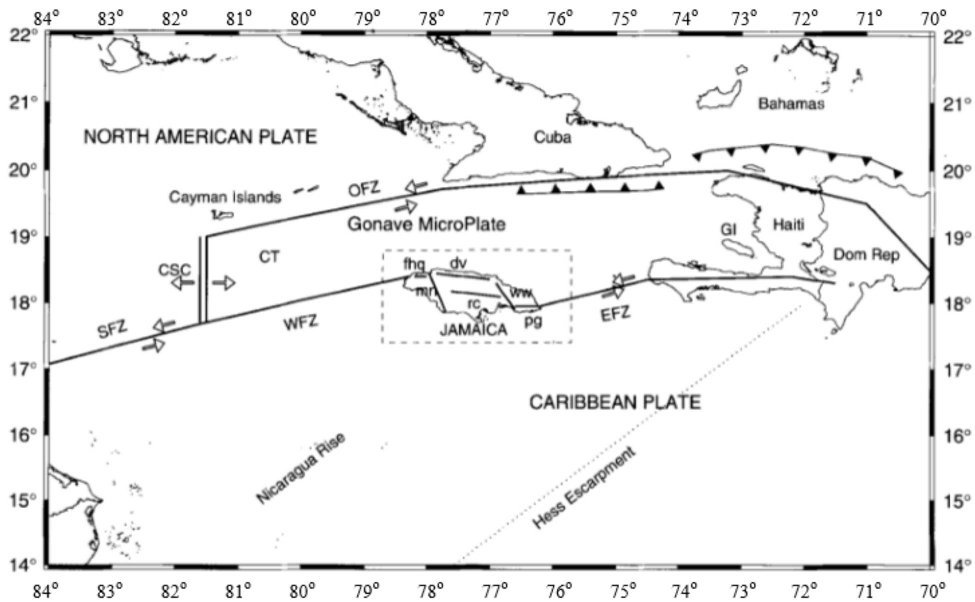

Fig. 3 Jamaica region tectonics: SFZ—Swan fracture zone; CSC—Cayman Spreading Center; CT—Cayman Trench; OFZ—Oriente fracture zone; WWF—Walton fault zone; EFZ—Enriquillo fault zone; Dom Rep—Dominican republic; GI—Gonave Island; fhq—Fat hog quarters fault; dv—Duanvale fault; ww—Wagwater fault; pg—Plantain garden fault; mn—Montepelier—Newmarket fault zone; rc—Rio Minho-Crawle river fault, reproduced with the permission of Seismological Society of America and Wiggins-Grandison [22].

Figure 5.1.9: Map highlighting Jamaica's location within the Caribbean Tectonic Region

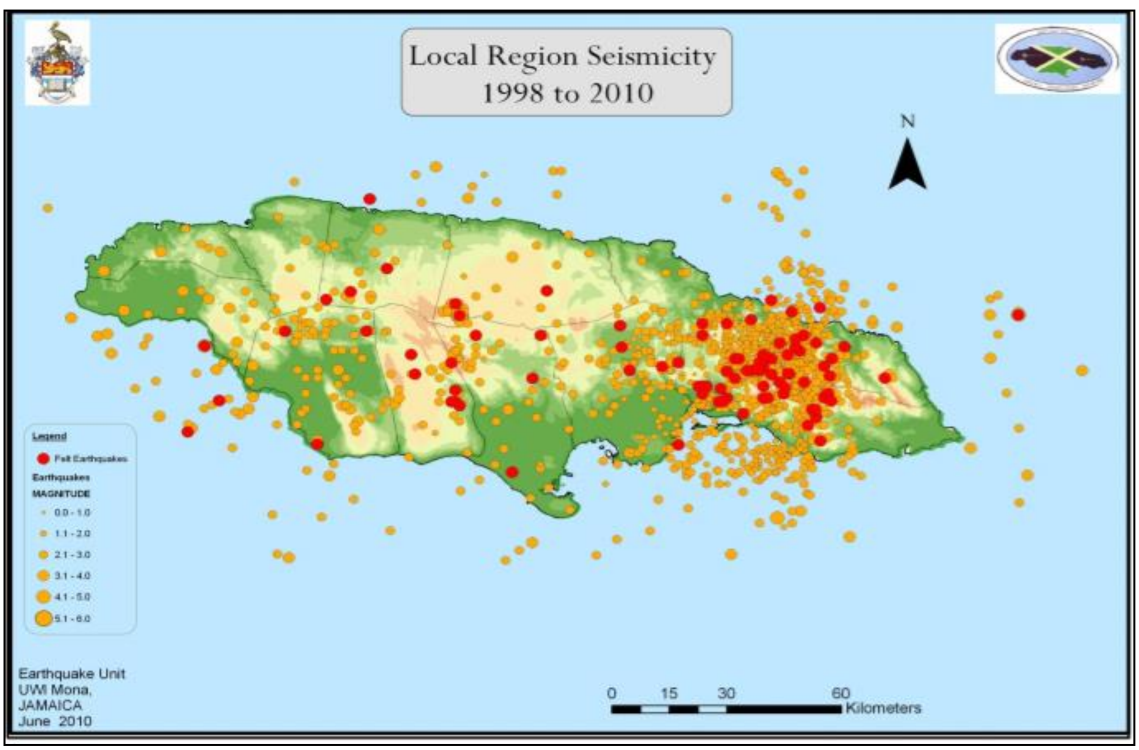

Figure 5.1.10: Updated seismicity map for Jamaica for period 1998-2010 (Source: Earthquake Unit,UWI)

Probabilistic Ground Motion Model

Under the Caribbean Disaster Mitigation Project (1999), a Seismic Hazard Assessment Study was conducted for the Kingston Metropolitan Area (KMA). This was a comprehensive study using probabilistic ground motion models to determine ground motion acceleration in the KMA with a 10 percent probability of being exceeded in 50 years (475 years return period). It shows that the project site has 30 percent ground acceleration (0.3g) with a 10 percent probability of exceedance in 50 years (Figure 5.10).

Excavation by Blasting

Excavation will be necessary to remove the limestone to create quarry pit and to remove material from benched slopes. In the construction of haul roads, particularly on the plateau area, ripping will be the main means of excavation although some blasting will be necessary where the moderately hard limestone may be encountered. The proposal is to construct benches consisting of 9m near-vertical benched slopes and a minimum 18m floor space (assuming a 2:1 floor to bench slope height) and this will be done on a phased basis. Blasting of the rock will therefore be a major and continuous activity in the operation of the quarry.

5.1.3.3 Hurricane and Tropical Storms

Jamaica is located in the northern Caribbean region between latitude 18 36 N 175' S and longitude 76 15'E and 78 22' W. It is also within the North Atlantic Hurricane Belt and therefore in the path of tropical storms and hurricanes. Over the past 2 decades, tropical storms and hurricanes have done extensive damage to coastal and inland infrastructure. During the period, approximately seven severe weather systems have caused significant economic damage to the country. These include Hurricane Allen (1980), Hurricane Ivan (2004), Hurricane Dean (2007), Hurricane Sandy (2012), Tropical Storm Gustav (2008), Tropical Storm Nicole (2010). Severe tropical storms systems tend to cause flooding in low lying areas, while hurricane damage is generally caused by sea surges (coastal flooding) and wind.

A history of hurricanes tracks from 1856 to 2005) that pass in close proximity to the island is shown in Figure 5.1.11 Recent hurricanes that have directly affected Jamaica from 1980 to 2008 are presented in Figure 5.1.12

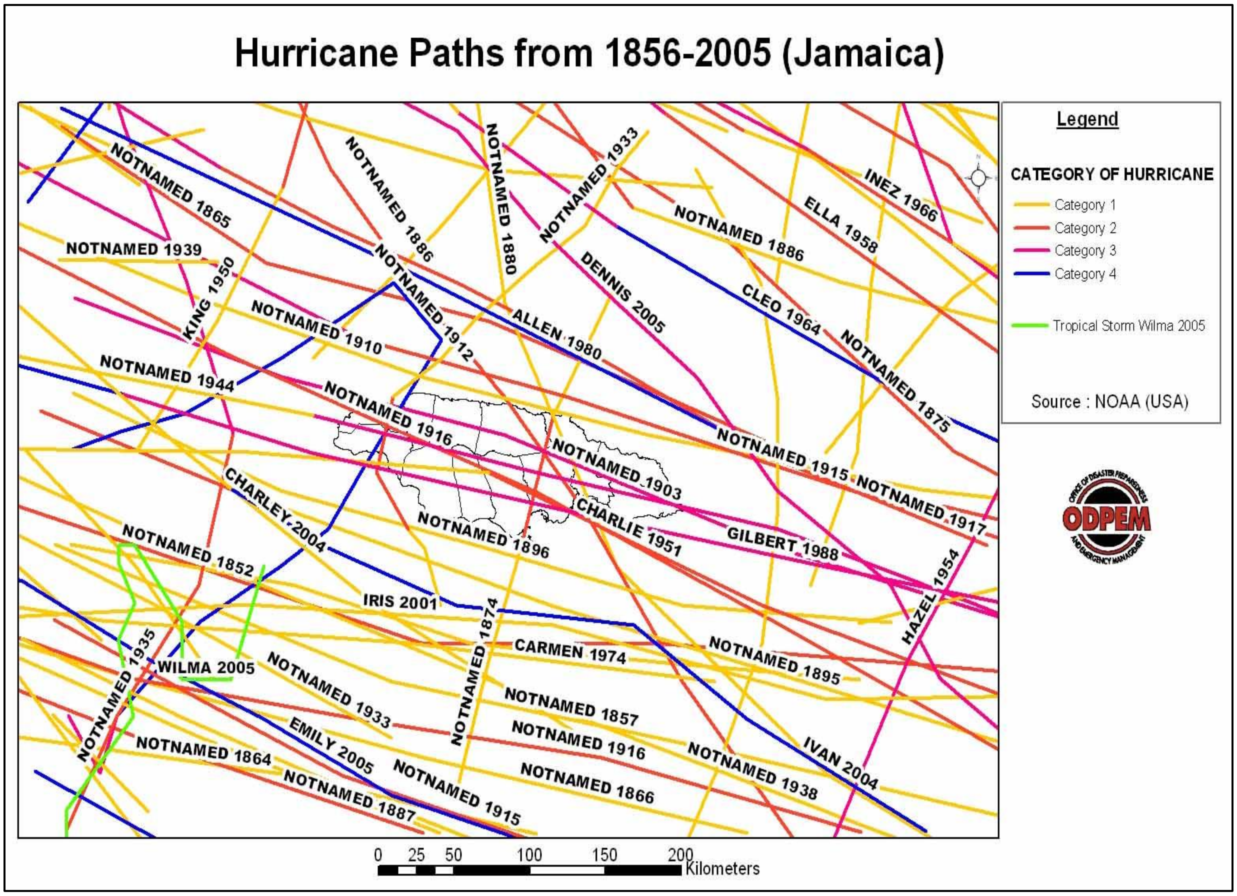

Figure 5.1.11: History of Hurricanes which have Impacted Jamaica (Source ODPEM)

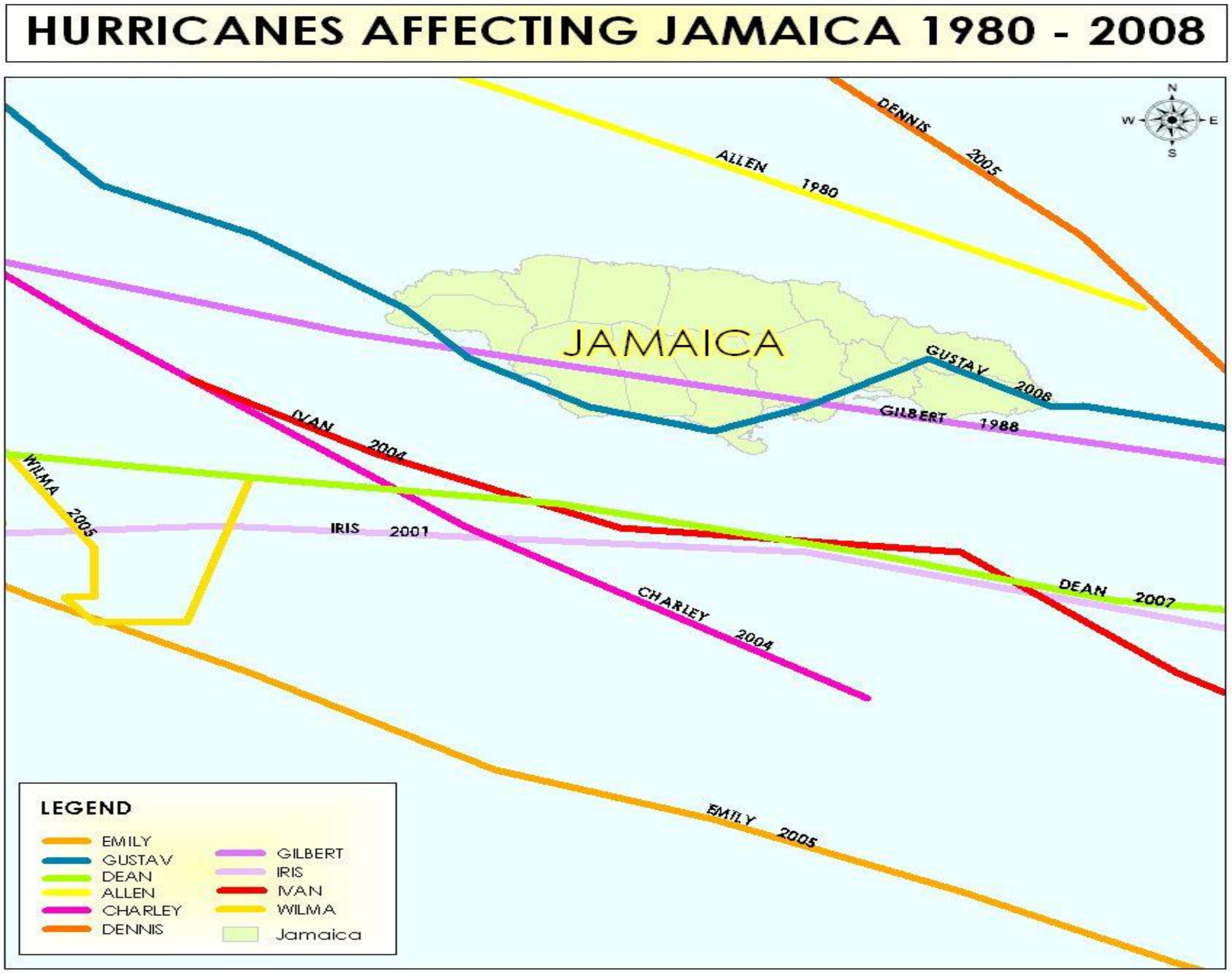

Figure 5.1.12: Recent Hurricanes Impacting Jamaica 1980-2008 (Source ODPEM)

5.1.4 Biological Environment

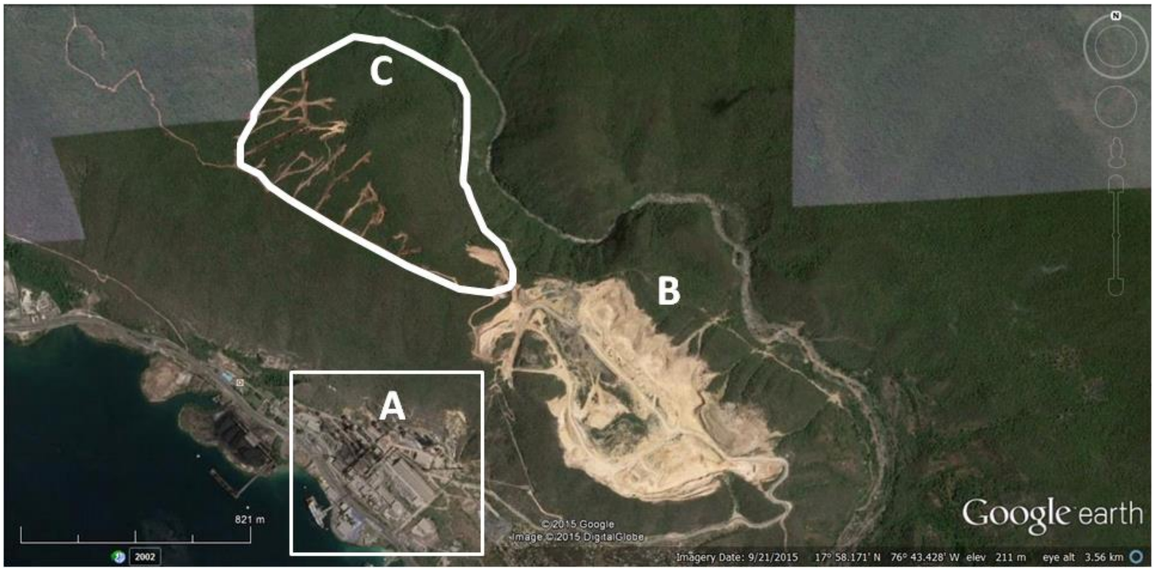

Figure 5.1.13: Close-up of the Caribbean Cement Company Processing Facility (A), Existing Limestone Quarry (B) and Proposed Quarry (C).

5.1.4.1 Methodology

5.1.4.1.1 Literature Review

Literature related to the expected forest types to be found within the project area were examined as a means of establishing a general description the various types of floral assemblages and fauna that could be found at the sites. Camirand and Evelyn (2004[8]) and Forestry Department[9],[10] references were valuable in establishing this general description.

[8] **Roland Camirand and Owen B. Evelyn –** National Forest Inventory Report 2003 Volume 1 of 2 – Main Report and Appendices I-V 2004.

[9]Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

[10] Forestry Department - Forest Inventories in Natural Forests [UNDP/FAO, 1972; Swedforest Consulting, 1981; FIDCO, 1982-83; TFT Project, 1998-99

Further technical guidance was obtained from H. Raffaele (2003)[11], Sutton and Downer (2009)[12], Peter Vogel [13] and other butterfly/insect references and gastropod references sourced on the internet. From these references, visual identification keys were generated for use in the identification of flora and fauna species observed in the field, with special attention being placed on the identification of species that are known to be endemic to the environment or otherwise threatened or endangered.

Further literature research related to disturbances in Dry Limestone Forests and the possible changes that could occur were sourced through McDonald, McLaren and Newton (2010[14]) and McLaren and McDonald (2003[15]).

5.1.4.1.2 Aerial Imagery/GIS Assessments –Flora/Fauna:

Google Earth images of the location dated 2015[16] were referenced to the JAD2001 coordinate system using a Geographical Information System software[17]. After referencing, the Google Earth images were then used for the broad-scale characterization of floral spatial coverage on the site.

Additional spatial data, specifically topography, elevation, soil type and any floral/faunal ground truthing data obtained in the field were inputted into a geographical information systems software to be used to help further analyze and illustrate any spatial variations that could be detected at the site.

Positional data for field information was collected with a Garmin GPS Map 60CSx hand held global positioning system (GPS), with waypoint and track information being managed through Garmin MapSource software.

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[11] Birds of the West Indies by Herbert Raffaele, James Wiley, Orlando Garrido, Allan Keith and Janis Raffaele - 2003

[12] Ann Haynes-Sutton, Audrey Downer, Robert Sutton and Yves-Jacques Rey-Millet: A Photographic Guide to the Birds of Jamaica - 2009

[13] **www.jpat-jm.com>pdfs>Amphibians**

[14] McDonald, M.A, McLaren, K.P, and Newton, A.C., 2010, What are the mechanism of regeneration post disturbance in tropical dry limestone forests? CEE review 07-013 (SR37). Environmental Evidence: www.envioronmentalevidence,org/SR37.html

[15] Kurt P McLaren and Morag A McDonald. Seedling Dynamics after different intensities of human disturbance in a tropical dry limestone forest in Jamaica. Journal of Tropical Ecology (2003) **19**: 567-578.

[16] Representing the most recent imagery available

[17] www.mapmaker.com

5.1.4.1.3 Floral Assessments –Ground Truthing

Line Intercept Method

The assessment was conducted over the period **2016-01-20, 23 and 28** for the CCC Limestone quarry. A line intercept [18] method was employed at the site**. Figure 5.1.15** illustrates the main pathways that were traversed through the proposed Limestone quarry.

Figure 5.1.14: Existing (A) and Proposed (B) Quarry Areas.

These pathways were used as a transect line along which the intercept method was used. Incursion was made into the vegetation, typically to a depth of 10 metres. In this method, features existing along the lines traversed through floral aggregations were assessed, with observations being made along a vertical arc extending from the ground towards any

18 www.wikipedia.org – Line Intercept method

forest canopy existing to one side of the pathway (transect line), as well as into the foliage to the extent to which clear identifications could no longer be done (which was typically 3 meters – see **Figure 5.1.16** and **Plate 5.1.18**).

Figure 5.1.15: Transect Path Through the Proposed Limestone Quarry.

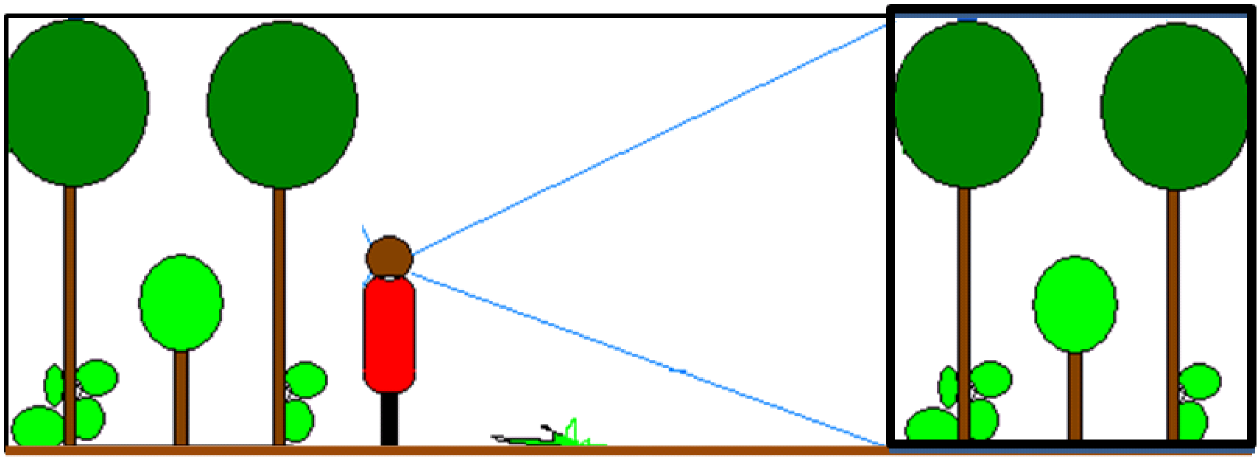

Figure 5.1.16: Schematic View of the Surveyed Areas Observed/Photographed Along the Transects.

Plate 5.1.18: Example of Photograph Taken for Data Collection Purposes.

The line intercept method was chosen because navigation within stands of vegetation on the site was proven to be difficult, considering the lay of the land and the density of vegetation in specific areas. A linear traverse of an area from one point to another along lines that would intersect various features was chosen to examine the areas of importance on the site.

Floral data collected along the transects was primarily used for the generation of a list of the different floral species assemblages that would have been bisected by the creation of the pathways. It also allowed the examination and listing of opportunistic floral species that capitalized on the availability of ground space created by the construction of the pathway. This would prove important in the evaluation of the manner in which cleared quarry areas might re-vegetate naturally.

5.1.4.2 Fauna

5.1.4.2.1 General

Literature reviews spoke to the potential presence of the following groups of animals within or associated with the vegetation assemblages identified as being present at the site:

1. Avi-fauna (Birds)
2. Herpetofauna (Lizards)
3. Insects (Butterflies and Moths)
4. Gastropods (snails)
5. Mammals (Bats, Mongooses)
6. Frogs

5.1.4.2.2 Faunal Line Transect Methods:

Assessments for fauna were made using presence/absence visual observations along the transects traversed for the floral surveys, with observations being made in accordance with the space depicted on Figure 5.1.17 below. For the area visually swept, the average dimensions were 3 meters in elevation and 15 meters in width, or a cross-sectional area of 45 square meters. As was the case with Flora, observations being made along a vertical arc extending from the ground towards any forest canopy existing to both sides of the pathway (transect line), as well as into the foliage to the extent to which clear identifications could no longer be done (which was typically 3 meters. Bird movement triggered by the disturbance caused the field operatives traversing the site lead to data collection records of bird calls were also made during the transect traverses where these were heard.

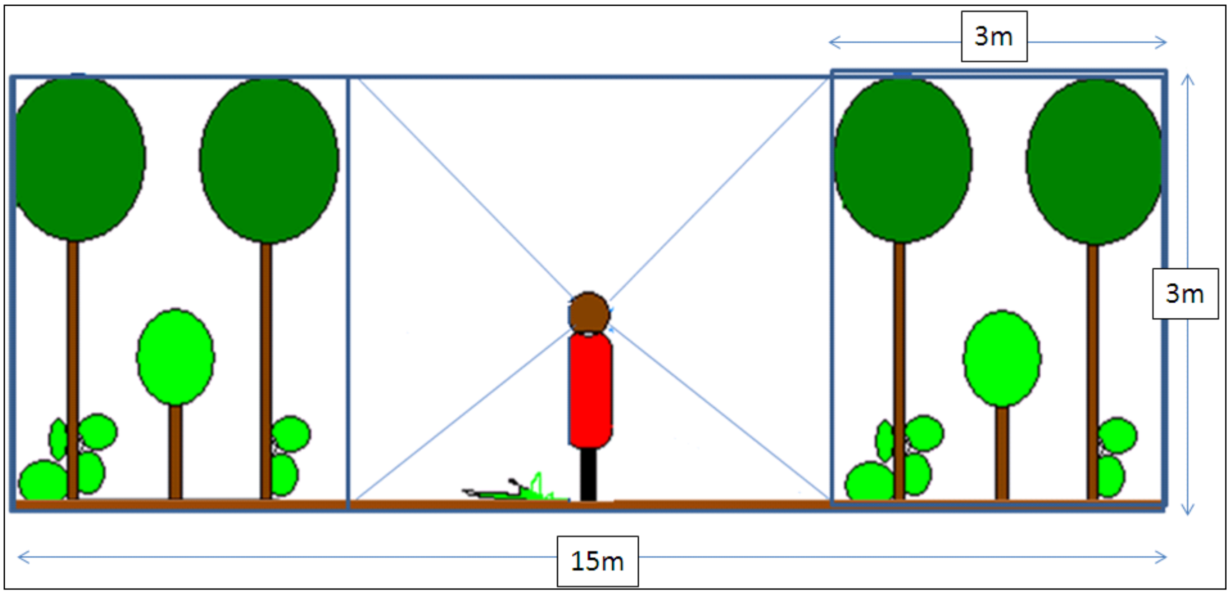

Figure 5.1.17: Schematic View of Space Assessed for Birds at the Study Site.

An attempt was made to stage the transect surveys at times that would facilitate most successful observations. These timings are listed below:

1. Day bird/insect observations: 5:30am – 8am
2. Reptiles: 5:30am – 8am
3. Night bird/insect observations: 5:30pm – 8pm
4. Bat observations 5:30pm – 6:30pm
5. During the course of the day for any birds or other animals that might be either observed flying or disturbed during the course of the vegetation surveys.

Again, like the transect use for flora, faunal transect observations/recordings were used for the generation of species lists.

5.1.4.2.3 Bird /Insect Line Transects:

Birds

The line transects survey method for birds were chosen so as to keep data collection in keeping with the paths being traversed for floral surveys. Visual observations of birds were made while walking along transects (in accordance with Bibby et al. 2000[19]). Where birds were heard, or seen while traverses were being made, audio recordings were made and photographs taken while remaining stationary for 5-10 minutes (mirroring techniques used for Bird Point Count methods – Bibby et al 2000). Birds in excess of 50 meters from the observer could therefore be heard and identified. Figure 5.1.18 shows the location of the stop locations for audio recordings.

A critical assumption of this line transect method was that all birds on the transect centerline, as well as ranging into the foliage for the dimensions of the observation area highlighted in Figure 5.1.15 were detected. Thus, birds distant from the transect centerline may have been missed, and thus, the proportions missed. This assumption was deemed to be important because the interpretation of the observations was based on numbers of sightings/hearings (assuming no repeat observations) in relation to the length and cross-sectional area of the footprint surveyed (see cross-section dimensions on Figure 5.1.17).

Insects

Emphasis was placed on the observation and identification of flying insects – specifically butterflies flying across the path of the transect being surveyed. This was done because it was opined that flying insects play an important role both as plant pollinators and as a food source for forest avi-fauna. It was anticipated that survey time allotments would not

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[19]Bibby, C.J, Burgess, N.D., Hill, D.A., and Mustoe, S.H (2000). ***Bird Census Techniques***, 2nd ed. Academic Press London.

allow for actual numbers to be determined. Therefore, an indication of relative prevalence was given, as defined using the DAFOR scale system[20] defined below:

D -Dominant
A - Abundant
F - Frequent
O - Occasional
R - Rare

In this case, the DAFOR scale was based on estimates of numbers of different species seen during the traverse along the transect with Dominant = >75 individuals, Abundant = 75 – 51 individuals, Frequent = 50 – 26 individuals, Occasional = 25 – 11%, Rare 10 – 1.

Species Diversity [21]

Species diversity, biodiversity or the measure of how varied the species composition is within an area, has traditionally been one of the primary interests of Ecologists. It is said that the more diverse an area is, the healthier it is.

Species diversity can be regarded as having two separate components, namely:

1. The number of species present – termed **Species Richness**
2. The relative abundance of the species present – termed **Dominance or Evenness.**

With this complexity in mind, many different measures or indices of species diversity have been developed.

The **Shannon Wiener** index (**H**) was used for the determination of biodiversity information, which is calculated in the formula H **= -SUM[(pi) * ln(pi)][22] Where:**

1. SUM = Summation
2. pi= Number of individuals of species

[20] http://www.surreyflora.org.uk/newnotes.php
[21] Biology.kenyon.edu>courses.biol229
[22] www.easycalculation.com/statistics/learn-shannon-wiener-diversity.php

3. i/total number of samples

The interpretation of the index results is based on the fact that typical summation values will be between 1.5 and 3.5 in most ecological studies, with 4.0 being the extreme upper end. The index increases in value as both the richness and the evenness of the community increases – thus pointing to the fact that this index incorporates both biodiversity description components. High values would be representative of more diverse communities – meaning that there is variety in the types of species represented and that their population numbers are evenly distributed[23].

The index was calculated for flora and for avi-fauna (birds).

5.1.4.2.4 Concluding Assumptions

The field methods described above were conducted over the period **2016-01-20, 23 and 28** for the CCCL Limestone quarry. **Section 5.4 of Appendix I** outlined the Flora/Fauna data collection requirements for the EIA and, considering the timeframe outlined for the collection of data, as well as terrain, access, vegetation density and safety considerations, the following data collection assumptions were made:

A. Data records were made along defined pathways or roadways constructed over the proposed quarry site, being limited by the ability to penetrate into the vegetation stands existing at the site.
B. Further to the above, no attempt was made to cut through vegetation so as to minimize impacts that the data collectors could make on the environment. In short, all the data collection methods were non-destructive in their nature.
C. Quantitative assessments were attempted for:
   - Floral percentage cover
   - Floral diversity
   - Bird population numbers and diversity

   Extrapolations were made over the total study site.

[23] En.m.wikipedia.org/wiki/Talk:Shannon_index

D. Quantitative assessments were not made for:
   - Bats and other mammals
   - Insects (day and night), though a qualitative assessment of population numbers was done for daytime flying insects.
   - Reptiles
   - Amphibians

   Mobilization limitations prevented the expenditure of time to make detailed assessments of these fauna possible.

E. Species lists were generated for all flora/fauna observed, with importance (endemism, rarity, threatened status, migratory status etc) being highlighted.

F. Micro-habitat examination was conducted with emphasis being placed on the identification of opportunistic floral gap occupiers within human-induced spaces within the natural floral environment, as well as those observed within the existing quarry area. This was done to shed light on the natural processes of vegetation recovery that could be experienced at the site.

5.1.4.3 Flora

5.1.4.3.1 Spatial Extent

Literature reviews, as well as the identification of characteristic flora within the vegetation assemblages found at the CCC site lead to the characterization of the forest at the site as a Tall, Open, Dry Forest[24] assemblage further re-enforced this conclusion. Figure 5.1.18 illustrates the extent of natural undisturbed floral cover, as opposed to disturbed floral cover – as interpreted from 2015 Google Earth images of the site.

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[24] A Tall Open Dry Forest is an open natural woodland or forest with trees at least 5m tall and crown not in contact, in drier part of Jamaica with species indications such as Red Birch Tree (***Bursera simaruba***) **-** Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

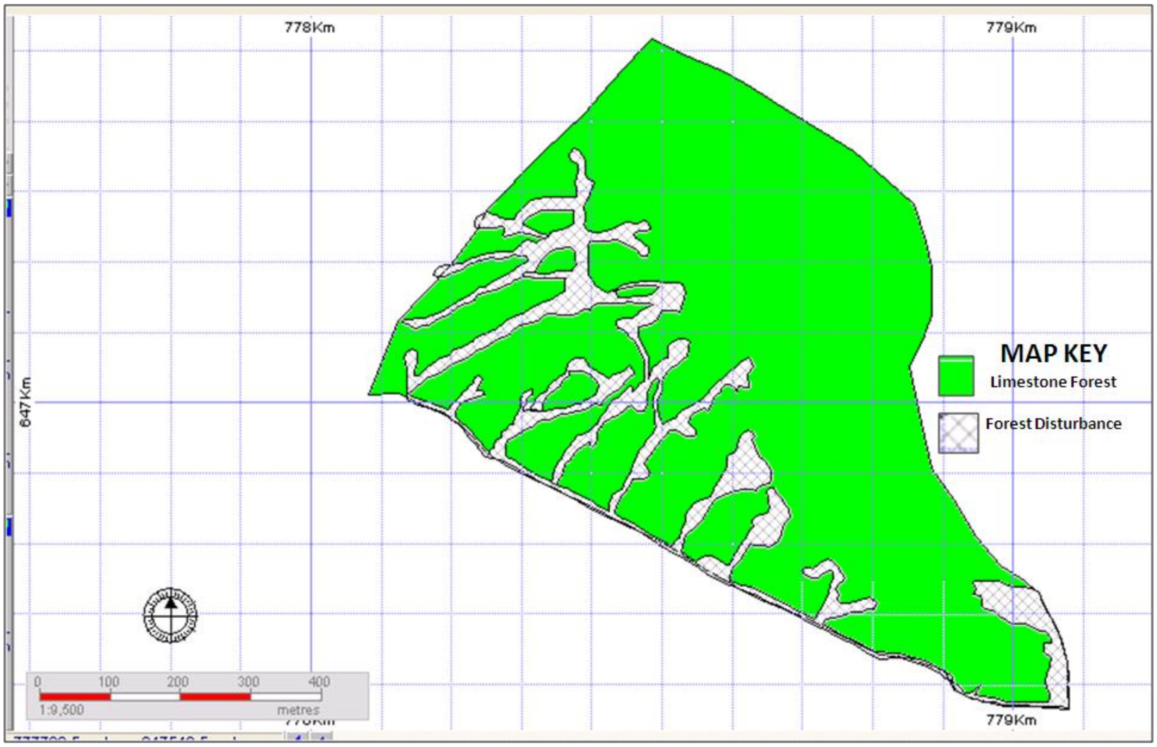

Figure 5.1.18: Extent of Natural Vegetation Disturbance at the Study Site.

It is estimated that the proposed quarry area is 46.3 Hectares in area[25]. Of this area, approximately 7.5 hectares has been disturbed by pathway construction. Approximately 38.8 Hectares can thus be interpreted to be natural undisturbed forest area.

5.1.4.3.2 Vegetation Types

Tables 3.1.2-A-D below lists the 34-floral species observed along the transect pathways at the study site. Floral species observed were divided into two main categories for the purpose of the study, namely natural vegetation – comprising predominantly **trees**[26],

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25 Not considering the influence of topography on planar area.

26 Tree – A woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground - Wikipedia.org

vines[27] and **bromeliads**[28] and gap occupiers – comprising **herbs**[29], and **grasses**[30] found in areas where tree cover had been disturbed.

Table 5.1.9: Tree Species List – (red highlighted = endemic)

LOCAL NAME	*SCIENTIFIC NAME*
SP-1[31]	-
SP-2	-
SP-3	-
Divi-divi	***Caesalpinia coriaria***
Water Oak/Buttercup	***Catalpa longissma***
West Indian Ebony/Coccuswood	***Brya ebenus***
Broom Thatch	***Thrinax parviflora***
Poponax, Wild	***Acacia tortuosa***
Yellow Tamarind	***Acacia villosa***
Lead Tree	***Leucaena leucephala***
Red birch	***Bursera simaruba***
Bull Hoof	***Bauhinia divaricata***
Barberry Bullet/Greenheart	***Erythroxylum confusum***
Burnwood	***Metopium brownii***
Dogwood	***Piscidia piscipula***
Torchwood	***Tecoma stans***
Maypole	***Agave sobolifera***
Silk Cotton	***Ceiba pentandra***
Wait-a-bit	***Pisonia aculeata***
Wild Grape	***Coccoloba venosa***
Mountain Pride	***Spathelia sorbifolia***

27 Vine – A climbing or trailing woody-stemmed plant.

28 Bromeliad- A plant of tropical and subtropical America typically having short stems with rosettes of stiff, spiny leaves. Some kinds are epiphytic.

29 Herb – Any seed-bearing plant which does not have a woody stem and dies down to the ground after flowering - google definition

30 Grass –Vegetation consisting of typically short plants with long, narrow leaves growing wild or cultivated on lawns.

31 Identification of SP-1, SP-2 and SP-3 being attempted through the Institute of Jamaica.

Table 5.1.10: Grass Species List

LOCAL NAME	***SCIENTIFIC NAME***
Guinea Grass	***Panicum maximum***
Yard Grass	***Eusine indica***
-	***Lasiacis divarcata***
-	***Sporobolus sp***

Table 5.1.11: Herb Species List

LOCAL NAME	***SCIENTIFIC NAME***
Buttonweed	***Borreria laevis***
Shame-me-lady	***Mimosa pudica***
Vervine	***Stachytarpheta jamaicansis***
-	***Croton linearis***
-	***Spilanthes urens***
-	***Waltheria indica***
	Corchorus siliquosus
	Centrosoma virginianum

Table 5.1.12: Vine, Moss and Bromeliad Species List

LOCAL NAME	***SCIENTIFIC NAME***
Maypole (B)	***Agave sobolifera***
Snake Withe (V)	***Cissus sicyoides***
Moses in the Cradle (B)	***Rhoeo spathacea***
The Springy Turf Moss (M)	***Rhytidiadelphus squarrosus***

The vegetation type distinction was made because it was quickly determined in the field that there was very little room for under-canopy vegetation growth where un-disturbed forest vegetation existed and that much of the non-tree vegetation existed along the sides of the pathways that had been excavated through the forest cover (as illustrated on **Plate 5.1.19**). However, where favourably soil conditions existed on the surface of the paths created (or where vehicular activity did not create a limitation), opportunistic gap vegetation growth did occur (as illustrated on **Plate 5.1.20**).

Plate 5.1.19: Spatial Relationship of Natural Vegetation (A) to Gap Occupying Vegetation (B) at a Point of Human Disturbance.

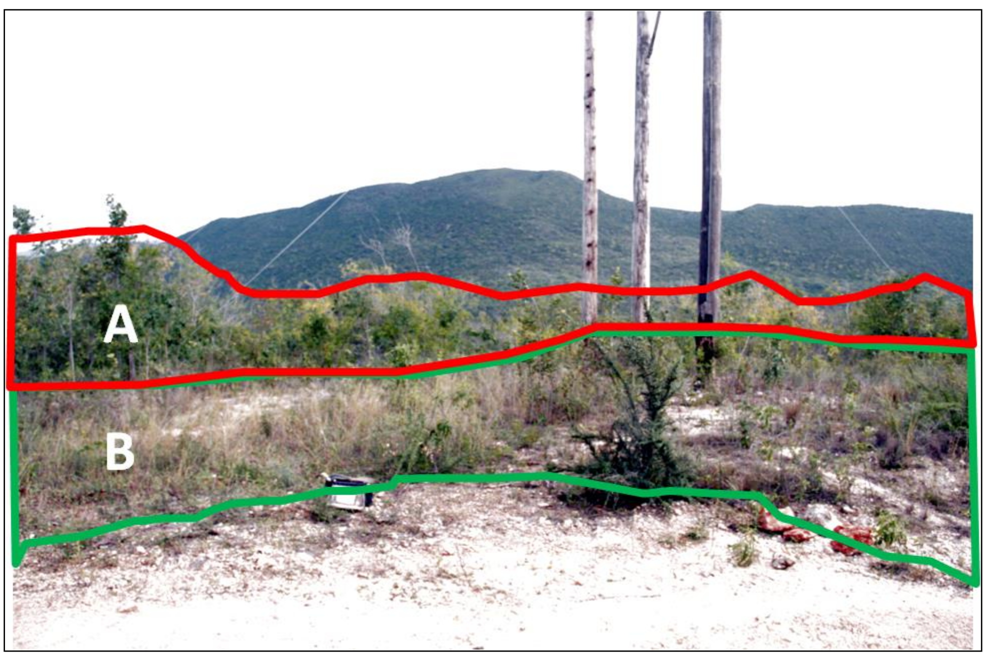


Plate 5.1.20: Spatial Relationship of Natural Vegetation (A) to Gap Occupying Vegetation (B) at a Point of Human Disturbance Where Favourable Space and Soil Type Exist

5.1.4.3.3 Flora Percentage Cover

Trees

Analysis revealed that the most commonly occurring tree types observed within the 15 photo quadrats analyzed were as listed in **Table 5.1.13** below in rank order of area covered:

Table 5.1.13: Percentage Cover for Trees

TREE TYPE	PERCENTAGE COVER %
SP-1	18
SP-2	11
Broom Thatch Palm	7
Coccuswood	7
Burnwood	6
Lead Tree	4
Bull Hoof	2
SP-3	2
Red Birch	2

A general conclusion[32] can thus be made that these tree types would represent the majority of tree species present within the forest cover. **Plate 5.1.21** illustrate these tree types[33].

32 though limited by the limited number of quadrats sampled

33 All plates were taken on-site at CCC.

SP-1

SP-2

Broom Thatch Palm

Burnwood

Lead Tree

Bull Hoof

Plate 5.1.21: Dominant Tree Types Observed at the Study Site.

Red Birch (trunk)

Coccuswood

Plate 5.1.22: Dominant Tree Types Observed at the Study Site.

5.1.4.3.4 Gap Occupiers and Others (A)[34]

The most commonly occurring non-tree types observed were as listed **Table 5.1.14** below lists these flora types in rank order of area covered:

Table 5.1.14: Percentage Cover for Non-Tree Flora: CCC Site

VEGETATION TYPE	SPECIES	PERCENTAGE COVER%
Herb –gap occupier	***Waltheria sp.***	7
Herb –gap occupier	***Croton sp.***	7
Grass –gap occupier	***Sporobolus sp.***	2
Grass –gap occupier	Guinea Grass	1
Vine	Snake Withe	1
Bromeliad	***Agave sp***	1

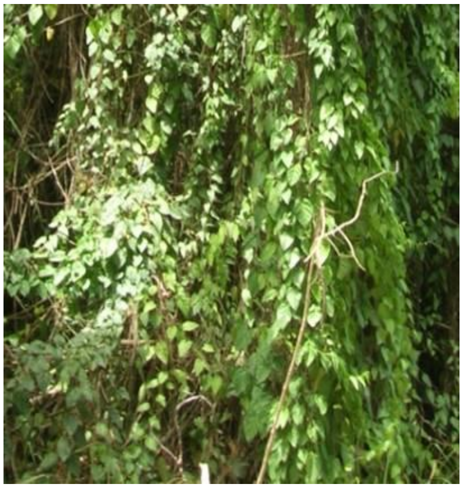
Of the gap occupiers identified, it was very clear that both ***Waltheria sp*** and ***Croton sp*** were the dominant occupiers of created space on the site, with ***Waltheria sp*** occupying exposed flat areas with moderate distributions of clay-type soils. ***Croton sp***

34 Grasses are monocotyledonous, usually herbaceous plants with narrow leaves growing from the base. –Wikipedia.org

was more common at the forest/cleared area interphase. **Plates 5.1.23** illustrate these vegetation types:


Waltheria sp ***Croton sp***

Sporobolus sp




Snake Withe　　　　**Agave sp**

Plate 5.1.23: Dominant Gap Occupiers and Other Flora Types Observed at the Study Site.

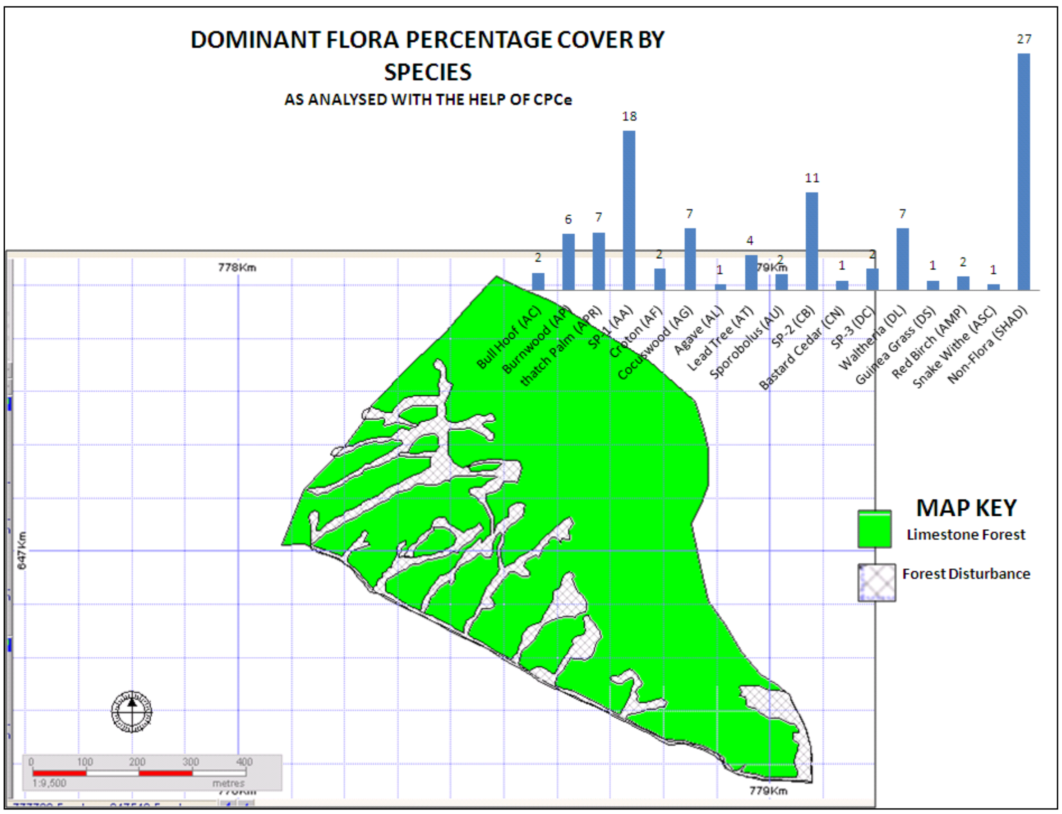


Figure 5.1.19: graphically illustrates the percentage proportions of the dominant vegetation types observed in the sampled as compared with one another.

5.1.4.3.5 Floral Variation over the Study Site

An examination of the manner in which floral compositions varied over the study site was attempted, primarily to facilitate the determination of where particular flora of significance might be distributed.

Of the 34 species of plants identified during transect surveys at the CCCL site, one example, the Broom Thatch Palm (***Thrinax parviflora***) was determined to be endemic.

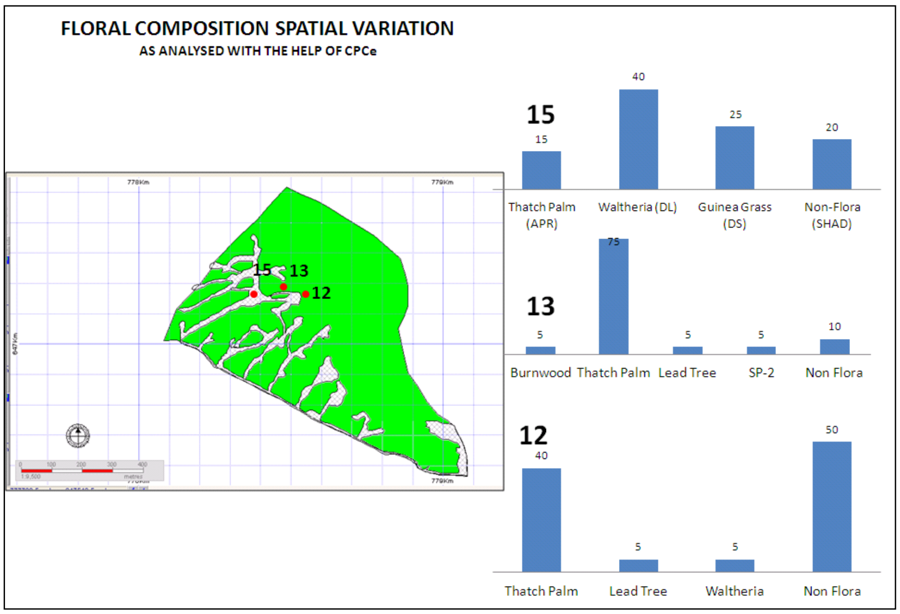


Figure 5.1.20

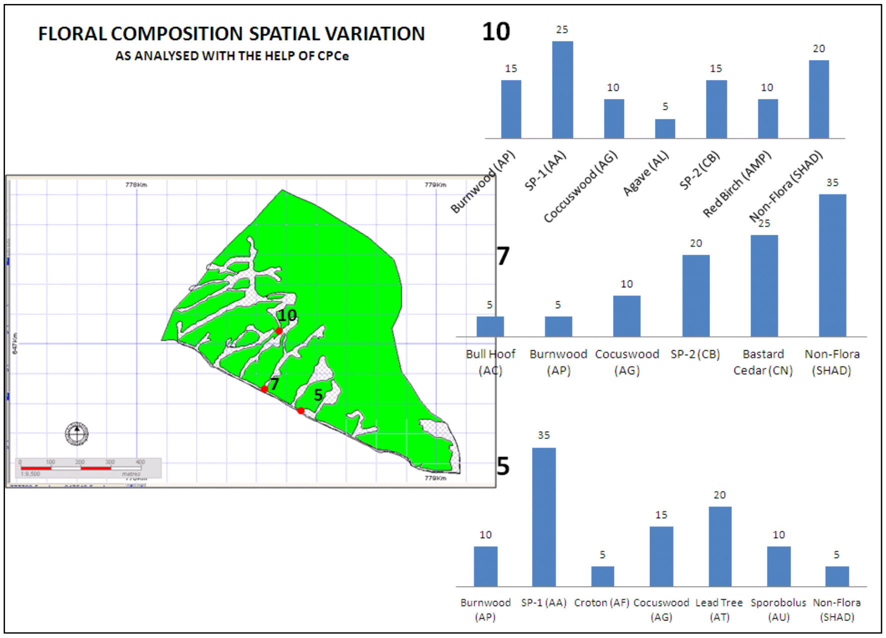


Figure 5.1.21

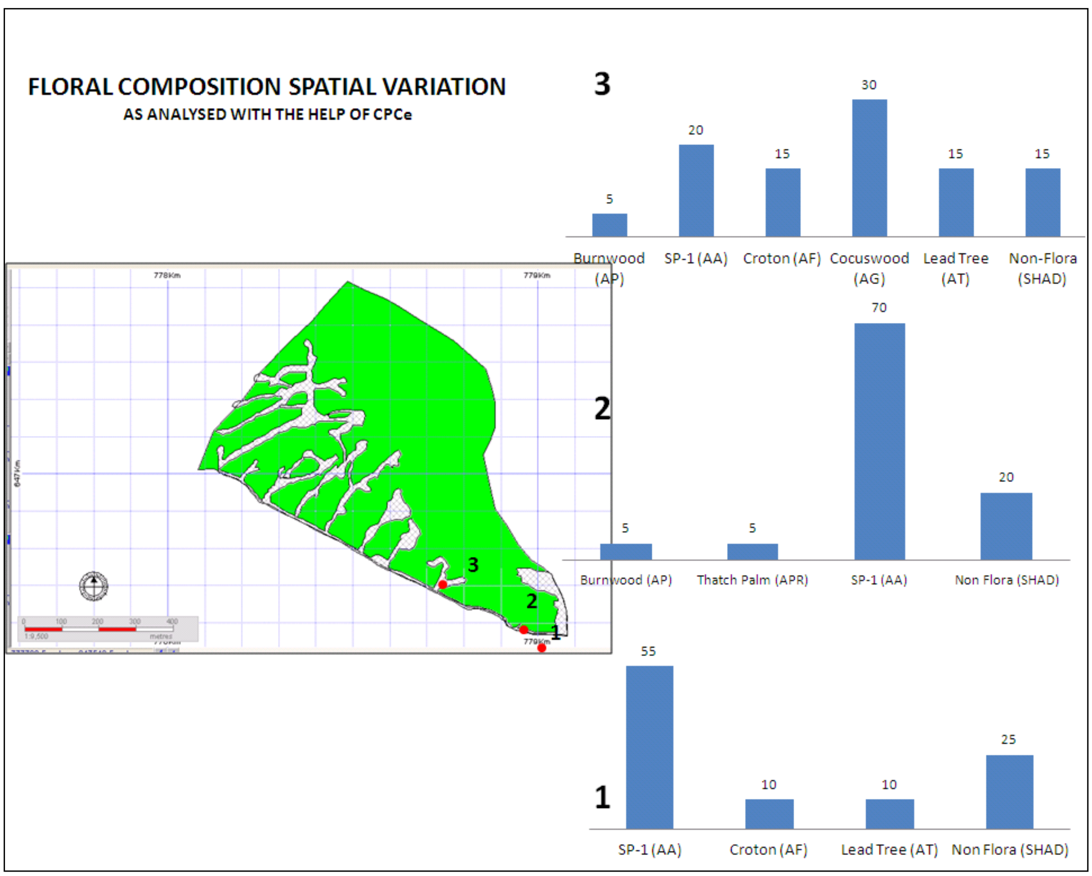


Figure 5.1.22

Plate 5.1.24: Dense Congregation of Broom Thatch Palm Trees Observed at Study Site

Figure 5.23 illustrates the estimated area within which significantly large numbers of the endemic tree existed on the site.

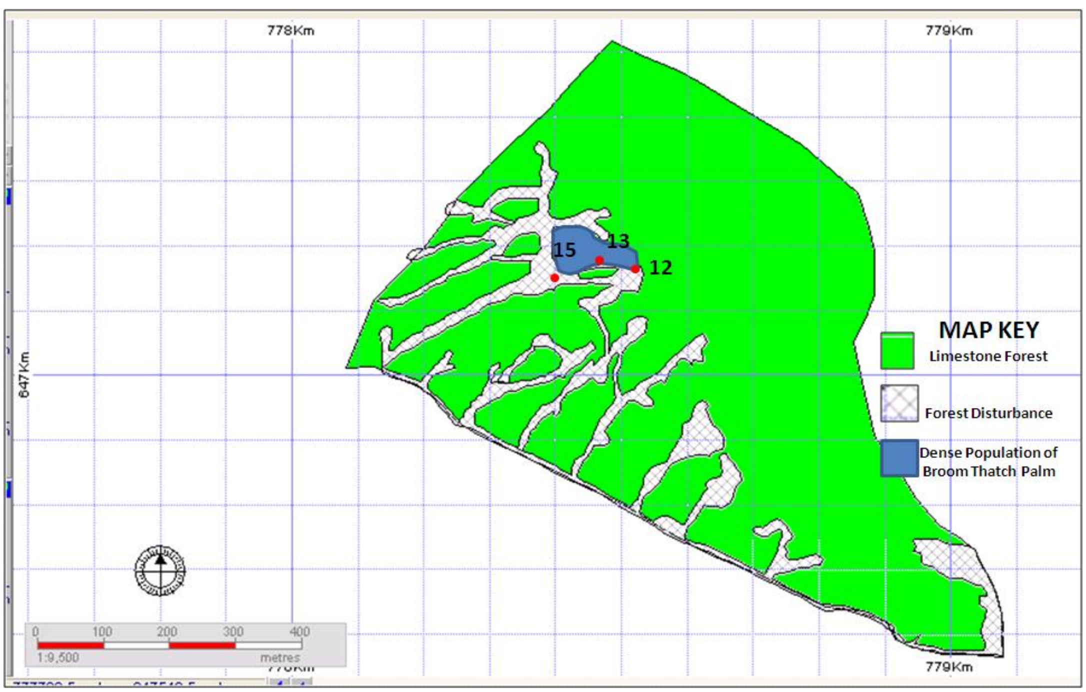


Figure 5.1.23: Approximate Location of Dense Population of Broom Thatch Palm Trees at Study Site.

5.1.4.3.6 Floral Species Diversity

Figure 5.1.19 illustrates Shannon Wiener index results for the species sampled from the photoquadrats taken at the study site. The sum of the values represented here, or the diversity index (**H**) is 1.8, suggesting a floral population of relatively **low species richness and relative un-evenness in abundance**.

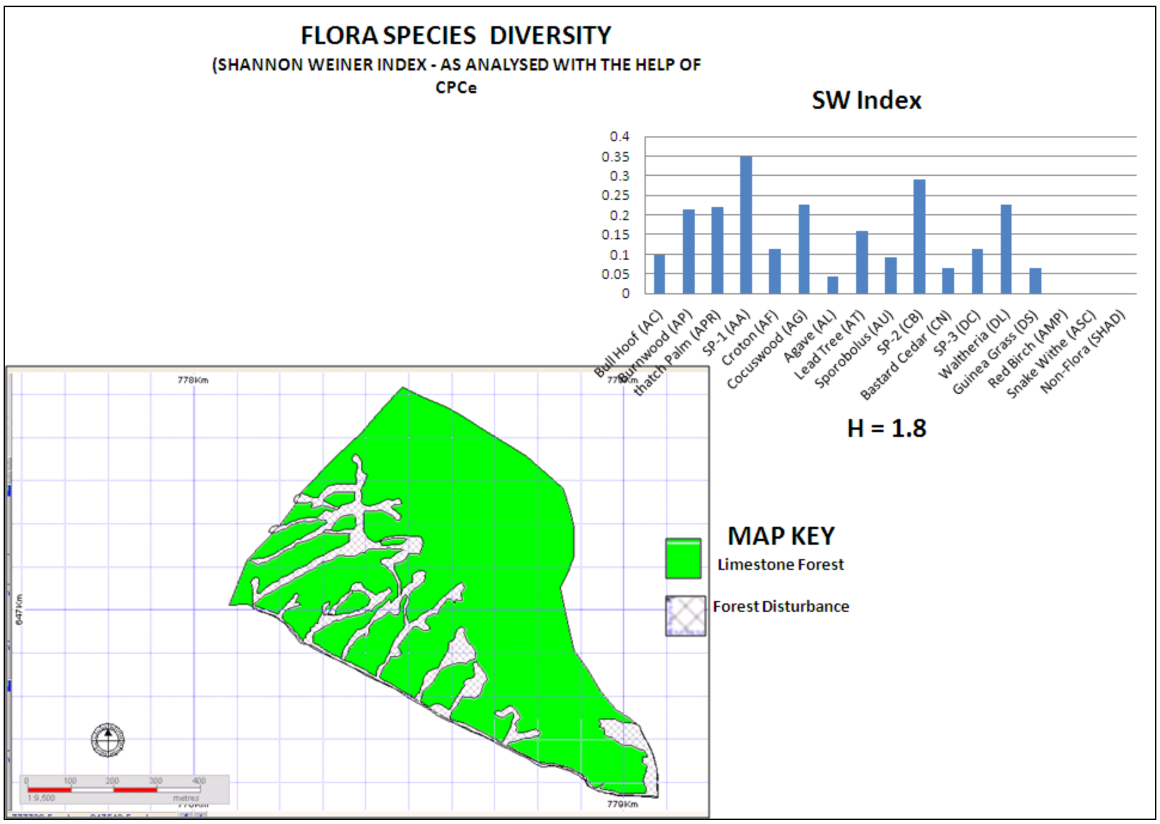


Figure 5.1.24

5.1.4.4 Fauna types

5.1.4.4.1 Birds:

Table 5.1.15 lists the types of birds that were detected (seen AND heard) within (or in the case of the Turkey Vulture immediately above) the survey transects. This table is supported by Plate 5.1.25 Seventeen varieties were observed. No nocturnal birds were observed or heard during night surveys conducted along the same transects.

Table 5.1.15: List of the Types of Insects Observed During Surveys Conducted at the Site (red highlighted = endemic)

COMMON NAME	SCIENTIFIC NAME	NUMBERS OBSERVED
1-American Kestrel	*Falco sparverius*	**1**
2-Zenaida Dove	*Zenaida aurita*	**2**
3-Yellow-faced Grassquit	*Tiaris olivacea*	**18**
4-Turkey Vulture	*Cathartes aura*	**4**
5-Baltimore Oriole	*Icterus galbula*	**1**
6-Northern Mockingbird	*Mimus polyglottos*	**4**
7-Loggerhead Kingbird	*Tyrannus caudifasciatus*	**5**
8-Jamaican Oriole	*Icterus leucopteryx*	**1**
9-Sad flycatcher	*Myiarchus barbirostris*	**7**
10-Common Ground Dove	*Columbina passerina*	**9**
11-Caribbean Dove	*Leptotila jamaicensis*	**1**
12-Black Whiskered Vireo	*Vireo altiloquus*	**1**
13-Blackfaced Grassquit	*Tiaris bicolor*	**1**
14-Baltimore Oriole	*Icterus galbula*	**1**
15-White-crowned Pigeon (Bald Pate)	*Patagioenas leucocephala*	**6**
16-American Redstart	*Setophaga ruticilla*	**3**
17-Swainsons Thrush	*Catharus ustulatus*	**1**

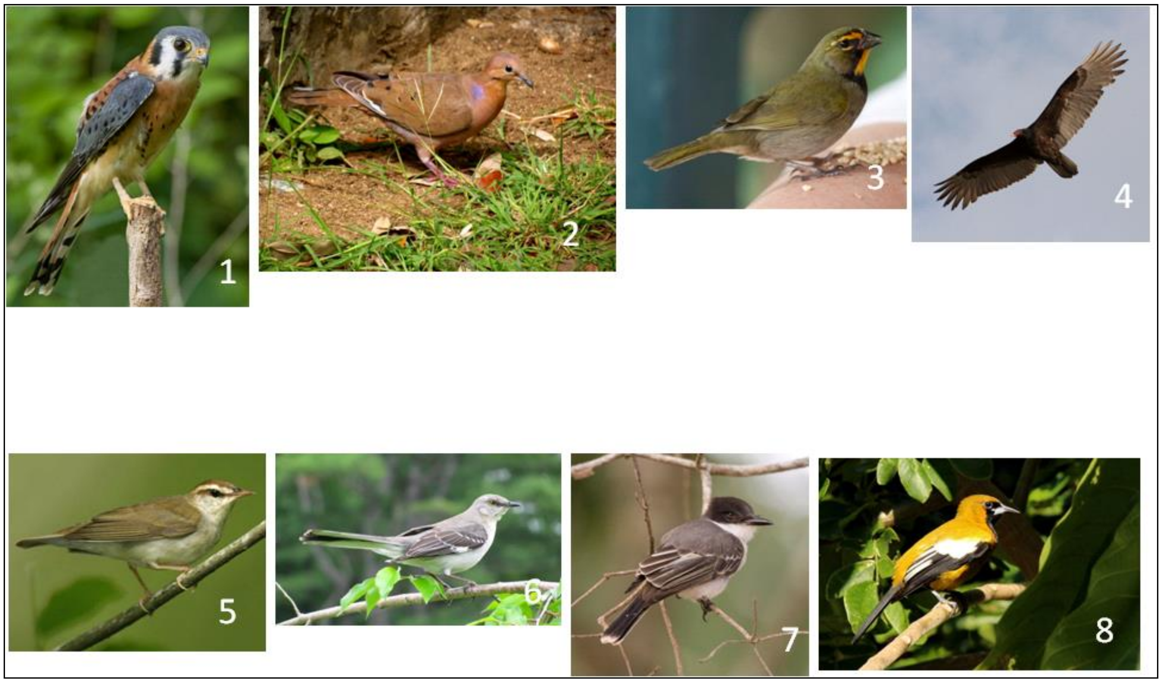


Plate 5.1.25: Bird Species Observed at the Study Site (relate to Table 3.2.1-1)

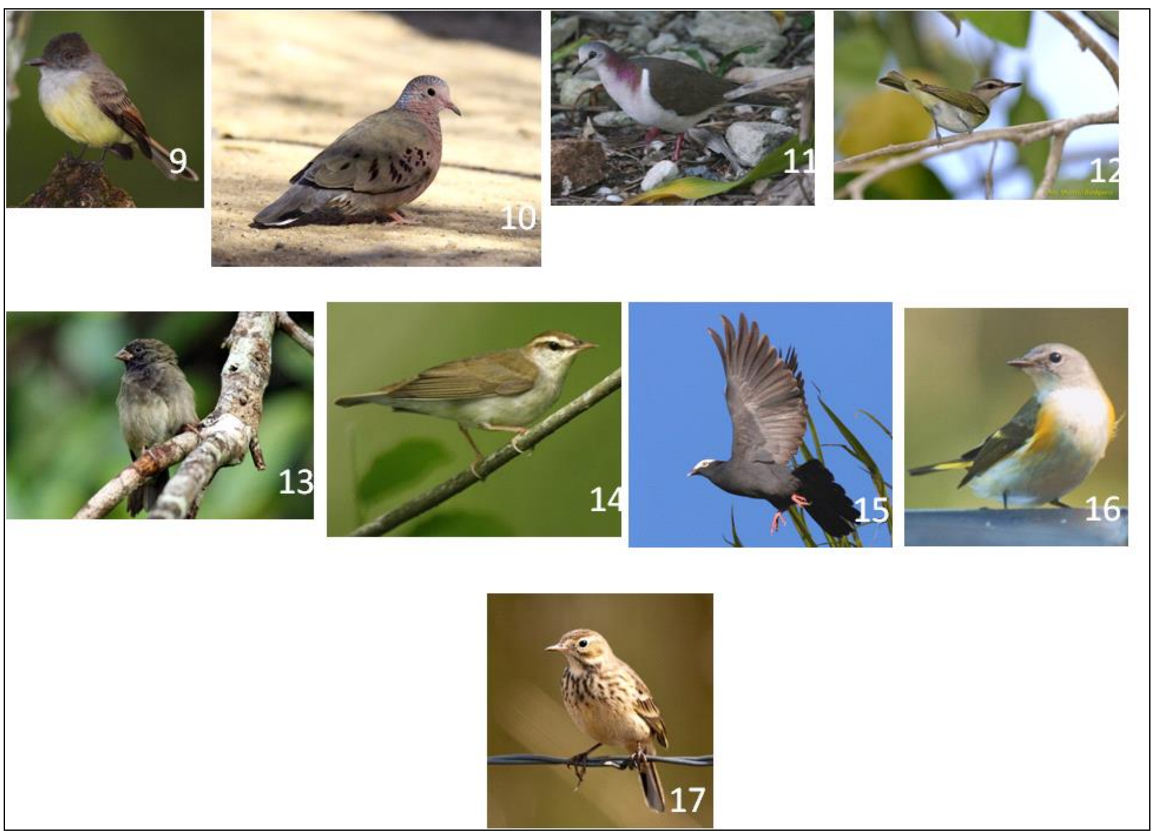


Plate 5.1.26: Bird Species Observed at the Study Site (relate to Table 3.2.1-1)

A total of 66 birds were observed in the approximately 7.5 hectares of open space environment surveyed over the CCC Limestone study area. **Figure 5.1.26** illustrates Shannon Wiener index results for the species sampled from the transect survey taken at the study site. The sum of the values represented here, or the diversity index (**H**) is 1.6, suggesting a bird population of relatively **<u>low species richness and relative un-evenness in abundance</u>**.

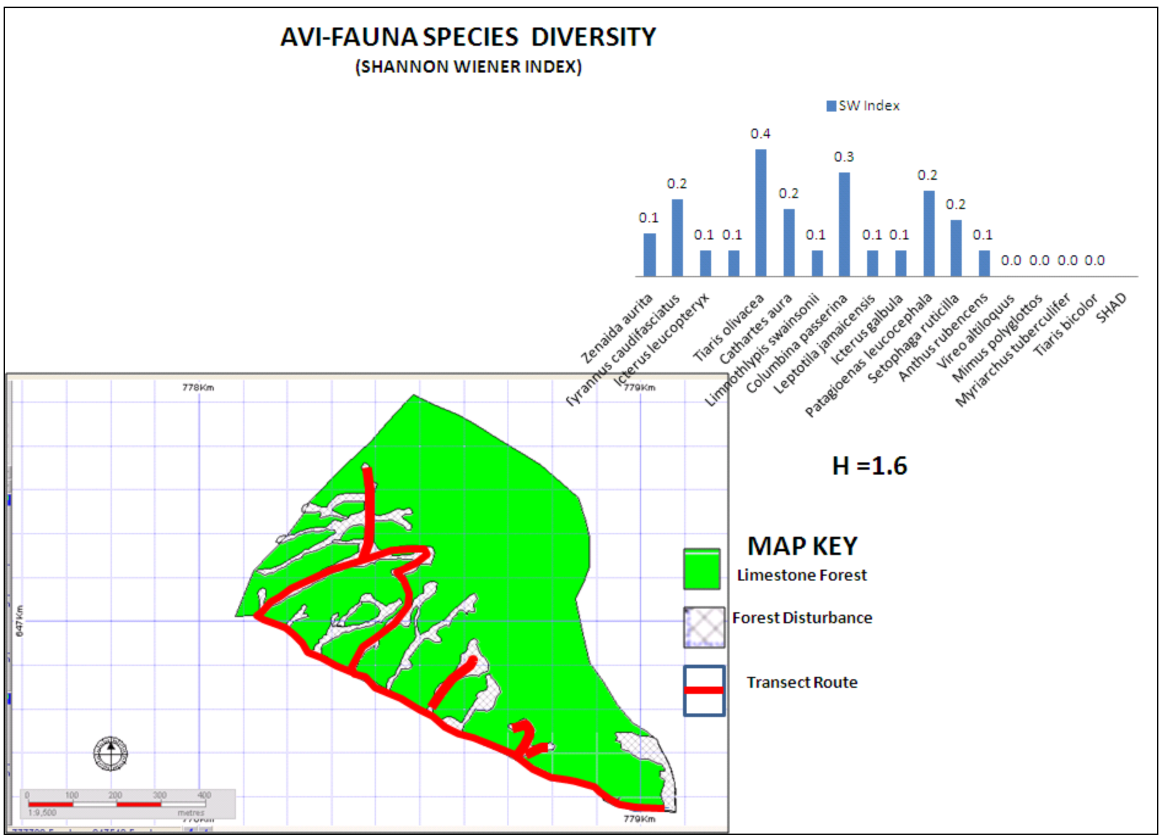


Figure 5.1.25

5.1.4.4.2 Herpetofauna (Lizards):

It was somewhat surprising that, for the most part, lizards were not observed along the survey transects – with the exception of one variety, the Jamaican Brown Anole (*Anolis lineatopus* - see Plate 5.1.27).

Plate 5.1.27: The Jamaican Brown Anole (Anolis lineatopus – taken on site)

5.1.4.4.3 Insects (Butterflies and Moths):

Table 5.1.16 lists the types of flying insects that were detected within the survey transects. Eight varieties were observed. Table 5.1.16 is further supported by Plate 5.1.28. One variety of nocturnal insect was observed – an unidentified variety of Cricket that was heard frequently throughout the night traverse.

Table 5.1.16: List of the Types of Insects Observed During Surveys Conducted at the Site

COMMON NAME	SCIENTIFIC NAME
A - Lignum Vitae Butterfly	*Krigonia lyside*
B - Zebra Longwing	*Heliconius charitonius simulator*
C – Hairstreak butterfly	*Chlorostrymon orbis*
D - Tropical Silverspot	*Dione vanilla insularis*
E - Honey Bee	*Apis sp.*

F - Unidentified Cricket	**-**

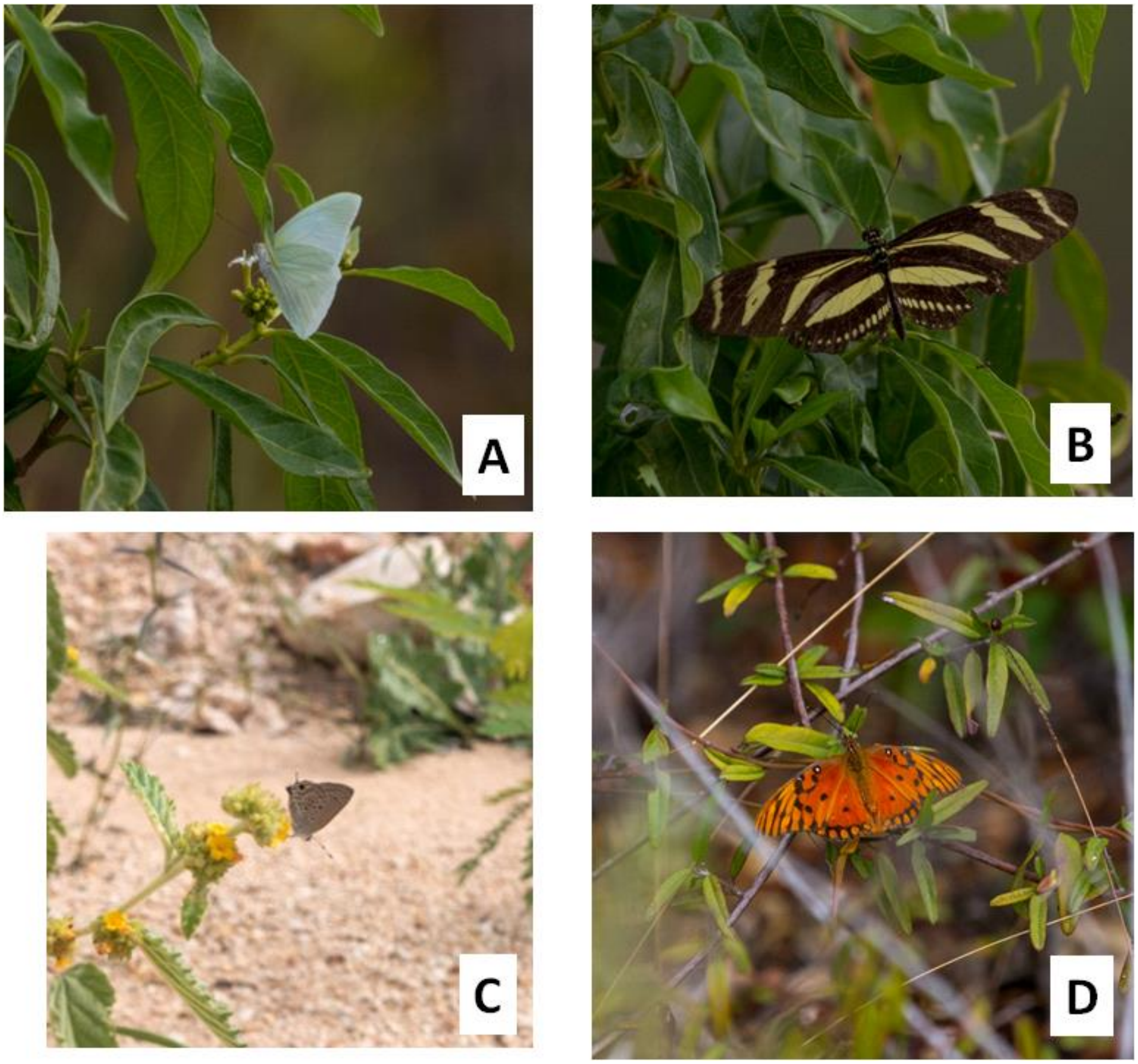


Plate 5.1.28: Flying Insects Observed at the CCC Limestone Study Site – refer to Table 3.2.3-1

5.1.4.4.4 Gastropods (snails)

Two varieties of snails were observed at the site. These were the Jamaican Tree Snail *Orthalicus undatus* and the ground gastropod *Pleurodonte peracutissima* (see Plate 5.1.29)

Plate 5.1.29: (A) Jamaican Tree Snail, (B) Pleurodonte peracutissima

5.1.4.4.5 Mammals (Bats, Mongooses)

The only mammals observed during the data collection process at CCCL Harbour Head were Bats, which were seen during the dusk portion of fauna assessments conducted at the site. The identity of the Bats could not be ascertained; however, it is very likely that these Bats were insect eaters. There were no fruit trees of any significance within the study area that could be regarded as providing nutritional support for Bats seen in the area.

5.1.4.4.6 Amphibians (Frogs)

The Cane Toad (*Bufo marinus*) was observed (see Plate 5.1.30).

Plate 5.1.30: Cane Toad (Bufo marinus) Observed at Study Site.

5.1.5 Heritage

The site has no heritage feature of significance. A copy of the correspondence send to the National Heritage Trust is included as Appendix 3.

5.1.6 Socio-Economic Environment

As outlined in Section 4.4, and map below, there are no social or economic activities within 1 km of the proposed quarry site. There will not be any interaction with the external as the entrance to the site is through the existing quarry. The crushing plant is located in the existing quarry and material is transported to the cement plant via an existing conveyor. The expansion of the Harbour Head limestone quarry to the new proposed site is to ensure the availability of mineral of the appropriate chemistry for blending. This is to ensure the continued viability of the cement plant operation and is not expected to result in a net increase in the rate of mineral extraction.

The socio-economic environment will remain the same as per the existing limestone quarry. The project can be considered to be a transfer of a percentage of quarrying activities to adjacent land in order to obtain the required chemical composition of limestone. This implies that there will not be any additional impact due to this project.

Figure 5.1.26: Google Image showing the project site 1 km zone of influence

A housing development has been proposed for the Dallas area and the is shown in Figure 5.1.27 below. Should this development materialized it would be outside the zone of influence for the proposed Harbour Head Quarry extension.

Figure 5.1.27: Google Map showing area proposed for Dallas housing development

5.2 Halberstadt

5.2.1 Physical Environment

5.2.1.1 Location and Description

The Halberstadt Quarry is located towards the eastern boundary of the parish of St. Andrew, less than 1 km west of the parish of St. Thomas. It is situated approximately 1.5 km north of Salt Spring, St. Andrew and 1.2 km northeast of Bito, St. Andrew on faulted mountains at a height of between 500 metres and 600 metres above sea level overlooking the valley of Bull Park River (Figures 1.1). The area consists of a rugged terrain, characterized by steep slopes, high ridges and narrow gullies, which drain into the Bull Park Gully.

The total size of the Halberstadt property is approximately 13 hectares, of which 6.7 hectares is covered by deposits of gypsum and anhydrite. An estimated 1 hectare of the

6.7 hectares was approved for mining in 2013 and an additional 1 hectares recently approved.

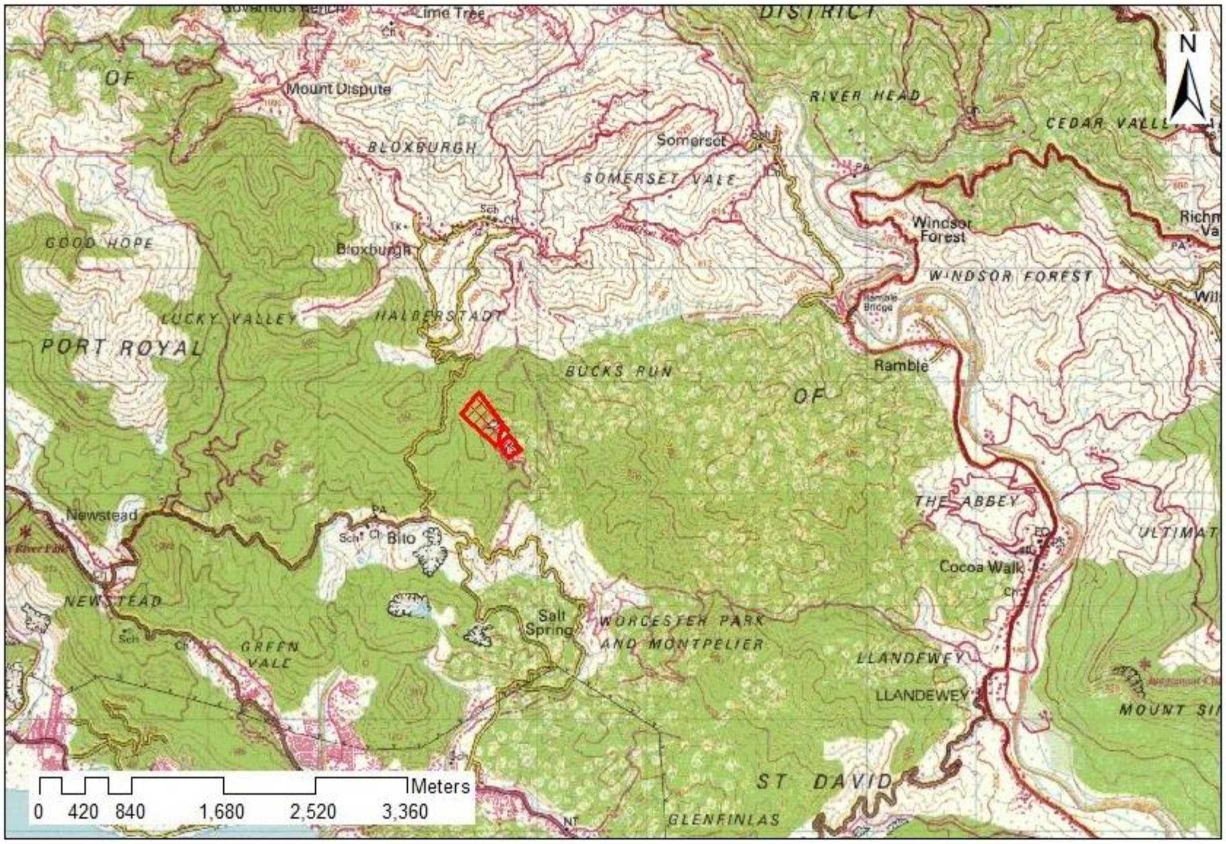


Figure 5.2.1: Location of the Halberstadt Quarry (Source: 1: 50,000 metric Kingston Topographic-Sheet 18)

5.2.1.2 Geomorphology

5.2.1.2.1 Regional Geomorphology

The geomorphology of the wider Halberstadt area is largely determined by geology and tectonic activities that evolved during the lower Eocene period. The landform features can be described as rugged terrain consisting of high hills, sharp ridges, deeply incise gullies and streams (Figure 5.2.1).

North-west of the Halberstadt Quarry site, the land rises into a peak, 1,036m high (3,420ft) at the Bloxburg Survey Grid Point. Narrow and elongated ridges radiate into different directions from this peak to form a radial pattern. The hills and ridges are rugged due to a well-developed dendritic drainage system that has carved deeply into the surface rock to form the typical 'hill and gully' features that dominate the area. The main ridges are aligned in a NW-SE and N-S directions, while the deep gullies and streams are aligned parallel or sub-parallel to the ridges. On either side of the ridge, the steep slopes are dominated by numerous smaller gullies which drain storm water into the larger gullies and streams (Plate 5.2.1).

Figure 5.2.2: Rugged landform consisting of high ridges and deep gullies (1: 25,000 1961 Aerial Photo)

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Plate 5.2.1: High hills and deeply dissected valleys viewed from top of the existing Halberstadt quarry

Further south, the general topography has been somewhat altered by previous mining activity particularly in the Bito area which began during the 1950's and has continued for over 60 years, but has ceased operation in recent times. As a result, large quarry pits and high rock faces have been created which has changed the landscape of the natural landform features in the Bito area.

Figure 5.2.3: Google image of landform features of the Halberstadt site and environs

5.2.1.2.2 Site Geomorphology

The Halberstadt Quarry site is hinged between the upper reaches of the Bull Park Gully and a NNW-SSE aligned ridge. There are three small gully features which drain in a NW-SE and W-E direction through the site and into the major Bull Park Gully on the north-eastern section of the existing quarry site (Figure 5.2.4).

The most northerly of the gullies drains north of the existing gypsum quarry into the major gully; another gully drains in a WNW direction and forms the boundary of the existing quarry and the additional land for which a quarry licence is being sought for mining. Drainage is captured and then flows into a detention pond. The most southerly gully drains easterly through the current mining area and is eventually captured by a detention pond which was constructed to take storm water from the existing mining area.

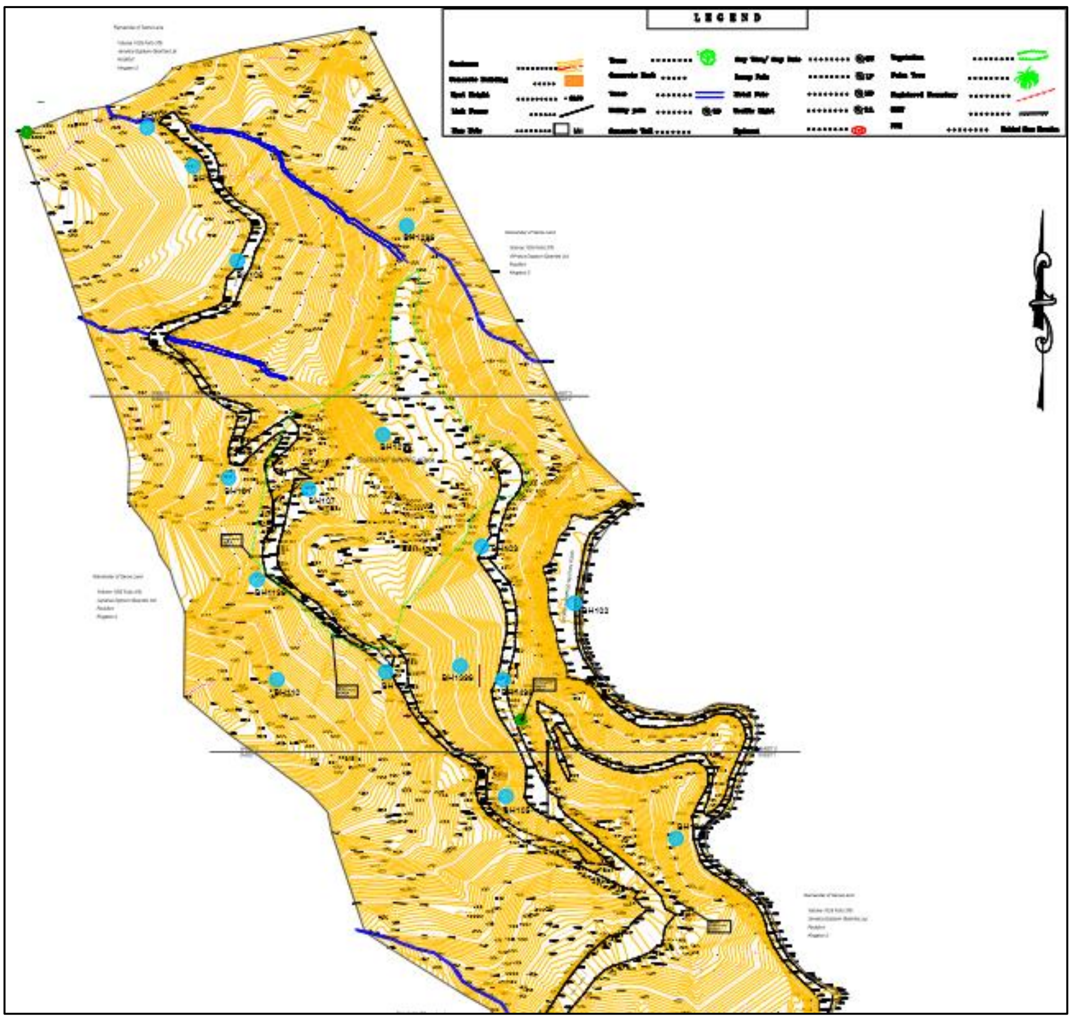

Figure 5.2.4: Gypsum mining area, topographic plan and borehole locations for Project Site

The topography of the land is generally steep, consisting of slopes ranging from 26 degrees (50% slope) to over 38 degrees (80 % slope). Slope map taken from the CCCL Environmental Impact Statement report shows variation in slope steepness which gives an indication of the challenges for mine/quarry development (Figure 5.2.5).

Alteration of the site topography has been done as a result of quarry activities on approximately 1 hectare of land for the extraction of gypsum (Plate 5.2.2). Further alteration of the site is expected once a quarry licence is granted to conduct mining activities for the 6.7 hectares. This will significantly change the natural landform and drainage pattern within the Halberstadt quarry site.

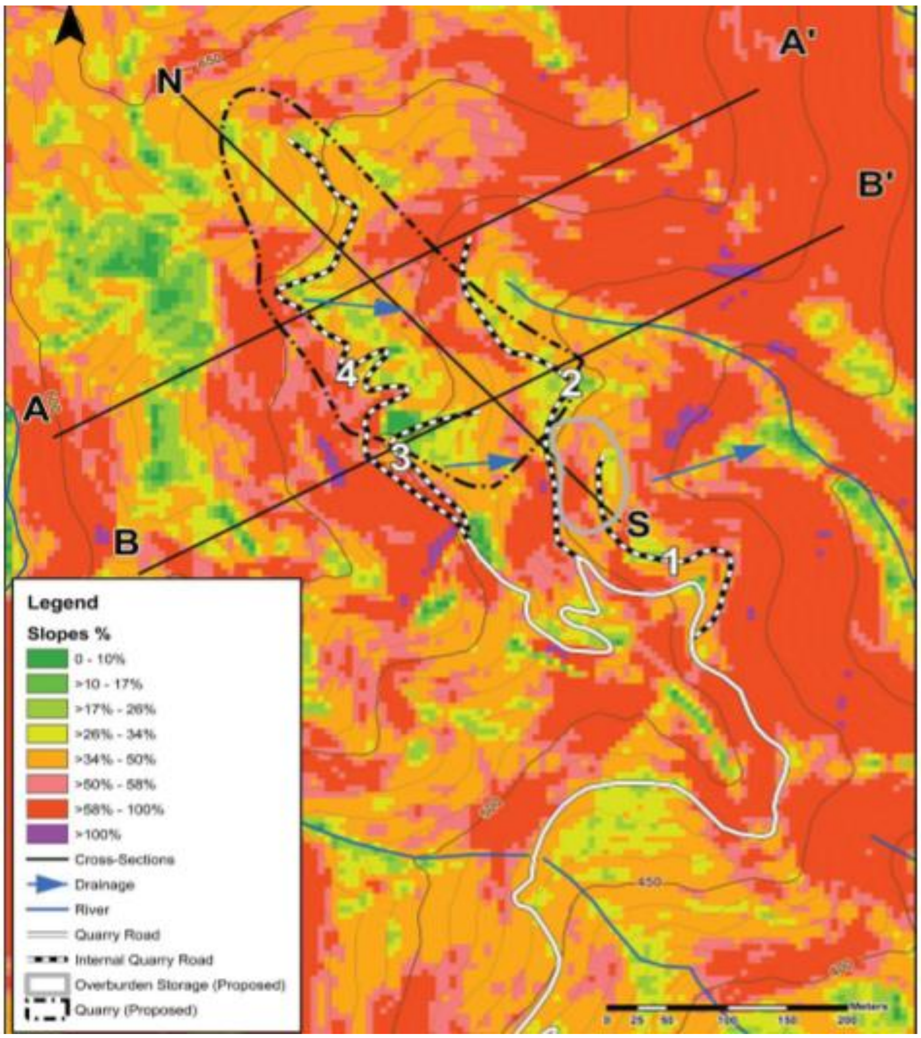

Figure 5.2.5: Slope map for the Halberstadt site and surrounding areas (Source: CL Environmental Consultants)

Plate 5.2.2: Gypsum mining which has altered the landform at the Halberstadt site

5.2.1.3 Geology

5.2.1.3.1 Regional Geology

The project site and surrounding areas is part of a larger geological sequence commonly referred to as the Wagwater Group. The Wagwater Group consists of a series of rocks formed during the Lower Eocene period, made up of reworked sediments derived from older rocks and from lava flows which occurred during the period. This group of rocks is situated between the Blue Mountain Fault in the NE and the Wagwater Fault to the SW of the site. A major unconformity exists between the Cretaceous rocks of the Blue Mountain Group and the Lower Eocene Wagwater Group. The gypsum found within the Wagwater Group would have been formed in a lagoonal environment close to an ocean front during the Lower Eocene.

From a regional standpoint, the major structural feature is the Wagwater Belt which is a down warping area between the NW-SE trending Wagwater Fault and the Plantain Garden Fault, of which the NW-SE Yallahs Fault is a part (Robinson et al). This major tectonic movement led to down thrust during the lower Eocene resulting in extensive erosion of older sediments from the NE into the Wagwater Belt or trough in which thick sediments were accumulated. Within the Wagwater Belt are dominant NW-SE and NNW-ESE trending faults that are related to the major Wagwater Fault System.

5.2.1.3.2 Geology of Halberstadt Site

The geology of the Halberstadt area is comprised of four (4) main geological formations; the Newcastle Volcanics, Halberstadt Volcanics, Wagwater Formation and Gypsum (Figure 5.2.6). *The Newcastle Volcanics* dominate the Halberstadt Quarry Site. It consists of lava of intermediate composition which is grey in colour when fresh, but changes to greyish brown, purplish brown and buff colour when weathered. Volcanic breccias and tuffs are also associated with the Newcastle Volcanics.

At the proposed quarry site, the Newcastle Volcanics is highly to completely weathered and brecciated and is a major feature of the rock. The weathered volcanics forms the overburden material for the gypsum (Plates 5.2.7 and 5.2.8). It can be described as extensively fractured or brecciated greyish brown rock which breaks up into angular cobble and pebble size fragments and occasional boulders intermixed with finer gravel and sand matrix. The angular volcanic fragments are easily crushed between fingers when a light force is applied. Less weathered Newcastle Volcanics is infrequently exposed and when this occurs, the rock is moderate to highly jointed and fractured and generally maintains its original geological structure (Plate 5.2.9).

Based on borehole data, the Newcastle Volcanics, which forms the overburden sits on top of the gypsum. The depth of overburden is variable, from close to ground surface (Plate) to depths of over 35m. *The Halberstadt Volcanics* outcrops further north of the project site. It is usually associated with gypsum, especially in the Bito area. This formation consists of basalts, pillow lavas and some pyroclastic flows. The lavas are dark green when fresh and weathers to rusty brown colour.

The Wagwater Formation is a terrestrial sequence of purple and reddish-brown conglomerates, sandstone and mudstone. However, conglomerate dominates this formation and is made up of reworked sediments from older rocks in the Blue Mountain Inlier.

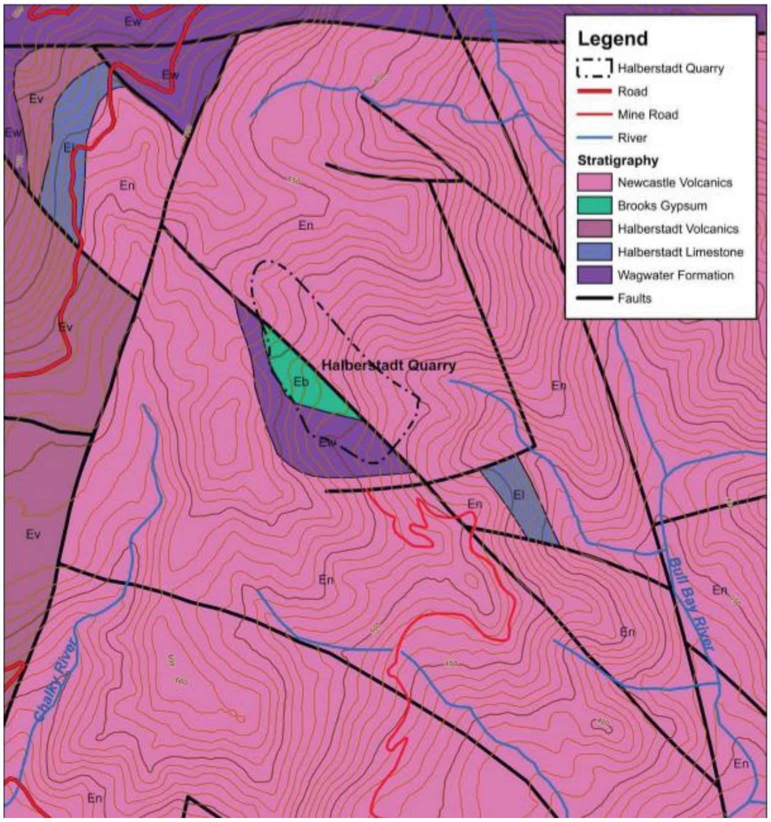

Figure 5.2.6: Geology of the Halberstadt Quarry and surrounding areas

Figure 5.2.7: Highly weathered Newcastle Volcanics located on top of the existing Halberstadt Quarry, which forms the overburden for the Gypsum

Figure 5.2.8: Close-up view of the weathered and brecciated Newcastle Volcanics consisting of coble and pebble-size clastics

Figure 5.2.9: Slightly to moderately weathered Newcastle Volcanics with vertical rock joints Less weathered

Gypsum, which is the mineral to be extracted, sits on the older Wagwater Formation, but is overlain by the weathered Newcastle Volcanics. This rock is an evaporite formed within a lagoon that consists of ocean water rich in calcium and sulphate minerals. The gypsum is presented in the hydrated form as well as an anhydrite. It is well bedded and highly fractured consisting of light grey to grey steaks or bands which gives the rock its characteristic appearance.

Figure 5.2.10: Gypsum rock outcropping near to ground surface with little overburden

Figure 5.2.11: Exposed Gypsum rock in existing mining area

5.2.1.4 Hydrogeology

5.2.1.4.1 Hydro-Stratigraphy

The site lies atop the Basal Aquiclude Hydrostratigraphic unit which is comprised of Newport Volcanic volcaniclastic rocks with particle sizes varying from fine grained tuffs to coarse grain conglomerates resulting from lava flows overtime. The quarry area lies within Bull Bay Chalky River sub watershed management units of the Hope River Watershed Management Unit of the Kingston Hydrological Basin (Water Resources Authority Hydrological Database: http://webmapjam.dyndns. pro/). The elevation of the site is above 500m with steeply sloping section located to the north-eastern section of the site contiguous with the surface feature (gully) leading to the Bull Park River.

No groundwater is expected within this formation as a result of the very low permeability of the basement rock formulation. The main resource type in this area is surface water which originates from the generation of overland flow associated with rainfall event and/or the existence of spring in weathered/fractured section s of these rocks allowing for sustained yields in the rivers that drain these areas. Faults are generally zones along which increased permeability occurs and groundwater may also occur along these zones. The Draft Water Resources Development Master Plan (2005) prepared by the Water Resources Authority gives the safe water yield within the Hope River WMU as 23m^3/year and the exploitable yield for the Bull Bay River Sub –WMU is 2.7 m^3/year.

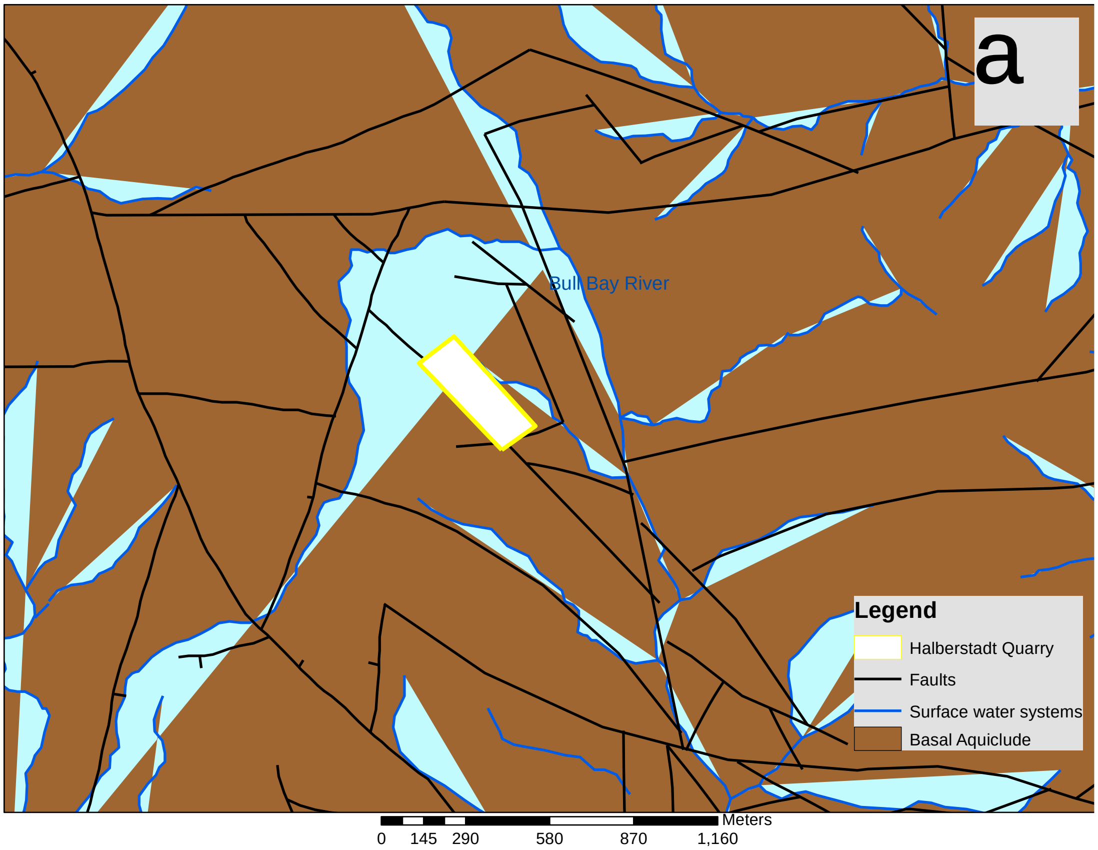

Figure 5.2.12: Hydro-stratigraphic Map of Halberstadt Quarry Site

5.2.1.4.2 Hydrology

The site is located in the watershed drained by the Hope River which is approximately 19.6km in length. The closest perennial surface water system to the site is the Bull Bay River located 300m east of the site. The site is located within the Bull Bay Chalky River Sub-Watershed Management Unit of the Hope River Watershed Management Unit of the Kingston Hydrological Basin (Water Resources Authority Hydrological Database: http://webmapjam.dyndns.pro/). Site assessments along with topographical maps have shown that there is no significant feature traversing the site. A gully feature is contiguous with the eastern boundary of the site which is primarily seasonal, characterized by high flows in short duration during rainfall events which drains toward the Bull Bay River Valley.

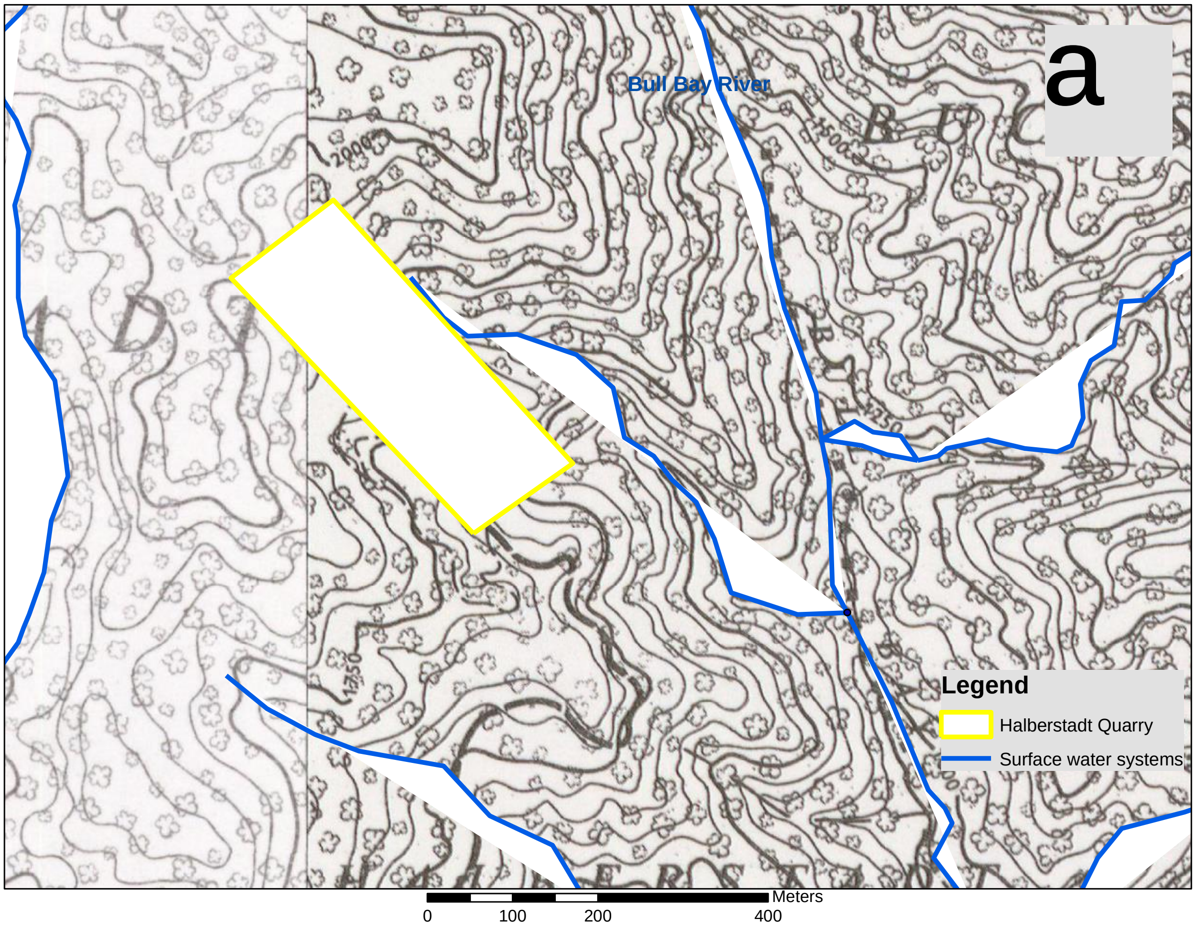

Figure 5.2.13: Topographic Map Showing Drainage features for the Halberstadt Quarry Site

5.2.1.4.3 Water Quality

Baseline water quality samplings were conducted on February 23 and February 29, 2016 at three sites for this project. The locations are: Bull Bay River known locally as the Bull Park River above the entry of the Halberstadt Gully; Bull Park River above the Jacksville Community; and the Spring labelled as Spring 1 located 2km south of the Halberstadt Quarry site.

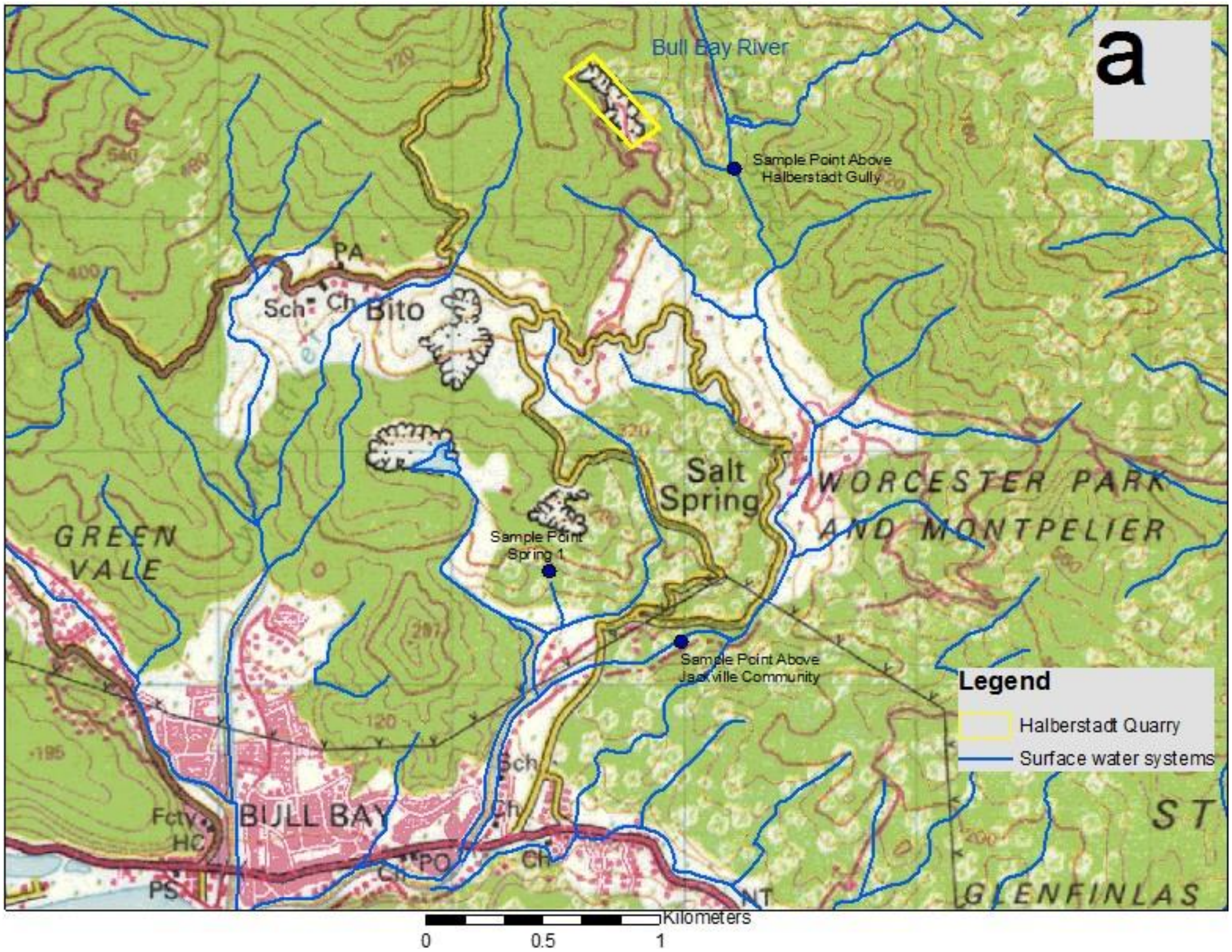

Figure 5.2.14: Topographic Location map showing location of water quality sampling points

Samples were collected in pre-sterilized bottles acquired from the laboratory, stored on ice and taken to the Scientific Research Council Laboratory for analysis of all parameters.

Parameters tested are Total Phosphate, Total Suspended Solids, Total Dissolved Solids, Nitrate, Dissolved Oxygen, FOG, Turbidity Faecal Coliform and pH in keeping with approved TOR by the National Environment and Planning Agency.

Results

Results are compared with the NRCA Ambient Water Quality Standard.

Table 5.2.1

Parameter	Bull Park River above Halberstadt Quarry Site Gully Coordinate JAD 2001: 778227.67N 648256.57E	Bull Park River above Jacksville Community Coordinate JAD 2001: 778227.67N 648256.57E	Spring 1 Coordinate JAD 2001: 778227.67 N 648256.57 E	NRCA Ambient Standard
Total Phosphate mg/L	0.17	0.05	0.07	0.01 – 0.8
Total Suspended Solids mg/L	3	6	2	-
Total Dissolved Solids mg/L	826	1400	710	120 – 300
Nitrate mg/L	ND	ND	4.62	0.10 – 7.5
Dissolved Oxygen mg/L	8.2@22^{0}C	8.4@22^{0}C	5.3@20^{0}C	-
FOG mg/L	4.05+/-0.50	2.13+/-0.26	0.90+/-0.10	-
Turbidity NTU	1.39	2.48	0.26	-
Faecal Coliform MPN/100mL	70	79	<1.8	-
pH	7.9@23^{0}C	8.0@22^{0}C	7.2@23^{0}C	7.00 – 8.4

Surface Water

The water quality of the spring indicates TDS elevated above the ambient standard. This can also be the result of the use of agrochemicals within the area.

5.2.2 Ecological Services

The mining plan for the Halberstadt Gypsum Quarry proposes to undertake progressive rehabilitation. That is, to restore mined out areas which will be divided into production blocks. As one production block is mined out, restoration of that block will be initiated concurrently with the commencement of mining the adjoining block. Depending on the nature of the deposit, the worst case is for no greater than 50% of the deposit will constitute a block. This would mean that approximately 3.5 of the 6.7 hectares may be disturbed before rehabilitation commences. In such case the ecological services of the proposed site could be reduced by as much as 50%.

5.2.3 Natural Hazards

5.2.3.1Landslide Hazard

A review of the literature has identified two studies that produced landslide susceptibility maps for Eastern St Andrew which encompasses the Halberstadt, Brooks and Bito Gypsum quarries. The first study was conducted by Unit for Disaster Studies of the University of the West Indies, funded jointly by USAID and OAS, which formed part of the Caribbean Disaster Mitigation Project. A Landslide Susceptibility Map for Kingston and St Andrew was developed in 1998 for the parish of St Andrew which includes the gypsum quarry areas (Figure 5.2.15). The model chosen is the Bivarite Statistical Method which uses landslide inventory of an area as the basis for developing the model. The Landslide Susceptibility Map shows that the Halberstadt project site has Moderately High to High landslide susceptibility.

The other study is an Environmental Impact Statement for the Proposed Quarrying and Mineral Processing at Halberstadt Quarry, St Andrew conducted by CL Environmental Consultants in 2013. A simplified Landslide Susceptibility model was created by CEAC engineers to determine the landslide susceptibility for the Halberstadt study area. Figure 3.2 is a landslide susceptibility map developed from the model which shows that the Halberstadt quarry and surrounding areas has moderate to high landslide susceptibility, of which 80 percent is within the high landslide susceptibility zone and 20 percent is in the moderate landslide susceptibility zone. Both studies compare favourably with each other.

In order to identify past landslides that may have occurred at Halberstadt and its environs areas, aerial photograph from the Hunting (Ja55) 1961 series at a scale of 1: 25,000 was used. At this scale only, large landslides would be identified. Landslides from road cuts and small gully slope failures would be difficult to be identified. Only one large landslide was identified from aerial photographic interpretation and this was located in the Bull Park Gully on the south east of the Halberstadt Gypsum site.

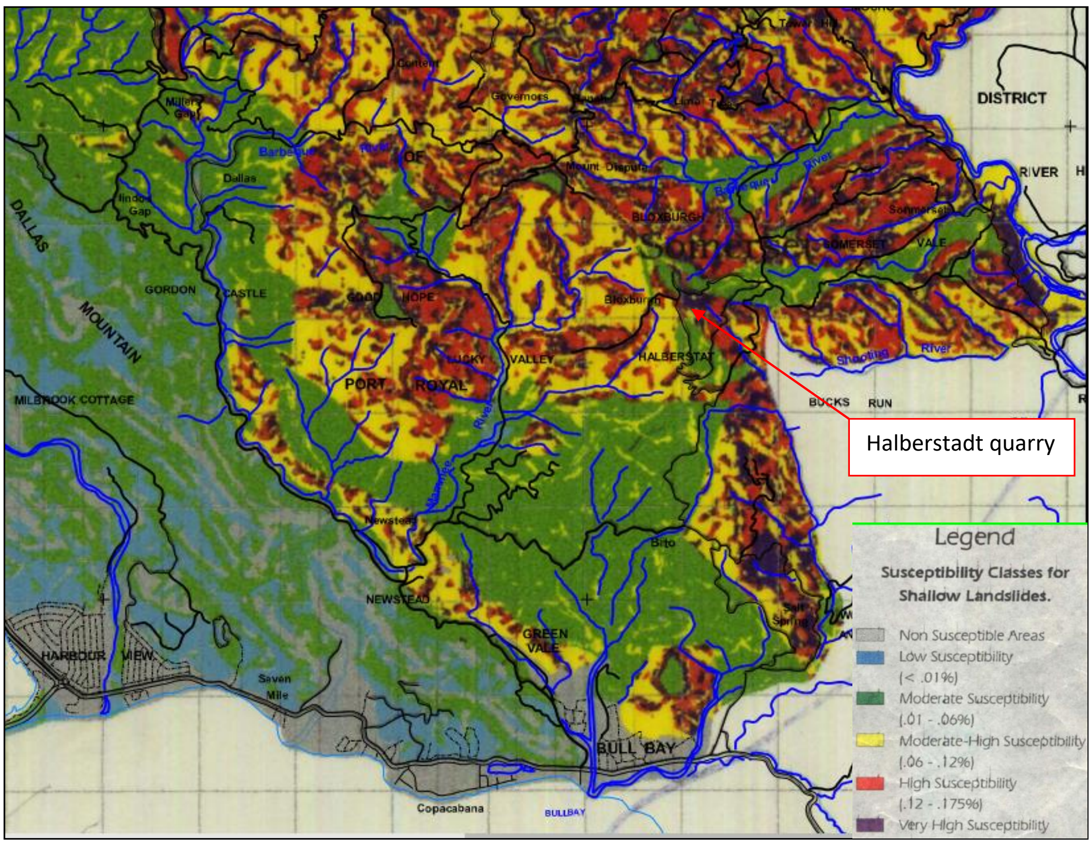

Figure 5.2.15: Landslide Susceptibility Map of Eastern St Andrew including the Halberstadt site

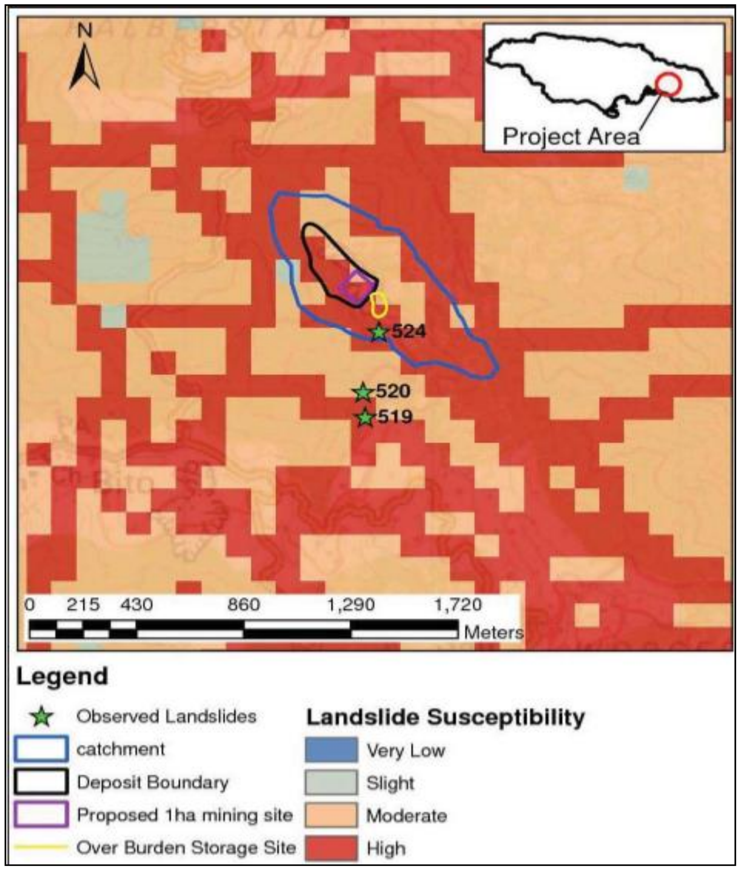

Figure 5.2.16: Landslide Susceptibility Map for Halberstadt site

A total of 4 landslides were identified during field work conducted at the site. 2 were observed on haul roads, 1 along a steep slope within the proposed 6 hectares of land behind the existing gypsum mine and the other observed on the face of the gypsum quarry (Plate 5.2.3 – Plate 5.2.4). The slope failures are small to medium rock and debris slides which are recent and may have occurred at different time over the past few years. The largest is a rock and debris slide identified on high cut slope on the haul road near to the gypsum quarry (Plate 5.2.5).

Plate 5.2.3: Landslide on Haul Road near Halberstadt quarry

Plate 5.2.4: Rock block failure at the end of quarry face of Halberstadt quarry

Plate 5.2.5: Large slope failure (rock and debris slide) on main haul road leading into Halberstadt

5.2.3.2 Hurricanes and Earthquakes

Information for the assessment of hurricanes and earthquakes hazards for the Halberstadt site is the same as obtained for the Harbour Head site which was presented in Sections 5.1.3.2 and 5.1.3.3 of this document.

5.2.4 Biological Environment

Figure 5.2.17:Close-up Google Image of CCCL Halberstadt Gypsum Quarry and surrounding areas

5.2.4.1Methodology

The methodology applied for the Halberstadt Biological Assessment was the same as used for Harbour Head and is described in Section 5.1.4.1. The assessment was conducted over the period **2016-01-20, 23 and 28** for the proposed CCC Gypsum quarry expansion.

5.2.4.1.1 The Line Intercept Method

A line intercept method was employed at the site. Figure 5.1.18 illustrates pathways that were used as a transect line along which the intercept method was used. Most of these pathways were already opened up to provide to support exploratory geological drilling work conducted by CCC within the area of the proposed limits of the mining area.

In this method, features existing along the lines traversed through floral aggregations were assessed, with observations being made along a vertical arc extending from the ground towards any forest canopy existing to one side of the pathway (transect line), as well as into the foliage to the extent to which clear identifications could no longer be done (which was typically 3 meters – see Figure 5.2.18 and Plate 5.2.6).

Figure 5.2.18: Path used as Transect Lines in the study area (white lines)

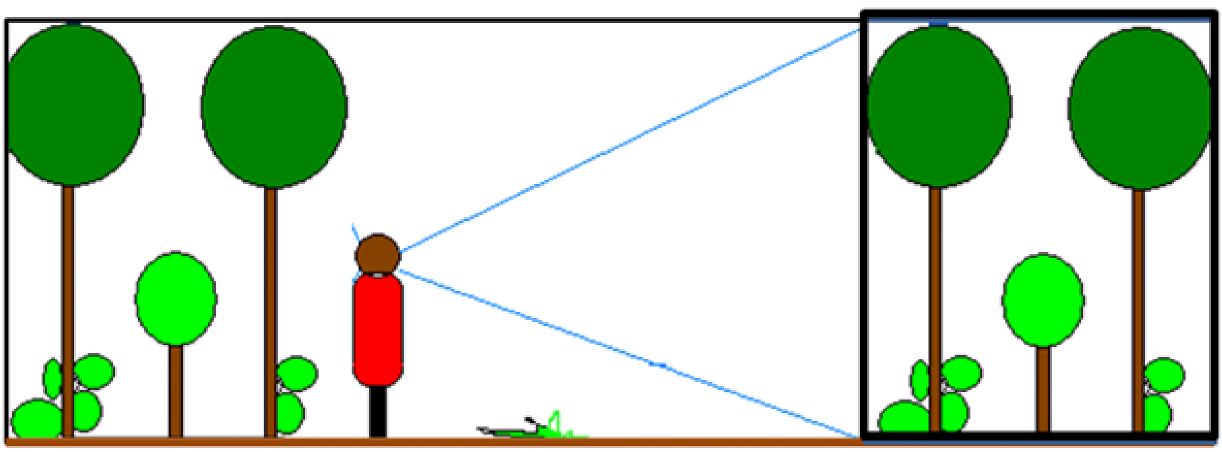

Figure 5.2.19: Schematic of the surveyed areas observed along the transects

Plate 5.2.6: Photographic View of vegetation along the Transects

5.2.4.2 General

Literature reviews spoke to the potential presence of the following groups of animals within or associated with the vegetation assemblages identified as being present at the site:

1. Avi-fauna (Birds)
2. Herpetofauna (Lizards)
3. Insects (Butterflies and Moths)
4. Gastropods (snails)
5. Mammals (Bats, Mongooses)
6. Frogs

Assessments for fauna were made using presence/absence visual observations along the transects traversed for the floral surveys, with observations being made in accordance with the space depicted on Figure 5.2.20 below. For the area visually swept, the average dimensions were 3 meters in elevation and 8 meters in width, or a cross-sectional area of 24 square meters. As was the case with Flora, observations being made along a vertical arc extending from the ground towards any forest canopy existing to both sides of the pathway (transect line), as well as into the foliage to the extent to which clear identifications could no longer be done (which was typically 7

– 10 meters. Bird movement triggered by the disturbance caused the field operatives traversing the site lead to data collection records of bird calls were also made during the transect traverses where these were heard.

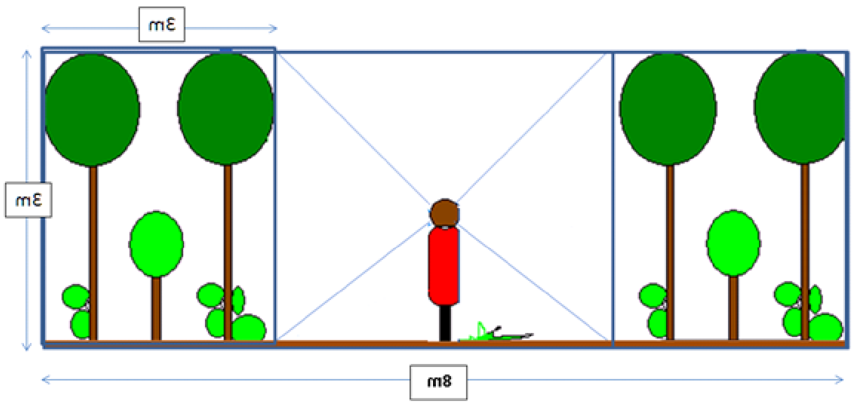

Figure 5.2.20: Schematic View of space assessed for birds at the study site

Transect surveys were staged at times that would facilitate most successful observations. These timings are listed below:

1. Day bird/insect observations: 5:30am – 8am
2. Reptiles: 5:30am – 8am
3. Night bird/insect observations: 5:30pm – 8pm
4. Bat observations 5:30pm – 6:30pm
5. During the course of the day for any birds or other animals that might be either observed flying or disturbed during the course of the vegetation surveys.

Again, like the transect use for flora, faunal transect observations/recordings were used for the generation of species lists.

<u>Birds</u>

The line transects survey method for birds were chosen so as to keep data collection in keeping with the paths being traversed for floral surveys. Visual observations of birds were made while walking along transects (in accordance with Bibby et al. 2000[35]). Where birds were heard or seen while traverses were being made, audio recordings were made and photographs taken while remaining stationary for 5-10 minutes (mirroring techniques used for Bird Point Count methods – Bibby et al 2000). Birds in excess of 50 meters from the observer could therefore be heard and identified.

Insects

Emphasis was placed on the observation and identification of flying insects – specifically butterflies flying across the path of the transect being surveyed. This was done because it was opined that flying insects play an important role both as plant pollinators and as a food source for forest avi-fauna. It was anticipated that survey time allotments would not allow for actual numbers to be determined. Therefore, an indication of relative prevalence was given, as defined using the DAFOR scale system[36] defined below:

D -Dominant

A -Abundant

F -Frequent

O -Occasional

R -Rare

In this case, the **DAFOR** scale was based on estimates of numbers of different species seen during the traverse along the transect with **D**ominant = **>75 individuals**, **A**bundant = **75 – 51 individuals**, **F**requent = **50 – 26 individuals, O**ccasional = **25 – 11%**, **R**are **10 – 1.**

5.2.4.2.1 Species Diversity

35Bibby, C.J, Burgess, N.D., Hill, D.A., and Mustoe, S.H (2000). ***Bird Census Techniques***, 2nd ed. Academic Press London.

36 http://www.surreyflora.org.uk/newnotes.php

Species diversity, biodiversity or the measure of how varied the species composition is within an area, has traditionally been one of the primary interests of Ecologists. It is said that the more diverse an area is, the healthier it is.

Species diversity can be regarded as having two separate components, namely:

1. The number of species present – termed **Species Richness**
2. The relative abundance of the species present – termed **Dominance or Evenness.**

With this complexity in mind, many different measures or indices of species diversity have been developed. The **Shannon Wiener** index (**H**) was used for the determination of biodiversity information, which is calculated in the formula H **= -SUM[(pi) * logn(pi)]**[37]where pi= Number of individuals of species i. Pi can be estimated as pi = ni/N, where ni is the number of individuals in species i and N is the total number of individuals in the community.

The interpretation of the index results is based on the fact that typical summation values will be between 1.5 and 3.5 in most ecological studies, with 4.0 being the extreme upper end. The index increases in value as both the richness and the evenness of the community increases – thus pointing to the fact that this index incorporates both biodiversity description components. High values would be representative of more diverse communities – meaning that there is variety in the types of species represented and that their population numbers are evenly distributed[38].

Microclimate[39]:

Microclimates are variations in the general climatic conditions within an area caused by variations in biological, hydrological or geomorphologic features present within the area.

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[37] www.easycalculation.com/statistics/learn-shannon-wiener-diversity.php
[38] En.m.wikipedia.org/wiki/Talk:Shannon_index
[39] *www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-67622011000600018*

For example, in northern latitudes, southerly facing hill slopes will receive more solar exposure than northern facing slopes. Thus, the more shaded north slopes will have moisture conditions that are more prevalent than on southern facing slopes. Vegetation populations supported by the terrain will invariably represent a reflection of the presence/absence of moisture in the soils on both sides of a slope, with denser vegetation growths being expected where more moisture exists.

From another plant perspective, microclimatic changes can occur due to changes in the terrain or vegetation cover of an area that have been induced by human activity. Vegetation clearing within a previously uniform stand of forest will result in a gap in the cover that will increase light exposure, heat and rainfall impact. Plants that may have been adapted to shade, higher moisture content and deeper soil conditions that may exist in forest stands with full canopies may not be able to tolerate the new conditions resulting from the human disturbance and may therefore not thrive in the clearings. On the other hand, the clearing conditions might favour the prevalence of plant types whose growth may have been inhibited in the denser vegetation areas.

Where fauna is concerned, significant changes in the vegetation coverage within an area may have negative effects on the ability of fauna to migrate within the system because the gap represents an unfavourable environmental barrier to their movement.

An evaluation of the potential changes that could occur in microclimatic conditions at the proposed CCC gypsum site was attempted and the expected Impacts that could occur as a result of the changes were assessed.

5.2.4.2.2 Concluding Assumptions

The field methods described above were conducted over the period **2016-01-20, 23 and 28** for the proposed CCC Gypsum quarry. the following data collection assumptions were made:

G. Data records were made along defined pathways or roadways constructed over the proposed quarry site, being limited by the ability to penetrate into the vegetation stands existing at the site.

H. Further to the above, no attempt was made to cut through vegetation so as to minimize impacts that the data collectors could make on the environment. In short, all the data collection methods were non-destructive in their nature.

I. Quantitative assessments were attempted for:

- Floral percentage cover
- Floral diversity
- Bird population numbers and diversity

Extrapolations were made over the total study site.

J. Quantitative assessments were not made for:

- Bats and other mammals
- Insects (day and night), though a qualitative assessment of population numbers was done for daytime flying insects.
- Reptiles
- Amphibians

Mobilization limitations prevented the expenditure of time to make detailed assessments of these fauna possible.

K. Species lists were generated for all flora/fauna observed, with importance (endemism, rarity, threatened status, migratory status etc.) being highlighted.

L. Micro-habitat examination was conducted with emphasis being placed on the identification of opportunistic floral gap occupiers within human-induced spaces within the natural floral environment, as well as those observed within the existing quarry area. This was done to shed light on the natural processes of vegetation recovery that could be experienced at the site.

5.2.4.3 **Flora**

5.2.4.3.1 Spatial Extent

Literature reviews, as well as the identification of characteristic flora within the vegetation assemblages found surrounding the CCC Gypsum site lead to the characterization of the forest at the site as a Tall, Open, Dry Forest[40] assemblage further re-enforced this conclusion. The authors of the 2013 Environmental Impact Statement prepared for the location[41] outlined that the general area had been disturbed by mining operations that had been terminated over 40 years ago. The location had naturally re-vegetated over the period leading up to the re-commencement of mining operations over a year ago. **Figure 5.2.21** illustrates the extent of natural undisturbed floral cover, as opposed to disturbed floral cover – as interpreted from 2015 Google Earth images of the site.

Figure 5.2.21: Extent of natural vegetation at study site.

40 A Tall Open Dry Forest is an open natural woodland or forest with trees at least 5m tall and crown not in contact, in drier part of Jamaica with species indicators such as Red Birch Tree (***Bursera simaruba***) **-** Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002
41 CL Environmental Co. Ltd October 2013

Plate 5.2.7: Natural vegetation stand at Halberstadt

Plate 5.2.8: Fire-induced secondary growth at Halberstadt

Vegetation Type

Tables 5.2.2 below lists the floral species observed along the transect pathways at the study site along with their DAFOR descriptions. Floral species observed were divided into two main categories for the purpose of the study, namely natural vegetation – comprising predominantly **trees**[42],**Shrubs**[43], **vines**[44] and **bromeliads**[45] and gap occupiers – comprising **herbs**[46], and **grasses**[47] found in areas where tree cover had been significantly (and recently) disturbed.

Table 5.2.2: Tree Species List – Proposed Gypsum Quarry Site (red highlighted = endemic)

LOCAL NAME	*SCIENTIFIC NAME*
Cassie Flower	***Acacia farnesiana* F**
	***Acacia tortuosa* R**
Coccuswood	***Brya ebenus* O**
Red Birch	***Bursera simaruba* O**
-	***Calliandra sp.* R**
Yellow Candle Wood	***Cassia emarginata* O**
French Oak	***Catalpa longissima* R**
Trumpet Tree	***Cecropia peltata*, R**
Silk Cotton Tree	***Ceiba pentandra* O**
Fiddlewood	***Citharexylum spinosum* R**
-	***Cocoloba sp.* R**
Maiden Plum	***Comocladia pinnatifolia* F**

42 Tree – A woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground - Wikipedia.org
43 A Shrub is a
44 Vine – A climbing or trailing woody-stemmed plant.
45 Bromeliad- A plant of tropical and subtropical America typically having short stems with rosettes of stiff, spiny leaves. Some kinds are epiphytic.
46 Herb – Any seed-bearing plant which does not have a woody stem and dies down to the ground after flowering - google definition
47 Grass –Vegetation consisting of typically short plants with long, narrow leaves growing wild or cultivated on lawns.

Clammy Cherry	***Cordia collococca O***
Spanish Elm	***Cordia gerascanthus O***
Calabash	***Crescentia cujete, O***
	Eugenia maleolens F
Prickly Yellow	***Fagara martinicensis O***
Bastard Cedar	***Guazuma ulmifolia F***
Lead Tree	***Leucaena leucephala O***
	Malpighia sp. R
Mango	***Mangifera indica O***
Burnwood	***Metopium brownii F***
-	***Peltophorum pterocarpum O***
-	***Pimenta dioica R***
Dogwood	***Piscidia piscipula R***
Castor Oil Plant	***Ricinus communis, O***
Guango	***Samanea saman O***
Bitter Damson	***Simarouba glauca F***
Torchwood	***Tecoma stans F***
Wild Mahogany	***Trichilia hirta F***
-	***Trichilia reticulate O***

Table 5.2.3: Shrub, Herb, Vine and Epiphyte Species List – Proposed Gypsum Quarry Site

LOCAL NAME	***SCIENTIFIC NAME***
Herringwood Flower	-
	Achyranthes indica
	Adenanthera pavonina
	Amaranthus viridis
Coralita	***Antigonon leptopus,***

Mexican Poppy	***Argemone mexicana,***
Spanish Needle	***Bidens pilosa O***
	Casearia guianensis
Periwinkle	*Catharanthus roseus A*
	Cissampelos pareira
	Cissus sicyoides
	Commicarpus scandens
	Cordia brownie
Clammy Cherry	***Cordia collococca F***
	Crotalaria retusa
	Cynodon nlemfuensis
Coca Shrub	***Erythroxylum areolatum***
	Eupatorium villosum
Species EUN	• ***F***
	Hylocereus triangularis
	Lantana camara
	Lasiacis divaricata
Christmas Candlestick	***Leonotis nepetifolia,***
	Melochia nodiflora
Guaco	***Mikania micrantha,***
	Mimosa pudica
	Momordica charantia
	Momordica charantia cerasee
Species AT	• ***O***
Species DL	• ***O***
Cockspur Vine	***Pisonia aculeate***
	Plumbago scandens

	Priva lappulacea
Species BRI	• ***R***
	Ricinus communis
	Sida sp
Black Nightshade	***Solanum americanum,***
Susumber	***Solanum torvum***
	Spilanthes urens
	Tecoma stans
	Tridax procumbens
	Wissadula amplissima

Table 5.2.4: Grass Species List – Caribbean Cement Company Proposed Gypsum Quarry Site

LOCAL NAME	***SCIENTIFIC NAME***
	Cynodon nlemfuensis O
Yard Grass	***Eleusine indica O***
Guinea Grass	***Panicum maximum F***

<u>Trees</u>

Trees were assessed using the **DAFOR method**, a review of the observations listed under **Table 5.2.2** pointed to the following tree types being most frequently observed at the site (see **Table 5.2.5** and **Plates 5.2.9** below):

Table 5.2.5: Most Commonly Observed Tree Species List – Proposed Gypsum Quarry Site

LOCAL NAME	***SCIENTIFIC NAME***
Cassie Flower	***Acacia farnesiana F***
Maiden Plum	***Comocladia pinnatifolia F***

-	***Eugenia maleolens F***
Bastard Cedar	***Guazuma ulmifolia F***
Burnwood	***Metopium brownii F***
Bitter Damson	***Simarouba amara F***
Torchwood	***Tecoma stans F***
Wild Mahogany	***Trichilia hirta F***

Acacia farnesiana

Tecoma stans

Plate 5.2.9: Most commonly observed tree type at the study site

Simarouba glauca

Metopium brownii

Plate 5.2.10: Most commonly observed tree type at the study site contd.

Comocladia pinnatifolia

Guazuma ulmifolia

Plate 5.2.11: Most commonly observed tree type at the study site contd.

5.2.4.4 Fauna

Birds, Butterflies and Gastropods were the predominant faunal types observed within/above the study site (refer to survey areas represented on **Figure 5.2.22 below**). These are described below:

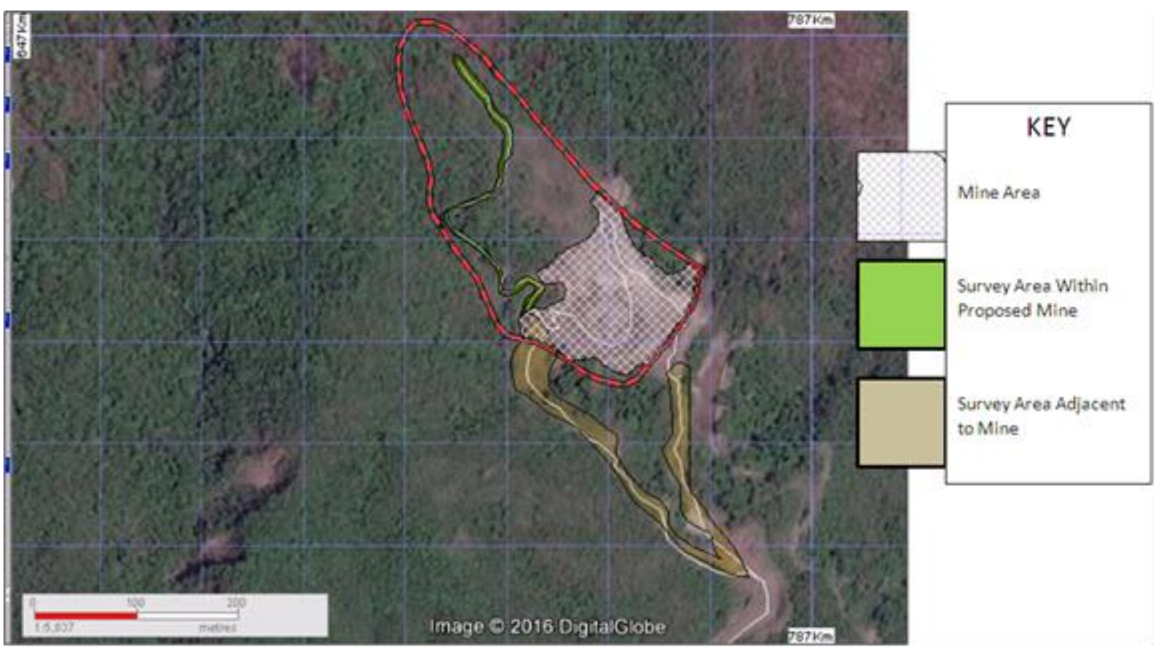

Figure 5.2.22: Survey Areas Examined for Birds and Butterflies at Halberstadt

5.2.4.4.1 Birds

Table 3.2.1-1 lists the types of birds that were detected (<u>seen AND heard</u>) within or above the survey transects. This table is supported by Plates 3.2.1. Twenty-three varieties were observed.

Table 5.2.6: List of the Types of Birds Observed at the Site (red highlighted = endemic)

COMMON NAME	SCIENTIFIC NAME	NUMBERS OBSERVED
1-American Kestrel	*Falco sparverius*	**1**
2-Zenaida Dove	*Zenaida aurita*	**3**
3-Yellow-faced Grassquit	*Tiaris olivacea*	**8**
4-Turkey Vulture	*Cathartes aura*	**1**
5-Jamaican Tody	*Todus todus*	**1**
6-Northern Mockingbird	*Mimus polyglottos*	**2**
7-Loggerhead Kingbird	*Tyrannus caudifasciatus*	**3**
8-Jamaican Oriole	*Icterus leucopteryx*	**1**
9-Sad flycatcher	*Myiarchus barbirostris*	**5**
10-Common Ground Dove	*Columbina passerina*	**7**
11-Caribbean Dove	*Leptotila jamaicensis*	**1**
12-Black Whiskered Vireo[48]	*Vireo altiloquus*	**1**
13-Blackfaced Grassquit	*Tiaris bicolor*	**1**
14-Baltimore Oriole	*Icterus galbula*	**1**
15-White-crowned Pigeon (Bald Pate)	*Patagioenas leucocephala*	**5**
16-American Redstart	*Setophaga ruticilla*	**1**
17-Red Tailed Hawk	*Buteo jamaicensis*	**1**
18-Bananaquit	*Coereba flaveola*	**1**
19-Mangrove Cuckoo	*Coccyzus minor*	**4**
20-Barn Owl	*Tyto alba*	**2**
21-Antillean Nighthawk	*Chordeiles gundlachii*	**2**
22-Olive Throated Parakeet	*Aratinga nana*	**2**
23 Smooth Billed Ani	*Crotophaga ani*	**5**

[48] Summer migrant. Presence deemed to be unusual

Plate 5.2.12: Bird Species Observed at the Study Site

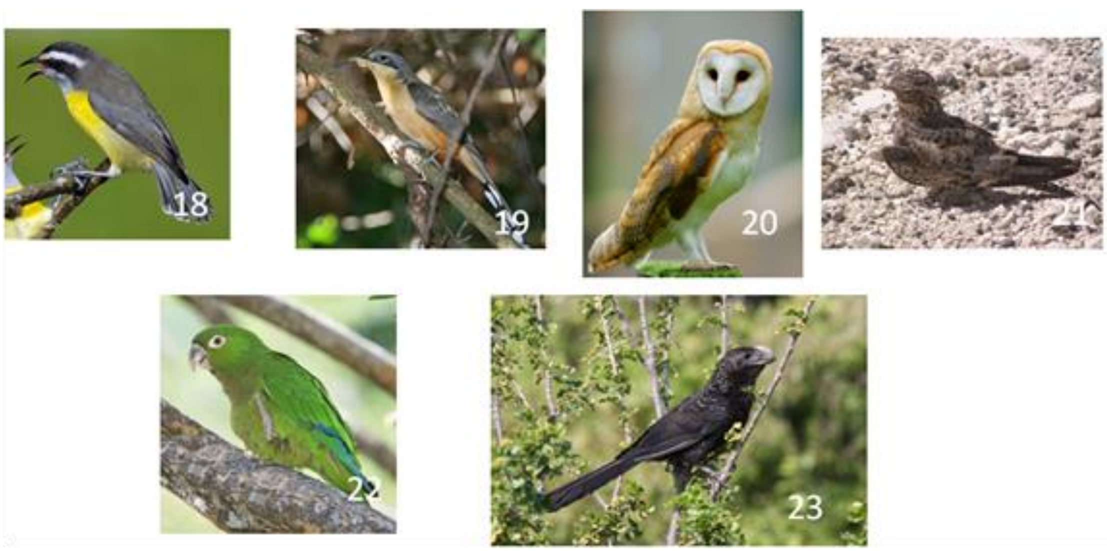

Plate 5.2.13: Bird Species Observed at the Study Site contd.

A total of 59 birds were observed in the study area surveyed. **Figure 5.2.23** illustrates Shannon Wiener index results for the species sampled from the transect survey taken at the study site. The sum of the values represented here, or the diversity index (**H**) is 2.7, suggesting a bird population of relatively moderate species richness and relative un-evenness in abundance.

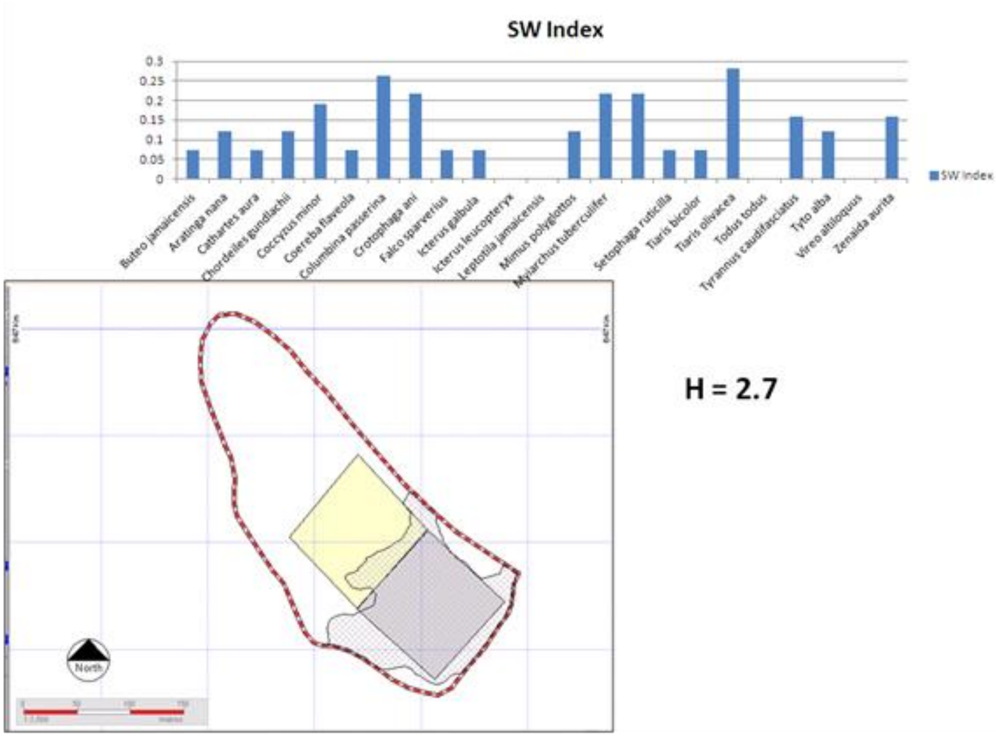

Figure 5.2.23: Shannon Wiener Index Results for Bird Species Sampled from Transect surveys at Halberstadt.

5.2.4.4.2 Insects

Six varieties of flying insects were observed at the Halberstadt site, with five being butterflies. Table 5.2.7 lists the flying insects observed along with their DAFOR ratings for population estimates.

Table 5.2.7: List of the Types of Insects Observed During Surveys Conducted at the Site

COMMON NAME	SCIENTIFIC NAME
A - Lignum Vitae Butterfly	*Krigonia lyside A*
B - Zebra Longwing	*Heliconius charitonius simulator O*
C – Hairstreak butterfly	*Chlorostrymon orbis*
D - Tropical Silverspot	*Dione vanilla insularis O*
E - Honey Bee	*Apis sp. F*

F – West Indian Buckeye	*Precis evarete zonalis O*

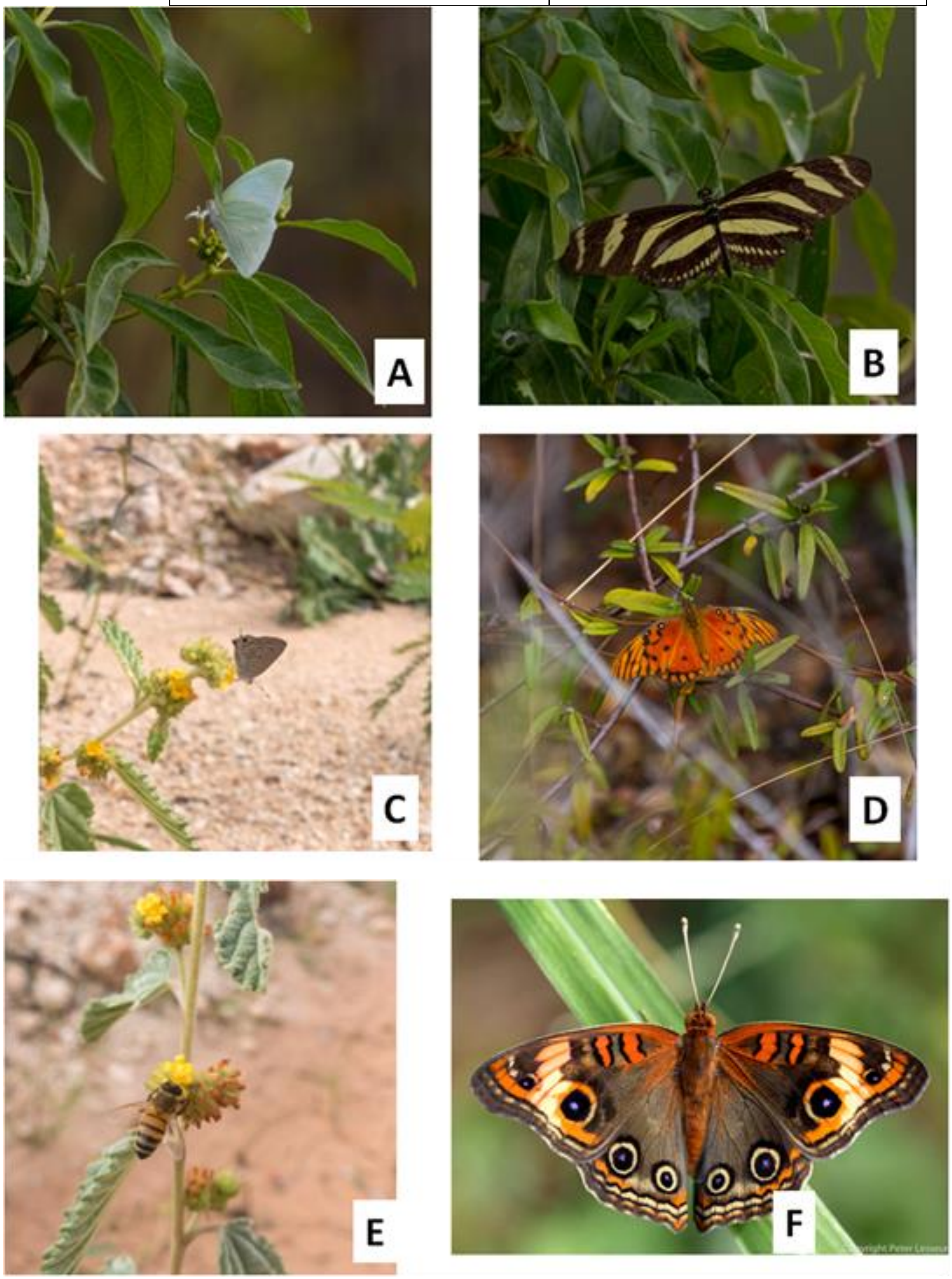

Plate 5.2.14: Insects Observed at the CCC Limestone Study Site

5.2.4.4.3 Gastropods (snails)

The ground gastropod ***Pleurodonte peracutissima*** was the only variety of gastropod observed during traverses conducted at the Halberstadt site. (see **Plate 5.2.15**)

Plate 5.2.15: Ground Gastropod *Pleurodonte peracutissima*

5.2.5 Heritage

Halberstadt is named after a town in Germany. The Tainos were the first occupants of the area evidenced by the find of a cave containing the skeletal remains of at least 34 individuals and other artefacts in 1895. The Halberstadt property has seen various land uses over the past centuries. In 1763 sugar was the main produce but by 1811 the estate was producing 6, 588 bushels of coffee. In 1824 the estate possessed 156 enslaved persons. The estate has passed through several owners such as Jakob Kellerman, John Mais, John Weiss and Beresford Gossett.

The proposed quarry expansion is to be located in the southern section of the historical Halberstadt property and is owned by Caribbean Cement Company Limited. The area is of rugged terrain with steep gradients of 45°- 60° angles making some parts inaccessible. During the study, the entire 6.7 hectares proposed for development was surveyed; this was facilitated by gaining access from both the northern boundary as well as the southern boundary and utilizing foot trails where they existed and intrusion into wooded area as much as possible to cover a represented sample of the property. No historical features or artifacts were observed during the survey.

Plate 5.2.16 Photograph of general area proposed for development

5.2.6 Socio-Economic Environment

5.2.6.1 Population

Population data (STATIN 2011 Population Census) showed that there were approximately 990 persons living within the 2-km radius of the proposed project location compared to 1144 in the 2001 census. This equates to a growth rate of approximately -1.44% per annum between 2001 and 2011. Based on this decline, the current (2017) population could be approximately 919.

The 15-64 years age category accounted for 68% of the 2011 population, with the age 0-14 years (26%) and the age 65 and over category accounting for 7%. The segment of a population that is considered more vulnerable are the young (children less than five years old) and the elderly (65 years and over). In this population, approximately 7% were in the young category and this is similar to the 7% within the 65 years and older category.

SDC Community Profiles exist (http://sdc.gov.jm/communities/bito/ and http://sdc.gov.jm/communities/bloxborough/) for two communities within the SIA, namely Bito and Bloxborough that are based on socio-economic survey conducted by the SDC in 2009. For both communities (2009), the populations can be considered as a working age population with 62.1% and 68.1% of the population in Bito and Bloxborough respectively being between the ages of 15-64 years. Bito and Bloxborough also had significant youth populations with 33.3% and 27.4% respectively being 14 years or younger; the latter percentage for Bloxborough is comparable to St. Thomas regional percentages, however Bito's young population is by far the greatest of all population grouping explored here.

The available data for the community of Bito indicated that there were noticeably more males for all age cohorts, with the exception of the 25-29 years cohort in which there were more females, and the 15-24years in which there were comparable percentages. Overall, there were a higher percentage of males (55.5%) than females (44.7%) and this is similar to Bloxborough, where there were less females (45.4%) than males (54.7%), with the major disparity being seen within the 30-64 years age cohort.

On the other hand, male and female populations in the overall 2 km radius differ from that of Bito and Bloxborough, in that there were a greater total percentage of females (65%) versus males (35%), with no age category having more males than females (Figure 6.76). The sex ratio (males per one hundred females) in the 2011 census was 53.33, which indicates that a higher percentage of the population is females.

In 2009, the percentage of male household heads in the community of Bito was 58% and 60.4% in Bloxborough (SDC). This finding slightly contrasts with national presentation in the Jamaica Survey of Living Conditions (JSLC) 2007, where slightly fewer males (53.4%) were heading households in Jamaica.

In 2001, 35.9% of the households in the area owned the land on which they lived. Approximately 6.6% leased the land on which they were, 16.1% rented, 24.5% lived rent free, 9.7% "squatted" and 0.1% had other arrangements. Compared to the national

(21.9%) and St. Andrew (35.2%), the project area had a very low percentage (7.1%) of persons not reporting the type of ownership arrangements they had.

5.2.6.2 Infrastructure

There was at latest a threefold increase in the households using kerosene as their main means of lighting in the 2 km radius areas, when compared with the national and regional context. While the national and regional data were generally similar for electricity usage, it is notable that there were a much lower percentage of households in the area using electricity when compared with the national and regional households. In the community of Bito, 64.5% of residents used electricity for lighting whilst in Bloxborough, 66% used this source of lighting (SDC 2009 socioeconomic survey).

The parishes of St. Andrew and St. Thomas, as well as the study area are served with landlines provided by LIME Jamaica Limited. Wireless communication (cellular) is provided by LIME and Digicel Jamaica Limited. A network to support internet connectivity is also provided by LIME and Flow. It was reported by SDC that over 95% of the residents in the communities of Bito and Bloxborough utilize cellular services for communication in 2009.

Sixty-three percent (62.7%) of the households within the SIA received their domestic water supply from the National Water Commission (NWC) in 2001. Water demand for the area in 2013 is estimated to be 218,262.3 litres/day (~ 57,658.8 2 gals/day) and is expected to decrease to 151,943.3 litres/day (~ 40,139.2 2 gals/day) over the next twenty-five years based on population growth rates prediction. As reported by SDC from their 2009 socioeconomic survey, 56.3% of residents in the community of Bito and 49.5% in Bloxborough received water from springs, rivers or streams.

Within the 2-km radius, a higher percentage of households used pit latrines (71.2%) or had no facilities when compared to the national and parish data This relatively high percentage of pit latrine usage was also reported in 2009 for the communities of Bito and Bloxborough by the SDC (75% and 79% respectively). Further, percentage of households with water closet disposal methods was far less when compared to regional and national figures.

5.2.6.3 Services

There are no hospitals or health centres within the 2-km radius. Bull Bay Health Centre is the closest health centre, and this is located approximately 3.6 km southwest of the quarry site. This centre is a Type II facility, serviced by a visiting Doctor and Nurse Practitioner. Typical services include family health (including antenatal, postnatal, child health, nutrition, family planning & immunization); curative, dental, environmental health, Sexually Transmitted Infections (STIs) treatment, counselling & contact investigation; child guidance, mental health and pharmacy.

The hospitals closest to the site are located 9.8 km west of the site at the University of the West Indies in Mona, St. Andrew - Type A Hospital, a multi-disciplinary institution providing both secondary and tertiary care.

There are no fire stations located within the study area. That closest to the quarry location is the Rolington Town Fire Station situated at 14 Giltress St, Kingston 2, approximately 12 km east of the study area.

There are no police stations situated within the study area. Bull Police Station is the closest, about 3.7 km southwest of the Halberstadt quarry.

There are no post offices located within the study area however, the Bull Bay Ten Miles Post Office would likely serve the areas in proximity to the quarry.

6 PUBLIC PARTICIPATION

6.1 Harbour Head & Halberstadt

Public participation was incorporated in the process through community meetings held with the following communities.

- Bull Bay
- Bloxburgh
- Benoa
- Bito
- Jack's Vale

During these meetings, the CCCL made presentations of the planned expansion of the Harbour Head and Halberstadt Quarries and received feedback from participants (copies of meeting minutes and presentation is included in Appendix 4. There was general support for the project, however the following were areas of concern.

1. Noise from the trucks transporting material from Halberstadt.
2. Dust from vehicle going to and from the Halberstadt Quarry.
3. Safety of mainly children using the road from Bull Bay leading up to the Gypsum Quarry.
4. Greater show of CSR by CCCL in support of the communities.

Representatives of Jamaica Environment Trust (JET) were also present at the community consultation meeting with the Bull Bay community. A copy of a summary of the project (Expansion of the Harbour Head Limestone Quarry and the Halberstadt Gypsum Quarry) as well as a copy of the first draft of the EIA report was supplied to Miss Felicia Wong, Project Coordinator at JET. (see Appendix 4).

7 IMPACT IDENTIFICATION AND ASSESSMENT

7.1 Introduction

As mentioned in previous sections of this report, the proposal for both the Harbour Head Limestone Quarry and the Halberstadt Gypsum Quarry are not to establish new facilities, but to extend currently existing and actively functioning operations to adjacent areas. The existing infrastructure will be use to carry out operations in the new areas proposed for mining.

The approach to identification and assessment of potential impact due to the proposed project was to focus on those impact emanating from the extended areas and the cumulative impact brought about by the extension.

The proposed Quarries extension project has the potential to create a variety of impacts when it is implemented, during both preparation and operation phases. These potential impacts can be either positive or negative depending on the receptors involved and other parameters such as magnitude, duration, project management and the mitigation measures employed.

The significance of a potential impact is assessed primarily based on the magnitude, frequency, likelihood/probability of occurrence and duration. Each parameter identified is evaluated according to the following:

- ❖ Potential impact - any change to the environment, whether adverse or beneficial, wholly or partially resulting from the proposed activities, products or services
- ❖ Activity – phase of development that action takes place in
- ❖ Magnitude - A measure of how adverse or beneficial an effect may be
- ❖ Duration - the length of time needed to complete an activity
- ❖ Significance - A measure of importance of an effect
- ❖ Mitigation - Measures taken to reduce adverse impacts on the environment

Potential impacts identified as being associated with the implementation of the project are divided into the following categories:

- Physical environment
- Natural Hazards
- Biological
- Heritage
- Human/Social/Cultural
- Public Health

An assessment of the identified potential impacts is presented below.

7.2 Harbour Head

7.2.1 Impact Assessment & Mitigation

Preparation & Operation Phases

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
Physical				
Site Clearance and removal of over-burden material	- Fugitive Dust impacting air quality - Aesthetics -Soil erosion -Increased turbidity in water bodies	• Minimize the size of cleared area; period wetting; wearing of PPE on site. • Plant vegetation on over-burden stockpile • Control exposed soil run-off through barriers and control flows from heavy runoff areas that threaten to erode or result in substantial turbid surface runoff to adjacent marine waters. • Monitor areas of exposed soil during periods of heavy rainfall to ensure erosion can be addressed where necessary • Stockpile material to be covered or wetted to prevent wind erosion • Wet Access Roads • Trucks with materials will be covered to prevent fugitive dust emissions • Trucks must not be overloaded to prevent spillage to the environment • Immediate clean-up of spilled material	Long term/Reversible Short term/Reversible	Major/Negative Major/Negative Major/Negative

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
Blasting and Excavation	Rock falls on the steep slope which could damage Yallahs pipeline in the Hope River valley Unstable benched slopes caused by poor blasting with the potential to cause serious injury to workers Potential for shallow slope failures in weak marls. These are likely to be small, but can cause injury to workers Potential for shallow slope failures in weak marls. These are likely to be small, but can cause injury to workers	Benched slopes should not exceed 9m in height. Qualified blaster should be employed to conduct blasting. Monitoring plan to monitor stability of benched slopes. Monitoring plan which should incorporate regular monitoring and assessment of the stability of the benches by qualified staff or contractor Use of earth berms to control run-off, prevent scouring on the edge of quarry floors and benched slopes. Erosion control strategy to be employed in the design and operation stage of the quarry		
Heavy Equipment Operation	- Air pollution from vehicular emissions. Greenhouse gas emission -Soil and water contamination from oil and other Chemical use -Noise from excavating, blasting and general mining activities	• Proper maintenance of vehicle and equipment. • Use fuel efficient and properly maintained vehicle and heavy equipment • Fuel and other onsite oil storage facilities will be properly bunded and maintained. • Emergency and Spill Response plans will be drafted for use • No routine maintenance activities will be done on site • Restrict drilling and blasting and noisier activities to normal working hours • Inform residents to be potentially affected of the pending activities • Conduct noise monitoring during noisy operations to ensure stipulated Noise levels are not exceeded off site	Short term/Reversible Long term Irreversible Short term/Reversible	Minor/Negative Minor/Negative Major/Negative
Workers on Site	- Generation of solid waste - Human waste generation - Water demand and supply	• Establish proper garbage receptacle and disposal. • Proper temporary sanitary facility with good servicing • Proposed training of workers on site on proper solid waste management and use of bins	Short term/Reversible	Minor/Negative
Biological				
Site Clearance	- Loss of vegetation, Habitat and Bio-Diversity	• Reserve as much buffer as possible • Carry out progressive rehabilitation.	Long term/Irreversible	Major/Negative

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
	- Damage to aquatic life from soil washed into water bodies - Habitat Fragmentation - Loss of Fauna	• Establish nursery to preserve bio-diversity • Erect barrier in natural storm water channels. • Limit Site clearance to working footprints so as to retain as much of the original vegetation for as long as possible. • Reserve as much buffer as possible • Carry out progressive rehabilitation. • Establish nursery to preserve bio-diversity	Short term/Reversible Long term/Irreversible	Major/Positive Minor/Negative Major/Negative
Socio- Economic				
Site Clearance and mining activities	Employment of skilled labourers and equipment operators Commercial activity (potential Increase)		Short term Long term	Major/positive Major/positive
Cultural				
Site Clearance	- Possible damage of cultural artefacts	Site clearance to be done keeping a keen eye out for potential artefacts, which if found will be secured.	Long term/Irreversible Short Term/Irreversible	Minor/negative Major/Positive

7.2.2 Physical

7.2.2.1 Erosion Potential

During construction for development of the quarry, benched slopes will be created by blasting or other mechanical means. In addition, stockpiles of overburden and other material will contain sediments that can be easily incorporated into run off during heavy rainfall with the potential to cause blockage in the on-site drainage system.

The potential for erosion on the benched slopes is generally moderate, however the impact may be largely one of a nuisance value, if the material is dominated by cobblestones and pebble stones and finer gravel and sandy material. In instances where large boulders are embedded in the benched slopes, the potential damage to machinery/equipment and operators of such equipment could be critical, if erosion mitigation measures are not included in the design of the benched slopes.

7.2.2.2 Erosion of the Steep NE Slope

The development of the quarry will be dynamic, which implies that location of activities for extraction of material may change over a short period of time depending on various factors such as material quality and quantity required at specific periods. The footprint of the area for extraction over the first 5-yr period has not yet been concluded by CCCL however it is understood that this footprint will not include the total 20 hectares (50 acres). As the quarry develops the potential for erosion will become greater as the footprint of the operation takes up a significant portion of the steep slopes, vegetation will be stripped and erosion potential accelerated on the steep terrain.

7.2.2.3 Blasting

The blast energy generated from excavation generally releases body and surface waves which could cause mobilization of loose limestone on the benched slopes which has the potential to cause serious injury to persons working in the pit. Additionally, rocks on the steep slope of the Hope River Valley could be easily detached from the slope due to excessive blast vibration to cause damage to the Yallahs pipeline. 'Fly rock' from air blast due to overcharging of blast holes could also cause serious injury to workers in the vicinity of the working area.

If proper blasting techniques are not conducted to create benches, then this could result in instability of the benched quarry slope which could impact on the safety of the workers and operators of equipment in the quarry.

Similarly, blast excavation conducted near to the JPSCo High Tension Electrical Power line, could result in damage to the electrical infrastructure caused by excessive blast vibration and the generation of fly rock from poorly designed blast holes.

7.2.2.4 JPS High Tension Electrical Power Line

The south-western boundary of the Harbour Head quarry site is bordered by the JPSCo high tension electrical power lines which runs along the ridge of Long Mountain (Figure 7.3.1). Development of a quarry at/near the boundary of the electrical transmission power line could have negative impacts on the power line in the following ways:

- Reducing the stability of the electrical poles if benched quarry slopes are too close to the power lines due to erosion or undercutting to cause tilting or overturning of the poles. This could result in damage to the electrical infrastructure and interruption to the transmission of electricity from Kinston to the eastern section of the island.
- Overcharging blast holes for extraction of limestone material close to the electrical power lines, which could either lead to excessive vibration to cause damage to the high tension electrical transmission system. Additionally, 'fly rock' from the overcharge of blast holes could also cause damage to the electrical poles and transmission wires to further interrupt the transmission of electricity to other parts of the country.
- Regular movement of large machinery and equipment during the development and operation of the quarry which could accidentally come in contact with wooden electrical poles carrying the high-tension wires. This could lead to serious injury, even death to operators of such equipment as well as damage to the infrastructure.

Plate 7.2.1: JPSCo Electrical Transmission Power line located on the south-western boundary of the Harbour Head site.

7.2.2.5 Yallahs Pipeline

The Yallahs Pipeline is located on the lower section of the north-eastern slope of the Long Mountain and forms the NE boundary of the Harbour Head quarry site. This pipeline takes water from the Negro River in St Thomas to the Mona Reservoir in St Andrew. There is evidence of large boulders on top of the Long Mountain and this is likely to be mobilized on the steep north eastern slope. Construction of haul roads and the stripping of vegetation for development of the quarry have the potential to mobilize loose boulders on the slope to cause damage to the pipeline. If the pipeline is damaged from rock falls during quarry development, then water supply which is a major source for the Mona Reservoir may be interrupted for extended periods.

During blast operations for the extraction of material, blast energy normally releases body waves and surface waves which have the potential to mobilize loose boulders or partly detached limestone down the slope with could increase the risk of damage to the Yallahs pipeline.

7.2.2.6 Hurricanes and Tropical Storms

Information on the physical impacts of hurricanes and tropical storms on quarry operations are not readily available. Damage from hurricanes is caused mainly by wind, either directly or indirectly from flying objects such as trees, light poles etc., while some level of damage is caused by rain due to flooding, depending on the intensity of rainfall generated by the weather system. The physical impact of tropical storms on the physical environment is normally the result of heavy rains which can lead to flooding and landslide.

The quarry site is located on the crest of the Mountain above the Cement Plant which implies that the wind velocity tends to be highest at elevated areas where there is little or no obstruction from the force of the wind. Given that the Harbour Head quarry site will be devoid of man-made structures, the direct physical impact will be negligible. However, the indirect impacts could be more significant, as flying object such as tree branches, electrical poles and wires as well as other loose debris could result in injury to workers during operational phase.

Heavy rains from hurricanes and tropical storms could lead to flooding within a quarry pit. However, flood waters are not expected to be present for long periods since the geology areas consists of pervious material which allows surface water to be transmitted to the subsurface. Man-made drains and natural drainage systems in the quarry will however be under stress from increase flows leading to excessive erosion and sedimentation within the quarry.

Similarly, shallow slope failures could occur on benched quarry slopes from intense rainfall following the passage of a hurricane or tropical storm, while the steep NE slope would be susceptible to rock falls.

7.2.2.7 Visual Intrusion

The existing CCCL quarry is expected to continue operating during the development of the Harbour Head Quarry. The Harbour Head quarry (20 hectares) is contiguous with the CCCL quarry (approximately 40 hectares). This suggests that there will be removal of vegetation and extraction of material when the Harbour Head Quarry becomes operational, thereby increasing scaring on the slope as quarrying progresses.

As a result of the strategic location of both quarries, scarring of the land will be hidden from the public so that it will not have a negative visual impact from public view. Additionally, the rehabilitation plan proposes that each bench or block will be rehabilitated immediately following extraction, thereby creating a minimal visual impact as mining progresses.

7.2.2.8 Solid Waste

Solid waste from a typical extractive quarry process is normally generated from the following:

- Organic/inorganic soils – usually top soils and/or sub-soils on the surface above the quarry material
- Overburden – non-mineral or other material above the mineral deposit having little or no market value
- Inter-burden – non-mineral material that occur between the mineral deposit such as clay beds in limestone deposits
- Rejected Extractive Materials – e.g. limestone deposits that may be contaminated by clay due to weathering as well as their location within fault zones or, material that does not meet the chemical physical or chemical requirements of the processing plant.
- Waste from Crushing and Screening – Waste material generated from the crushing and screening that does not have a market demand due to the particular size fraction produced. Typically, this relates to material 5mm or finer.

7.2.2.9 Disposal of Quarry Waste

Based on the preliminary operation plan for the extraction of quarry material at the Harbour Head site, CCCL proposes to commence rehabilitation following the completion of each block or quarry bench. This approach seeks to use up as much rejected material to assist in the rehabilitation process, thereby reducing the volume of solid waste as well as minimizing operation cost if rehabilitation is left at the back-end of the quarry operation.

Stockpile from quarry waste can be temporarily or permanently stored depending on whether the material will be used for rehabilitation work. Using this approach, storage of quarry waste (soils, overburden extractive waste material) is best kept close to the area of operation so that the material can be readily used for rehabilitation. The material must however, be stored safely in accordance with best practices. If not properly stored, the quarry waste can be incorporated into runoff during intense rainfall leading to increase suspended particles into artificial and natural drainage and cause blockage in drainage system.

7.2.2.10 Air Quality/Air Pollution

The only potential direct impact from the proposed quarries extension operations as it relates to air quality is dust emissions. The amount of dust emissions to be generated were calculated and these were subjected to an air dispersion modelling exercise (Appendix 6) that revealed predicted maximum dust (TSP and PM10) concentrations to be in compliance with the stipulated ambient dust standards.

Quarrying activities as proposed by the Harbour Head quarries have the potential for a two-folded direct negative impact on air quality. The first impact is air pollution generated from the heavy equipment. The second is from fugitive dust from exposed areas and materials stored on site. Fugitive dust has the potential to affect the health of quarry workers and the surrounding vegetation.

7.2.2.11 Noise Pollution

The quarry operations will require the use of heavy equipment to carry out the job. This equipment includes bulldozers, backhoes, excavators, graders, crushers and dumper trucks etc., additionally some blasting may also be carried out. They possess the potential to have a direct negative impact. Noise directly attributable to the quarry site operational activity should not result in noise levels in the residential areas to exceed 55dBA during day time (7am – 10 pm) and 50dBA during night time (10 pm – 7 am).

7.2.3 Biological

The quarrying activities, as that proposed for the CCC Harbour Head sites, by nature will result significant whole vegetation loss during the process of exposing the underlying resources for mining extraction. With the vegetation and soil layer removed, and with bulldozing and other heavy equipment movement, there will be no supporting substrate layers to facilitate the type of natural re-growth of vegetation that would restore natural diversity at the disturbed site. Further, mining activities could lead to the creation of property gradients that are not conducive to vegetation re-growth, or which would only be appropriate for a select few plant types adapted to the newly created gradient/exposure conditions. This is likely to result in habitat destruction and/or habitat fragmentation

At least two tree species known to be endemic to the forest type represented within the boundary of the proposed quarry site will be affected by vegetation removal. Vegetation removal will also negatively affect the faunal support that the forest area would have provided, with at least 4 endemic species of birds, 1 species of endemic lizard and 1 endemic species of snail being affected by the loss of flora.

7.2.4 Heritage

No archaeological features of significance are present at either site proposed for quarrying.

7.2.5 Human/Social/Cultural

There is not expected to be any significant increase in employment opportunity as the scale of operation is expected to remain constant. Access to the additional source of mineral will however enhance the viability of CCCL operations and ensure that the operation is continued.

7.2.6 Public Health Issues

Based on the location of the quarries away from any population center and the result of the air dispersion modeling report which indicates that all parameter will be in compliance with standards, there is not expected to be public health issues. Workers within the quarry may be affected and should therefore wear the appropriate PPE at all times.

7.3 Halberstadt

7.3.1 Impact Assessment & Mitigation

Preparation & Operation Phases

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
Physical				
Site Clearance and removal of over-burden material	- Fugitive Dust impacting air quality - Aesthetics -Soil erosion -Increased turbidity in water bodies	• Minimize the size of cleared area; period wetting; wearing of PPE on site. • Plant vegetation on over-burden stockpile • Control exposed soil run-off through barriers and control flows from heavy runoff areas that threaten to erode or result in substantial turbid surface runoff to adjacent marine waters. • Monitor areas of exposed soil during periods of heavy rainfall to ensure erosion can be addressed where necessary • Stockpile material to be covered or wetted to prevent wind erosion • Wet Access Roads • Trucks with materials will be covered to prevent fugitive dust emissions • Trucks must not be overloaded to prevent spillage to the environment • Immediate clean-up of spilled material	Long term/Reversible Short term/Reversible	Major/Negative Major/Negative Major/Negative
Blasting and Excavation	Rock falls on the steep slope which could damage property at the lower elevation Unstable benched slopes caused by poor blasting with the potential to cause serious injury to workers	Benched slopes should not exceed 9m in height. Qualified blaster should be employed to conduct blasting. Monitoring plan to monitor stability of benched slopes. Monitoring plan which should incorporate regular monitoring and assessment of the stability of the benches by qualified staff or contractor	Long term/Reversible	Major/Negative

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
	Potential for shallow slope failures. These are likely to be small, but can cause injury to workers	Use of earth berms to control run-off, prevent scouring on the edge of quarry floors and benched slopes. Erosion control strategy to be employed in the design and operation stage of the quarry	Short term/Reversible	Minor/Negative
Heavy Equipment & Trucks Operation	- Air pollution from vehicular emissions. Fugitive dust emission from trucks traversing the unpaved haul road. Noise pollution from haulage truck passing through communities. Greenhouse gas emission -Soil and water contamination from oil and other Chemical use -Noise from excavating, blasting and general mining activities	• Proper maintenance of vehicle and equipment. • Use fuel efficient and properly maintained vehicle and heavy equipment • Fuel and other onsite oil storage facilities will be properly bunded and maintained. • Trucks to operate only in daytime and be fitted with muffler that reduce noise and low noise braking systems • Emergency and Spill Response plans will be drafted for use • No routine maintenance activities will be done on site • Restrict drilling and blasting and noisier activities to normal working hours • Inform residents to be potentially affected of the pending activities • Conduct noise monitoring during noisy operations to ensure stipulated Noise levels are not exceeded off site	Short term/Reversible Long term Irreversible Short Term/Reversible Short term/Reversible Short term/Reversible	Minor/Negative Minor/Negative Major/Negative Major/Negative Minor/Negative
Workers on Site	- Generation of solid waste - Human waste generation - Water demand and supply	• Establish proper garbage receptacle and disposal. • Proper temporary sanitary facility with good servicing • Proposed training of workers on site on proper solid waste management and use of bins	Short term/Reversible	Minor/Negative
Biological				
Site Clearance	- Loss of vegetation, Habitat and Bio-Diversity	• Reserve as much buffer as possible • Carry out progressive rehabilitation. • Establish nursery to preserve bio-diversity	Long term/Irreversible	Major/Negative Major/Positive

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
	- Damage to aquatic life from soil washed into water bodies	• Erect barrier in natural storm water channels. • Limit Site clearance to working footprints so as to retain as much of the original vegetation for as long as possible.	Short term/Reversible	Minor/Negative
	- Habitat Fragmentation - Loss of Fauna	• Reserve as much buffer as possible • Carry out progressive rehabilitation. • Establish nursery to preserve bio-diversity	Long term/Irreversible	Major/Negative
Socio- Economic				
Site Clearance and mining activities	Employment of skilled labourers and equipment operators		Short term	Major/positive
	Commercial activity (potential Increase) Traffic flow and access		Long term	Major/positive
Cultural				
Site Clearance	- Possible damage of cultural artefacts	Site clearance to be done keeping a keen eye out for potential artefacts, which if found will be secured.	Long term/Irreversible Short Term/Irreversible	Minor/negative Major/Positive

7.3.2 Physical

7.3.2.1 Erosion Potential

During construction for development of the quarry, benched slopes will be created by blasting or other mechanical means. Stockpile material will contain sediments that can be easily incorporated into run off during heavy rainfall with the potential to cause blockage in the on-site drainage system.

The potential for erosion on the benched slopes is generally moderate, however the impact may be largely one of a nuisance value, if the material is dominated by cobblestones and pebble stones and finer gravel and sandy material. In instances where large boulders are embedded in the benched slopes, the potential damage to machinery/equipment and operators of such equipment could be critical, if erosion mitigation measures are not included in the design of the benched slopes.

7.3.2.2 Blasting

Blasting is expected to be concentrated mainly within the deposition boundary of the Halberstadt site. The main concerns are:

- Fragments of rocks will be propelled into the air by explosions on site. These rocks could create hazards for persons nearby such as workers. There are no residence within 1 Km of the site.
- Fumes (toxic and non-toxic) are released into the atmosphere as a result of using explosives for blasting. Person may be affected by dust and fumes within 100 metres
- Another concern is vibrations caused by blasting that will affect structures within close proximity to the blasting location.

The blast energy generated from excavation generally releases body and surface waves which could cause mobilization of loose stone on the benched slopes which has the potential to cause injury to persons working in the pit. Additionally, rocks on the steep slope could be easily detached from the slope due to excessive blast vibration to cause damage to structures below.

If proper blasting techniques are not conducted to create benches, then this could result in instability of the benched quarry slope which could impact on the safety of the workers and operators of equipment in the quarry.

7.3.2.3 Flooding

The topography of the site shows that the eastern boundary of the deposit is drained by the Bull Park River so mitigation steps should be taken to facilitate in the prevention of silt accumulating in the channel of the river. This increase in sediment load, generated by the quarry, could result in a shallower river channel which may induce flooding in areas downstream. This will more likely be evident where there exists a bend in the river channel or the river enters the sea due to the slowing down of the water within the channel. Some adverse effects of sediment loading are:

- Alters the natural flow of water and reduces water depth within a water course;
- Clogs storm drains and catch basins which transport water away from roads and structures – increases potential flooding;
- Nutrients transported by sediments negatively affect the ecosystem of the river.

The site is drained toward the boundaries and ultimately south-east via overland sheet flow and shallow concentrated flows to the existing gullies and roads. As the Halberstadt quarry is expanded, the runoff will increase due to vegetation being removed. The runoff from quarry surfaces will generally be faster and increased in volume. This can be attributed to the exposed hillslopes with little or no vegetation to reduce the flow. The more vegetation that is removed, the more the increase in storm water runoff and the more impacts it will have. The immediate community south of the proposed site does not experience flooding according to anecdotal information received.

7.3.2.4 Hurricanes and Tropical Storms

Information on the physical impacts of hurricanes and tropical storms on quarry operations are not readily available. Damage from hurricanes is caused mainly by wind, either directly or indirectly from flying objects such as trees, light poles etc., while some level of damage is caused by rain due to flooding, depending on the intensity of rainfall generated by the weather system. The physical impact of tropical storms on the physical environment is normally the result of heavy rains which can lead to flooding and landslide.

The quarry site is located on the windward side of a tropical storm on Jamaica's south coast which implies that the wind velocity tends to be high at elevated areas where there is little or no obstruction from the force of the wind. Given that the Halberstadt quarry site will not have man-made structures, the direct physical impact will be negligible.

Heavy rains from hurricanes and tropical storms could lead to flooding within a quarry pit. However, flood waters are not expected to be present for long periods since the geology areas consists of pervious material which allows surface water to be transmitted to the subsurface. Man-made drains and natural drainage systems in the quarry may however be under stress from increase flows leading to excessive erosion and sedimentation within the quarry.

Similarly, shallow slope failures could occur on benched quarry slopes from intense rainfall following the passage of a hurricane or tropical storm, while the steep NE slope would be susceptible to rock falls.

7.3.2.5 Roads and Transportation

The development and operation of the Halberstadt quarry will have some impact on traffic in the area. Vehicles will access the site from the South coast main road via a parish council road which is only paved for approximately 450 metres from the intersection with the main road (see Plate 7.2).

The NWA classifies the main road as a Class-A main road in its island wide road network. The existing PC road is listed as a part of the NWA network. Based on the NWA system of classification, the main Road should typically have over 1000 cars per day whereas the PC should be able to handle less than a thousand. Inspection of the roads indicated the width of the main road varies between 5-6 metres in the vicinity of the intersection as opposed to the 7.2m width that is recommended for Jamaica.

Plate 7.3.1 Bull Bay main road showing the intersection of the main road with the local road

There is not expected to be a net increase in the rate of haulage (number of trips) from the Halberstadt quarry, hence the impact on traffic should remain as currently exist. The heavily laden trucks transporting the gypsum to the cement plant will continue to add significant stresses to the base and sub-base of the road. This will affect the structural integrity of the paved roads which may result in failure. Secondly, the unpaved sections of the PC roads will deteriorate much further especially when it rains.

7.3.2.6 Visual Intrusion

The implementation of mineral extraction within a quarry can remove parts of an existing landscape, such as a hill, or can introduce intrusive features, such as quarry faces or overburden mounds.

The Halberstadt deposit however is situated behind the hill, away from the road so there will be no visual intrusion from the Bull Bay area. As the quarry expand however, there is the possibility that it will become visible from communities closest to it such as Bito.

7.3.2.7 Solid Waste

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

I. From human activities on site.
II. From construction/operations activities such as site clearance and excavation.

7.3.2.8 Air Quality/Air Pollution

The main potential direct impact from the proposed Halberstadt Quarry extension as it relates to air quality is dust emissions. The amount of dust emissions to be generated were calculated and these were subjected to an air dispersion modelling exercise (Appendix 6) that revealed predicted maximum dust (TSP and PM10) concentrations to be in compliance with the stipulated ambient dust standards.

Quarrying activities at the Halberstadt quarry has the potential for a two-folded direct negative impact on air quality. The first impact is air pollution generated from the heavy equipment during extraction and trucks on the haulage roads. The second is from fugitive dust from exposed areas and materials stored on site. Fugitive dust has the potential to affect the health of quarry workers and the surrounding vegetation.

7.3.2.9 Noise Pollution

The quarry operations will require the use of heavy equipment to carry out the job. This equipment includes bulldozers, backhoes, excavators, graders, crushers and dumper trucks etc., additionally some blasting may be carried out. They possess the potential to have a direct negative impact. Noise directly attributable to the quarry site operational activity should not result in noise levels in the residential areas to exceed 55dBA during day time (7am – 10 pm) and 50dBA during night time (10 pm – 7 am).

The truck hauling the mineral to the cement plant in Rockfort will traverse several communities and has been known to negatively impact the level especially from breaking.

7.3.3 Biological

The extension of quarrying activities, as that proposed for the CCC Halberstadt sites, by nature will result significant whole vegetation loss during the process of exposing the underlying resources for mining extraction. With the vegetation and soil layer removed, and with bulldozing and other heavy equipment movement, there will be no supporting substrate layers to facilitate the type of natural re-growth of vegetation that would restore natural diversity at the disturbed site. Further, mining activities could lead to the creation of property gradients that are not conducive to vegetation re-growth, or which would only be appropriate for a select few plant types adapted to the newly created gradient/exposure conditions. This is likely to result in habitat destruction and/or habitat fragmentation.

7.3.3.1 Habitat Destruction

Creating the pits or quarries requires the removal of virtually all-natural vegetation, topsoil and subsoil to reach the aggregate underneath leading to a significant loss in plant and interdependent animal diversity. At the end of life for the mine, the area could become more susceptible to invasive or introduced species if left fallow as well as the potential for land slippage is amplified. There would also be a permanent change in the structure, aesthetics and composition of the flora after mining operations have ceased.

7.3.3.2 Soil/Substrate Erosion

Quarries, particularly those on steep slopes with unstable rocks, increase landslides and other mass movements with consequent destruction of natural habitats and biodiversity. Removing the topmost soil layer and surface rock material also multiplies the vulnerability of groundwater contamination (Darwish et al., 2008).

The potential for land slippage is greatly increased as a result of vegetation removal. A plant's roots act as a mesh within the substrate increasing its cohesiveness and improving water percolation and drainage. Areas where bare ground is exposed tend to erode faster than areas inhabited by plants. Therefore, there could also be a resulting shift in the level of the water table as a result of plant removal.

7.3.3.3 Increased Effects of airborne particulates or dust

The dust is normally generated as a result of blasting, loading and vehicle movement in the quarry. Periodic earth works to remove and stockpile the overburden of soil will also result in dust emissions. The major environmental hazard from the quarry, especially on the flora surrounding the site, is the effect of dust (Lameed & Ayodele 2010).

Dust particles have the potential to block and damage the stomata of plants, impairing photosynthesis and respiration. Other effects are shading and light scattering by airborne particulates, which may also lead to a reduction in photosynthetic capacity. Over time even the cuticles and underlying layers may become worn due to abrasion (Lameed & Ayodele 2010; Langer 2001). Airborne pollutants will be produced at the quarry and these may get deposited on the plants and affect their physiology; leading to retarded growth and death (Lameed & Ayodele 2010).

7.3.3.4 Avifauna

The proposed limestone quarry will most likely have a negative impact on the bird population in the area. The removal of the present vegetation will have a deleterious effect on the bird population in the area as follows:

- Removal of vegetation will cause habitat loss including food resources.
- Noise from the heavy machinery and from the explosive will force several of the birds to leave the area.
- The dust nuisance will cause several of the birds to find a new refuge.

Birds will subsequently be forced to use the habitat in close proximity to the proposed site. This will have a negative impact on the bird population since they would have to compete with resident birds in the adjacent areas for limited resources in the area.

It should be noted that birds requiring special conservation protection were not encountered during the assessment.

7.3.4 Heritage

No archaeological features of significance are present at the Halberstadt site proposed for quarrying extension.

7.3.5 Human/Social/Cultural

There is not expected to be any significant increase in employment opportunity as the scale of operation at the Halberstadt gypsum quarry is expected to remain constant. Access to the additional source of mineral will however enhance the viability of CCCL operations. All mining and haulage activities at Halberstadt Quarry will be outsourced to qualified contractors with JGQ maintaining oversight and management of the mining

7.3.6 Public Health Issues

Based on the location of the Halberstadt Gypsum quarry, away from any population center and the result of the air dispersion modeling report which indicates that all parameter will be in compliance with standards, there is not expected to be public health issues. Workers within the quarry may be affected and should therefore wear the appropriate PPE at all times.

8 CUMULATIVE IMPACTS

8.1 Harbour Head

8.1.1 Air Quality

As was stated in the project description, the expansion of the CCCL Limestone quarry in Harbour Head will not result in increased activities as the rate of extraction is projected to be maintained at current levels. This implies that impacts from equipment operation, human presence, transportation and noise/vibration would is not expected to be altered significantly. However, the extension of the Harbour Head quarries will ultimately result in a significant increase in the size of the exposed areas. The main potential cumulative impact of significance that this extension will have are:

- Air Quality
- Noise/Vibration
- Increased surface run-off
- Increase loss of bio-diversity
- Aesthetics and Visual Impact

Figure 8.1.1 Google image showing Quarries operated by CCCL in the Region

8.1.2 Air Quality

The increase in exposed/cleared surface will naturally increase the source of dust nuisances within the quarries. The air dispersion modeling result indicates that notwithstanding this increase all parameters is expected to be in compliance with the standards.

There exist numerous sources of dust nuisances within quarries, including but not limited to:

- ☐ wind blowing across site;
- ☐ the grubbing (stripping) of topsoil;
- ☐ the excavation of sand and/or gravel;
- ☐ the crushing and screening of aggregates; and
- ☐ the transport of quarried material – fine materials deposited along public roads during transit.

As part of the air dispersion modeling analyses, a determination of the cumulative impact on ambient air quality of the nearby and the proposed quarry air pollutant sources was made. Table 8.1 shows the maximum predicted concentrations for the All Sources (including those at the proposed quarries operations) scenario, and their comparison with the JNAAQS.

The results revealed that the maximum predicted ground level concentrations for all the sources within the air shed plus the background concentrations (as recommended in the NRCA Ambient Air Quality Guideline Document) exceeded the respective JNAAQS with the exception of PM10 for the annual and 8-hr period. It should be observed that the main contributor to the cumulative air quality (TSP and PM10) impact concentration is CCCL, which have a number of instruments monitoring the particulate concentration within the air shed, for which reports are being submitted to NEPA.

Table 8.1.1 Model Results – Proposed Quarries & All Sources

Pollutant	Avg. Period	Background (µg/m³)	Jamaican NAAQS or GC (µg/m³)	Proposed Quarry Sources			All Sources		
				Max Conc (µg/m³)	UTME (m)	UTMN (m)	Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	84.4	316142	1988285	**435.8**	317399	1985124
	Annual	20	60	8.6	316277	1988292	**61.0**	317399	1985124
PM_{10}	24-hr	9	150	37.2	316142	1988285	**228.6**	318223	1987483
	Annual	20	50	3.8	316277	1988292	18.3	317399	1985124
	8-hr	0	10000	0.13	324610	1988120	1023.1	316688	1987791

Bold type indicates exceedance above the standard or Guideline Concentration

Figure 8.2 through Figure 8.5 show the pollutant contour plot-files for TSP and PM10 within the entire air shed for the All Sources category. The plot files show the most impacted areas based on the predicted pollutant concentrations generated by the model runs. The colour coded scale in each figure indicates the various impact concentrations obtained up to the maximum predicted concentrations achieved.

Dust particles deemed respirable (less than 10 micrometres in diameter) have the potential to cause negative effects on human health depending on exposure levels. In addition to this air quality concern, there are also potential visual impacts of dust, including:

☐ coating/soiling of personal property with dust;

☐ coating of vegetation;

☐ contamination of soils (water pollution, altered pH balances);

☐ change in plant species composition; and

☐ increased inputs of mineral nutrients.

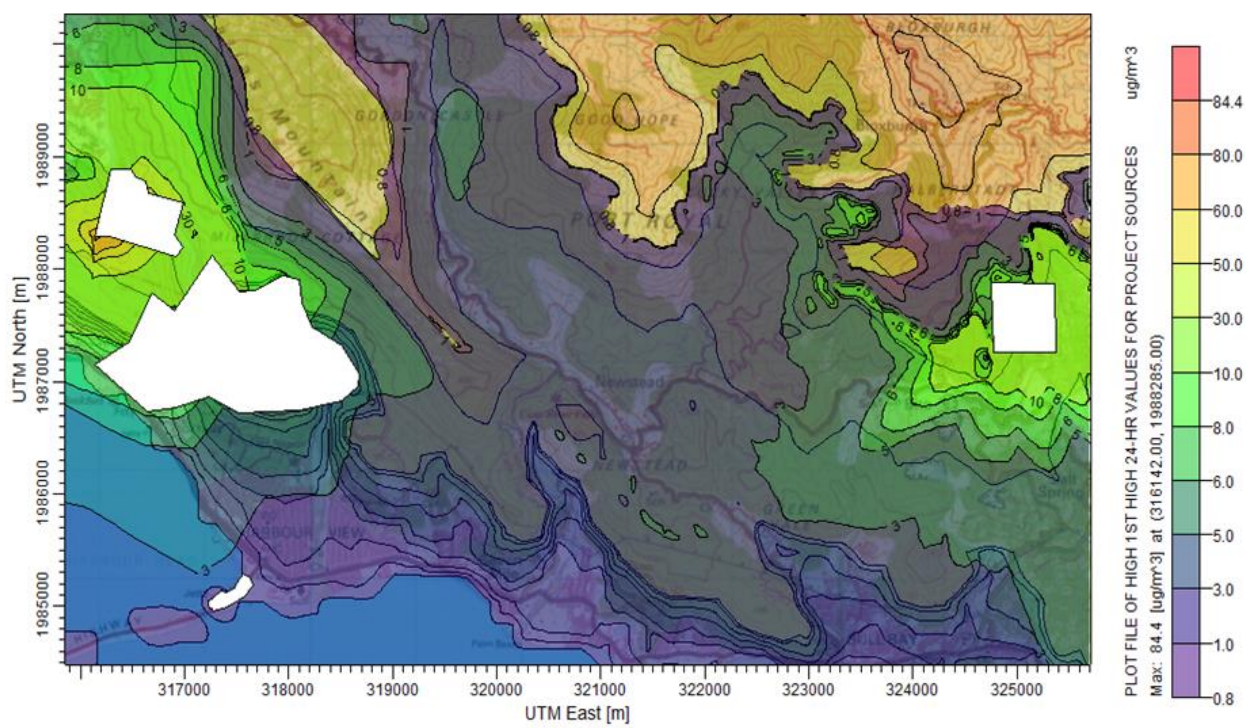

Figure 8.1.2 Cumulative 24-hr TSP Concentrations

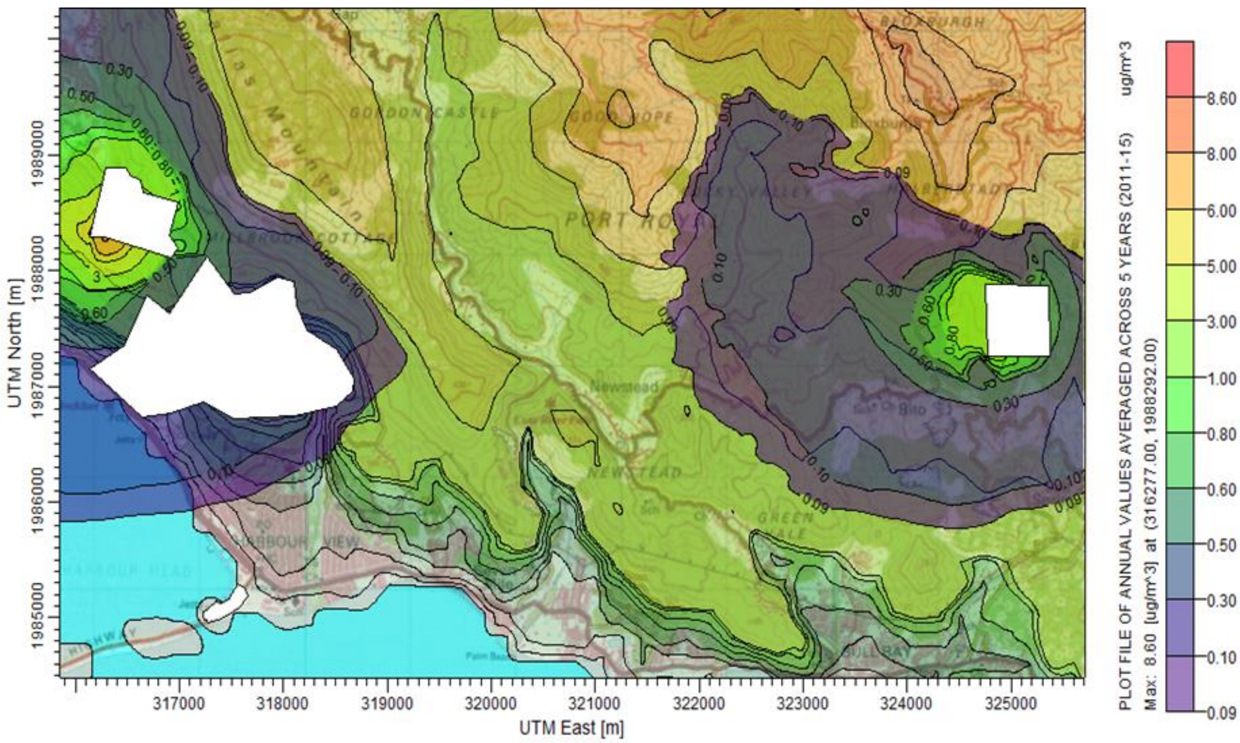

Figure 8.1.3 Cumulative Annual TSP concentrations

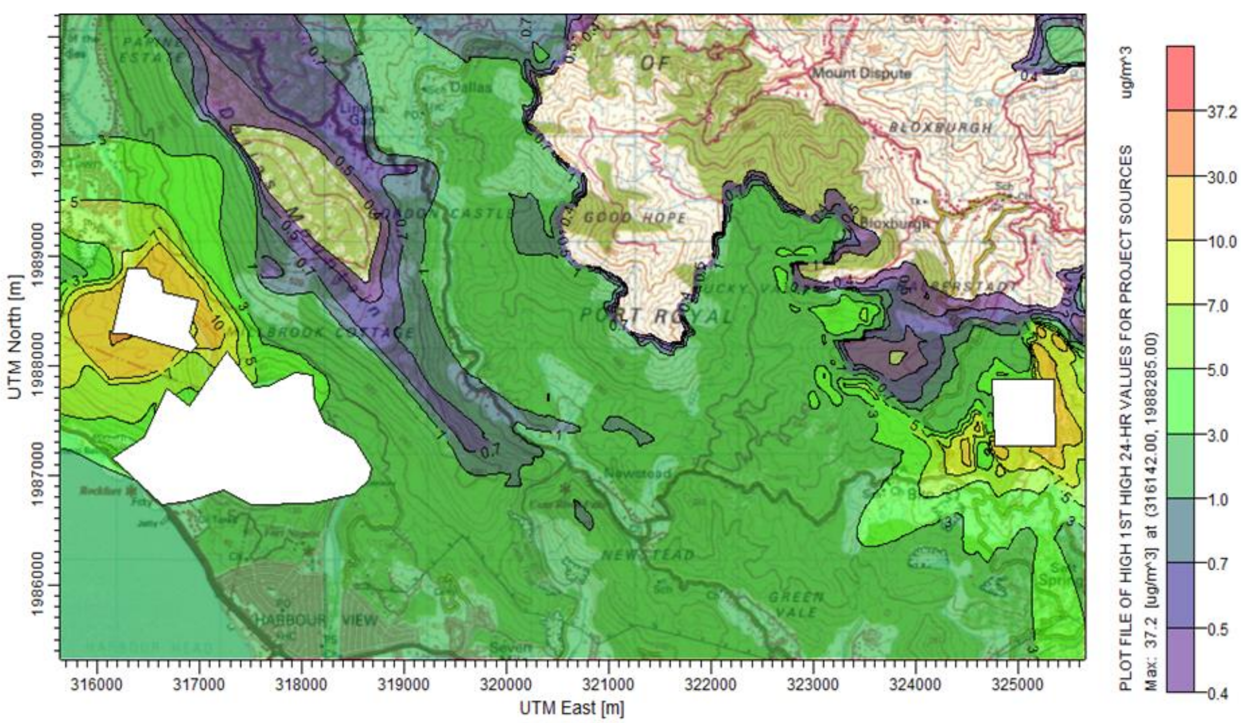

Figure 8.1.4 Cumulative 24-hr PM10 Concentrations

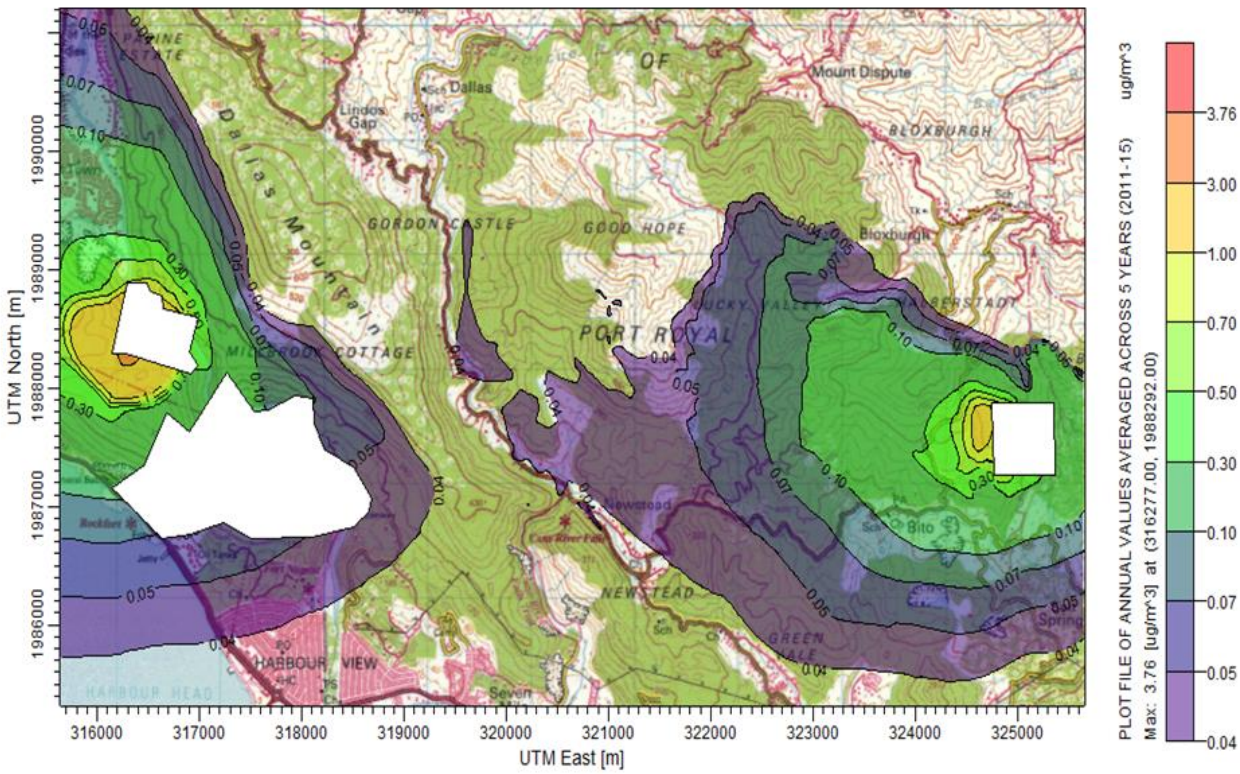

Figure 8.1.5 Cumulative Annual PM10 Concentrations

8.1.3 Noise/Vibration

The cumulative noise impact takes into account all the existing background noise sources. Existing mining industries are associated with various noise-generating activities, some of which are daily:

- removal of topsoil and overburden;
- excavation with machinery;
- drilling and blasting of rock;
- crushing and screening of aggregates;
- the transport of quarried material.

More importantly, blasting can contribute to vibrations, audible noise, fly-rock and dust. However, the levels of vibration induced by the blasting are not significant enough to cause any damage to nearby structures. What is likely to happen is the vibration will be transmitted through the ground and pressure waves through the air may lead to buildings and/or individual experiencing these vibrations accompanied by audible noise.

Noise may cause nuisance, sleep disturbance and can also affect wildlife. There exist no noise-sensitive receptors such as schools, hospitals, nursing homes, churches, etc. in the immediate area to be affected by the operations of the proposed quarries site.

The Proposed Harbour Head quarry is located away from any other source of noise/vibration and as such there is not expected to be any significant cumulative impact.

8.1.4 Surface Run-off

The increase exposed surface area will result in increased run-off with the potential of flooding and sedimentation. It is therefore important that the control measures recommended in the drainage assessment report (Appendix 7) be fully implemented.

8.1.5 Loss of Bio-Diversity

The clearance of additional vegetation will result in decrease habitat for both flora and fauna. Given the massive expanse of the combined mining area at Harbour Head it is critical that progressive rehabilitation be commenced without undue delay.

8.1.6 Aesthetics and Visual Impact

Quarries are known to be “eye-sours”, disrupting aesthetically pleasing landscape and it is no difference for Harbour Head quarry. The good thing about the geographical location however is that it is generally not visible from surrounding areas.

8.2 Halberstadt

8.2.1 Air Quality

As was stated in the project description, the expansion of the Gypsum Quarry at Halberstadt will not result in increased activities as the rate of extraction is projected to be maintained at current levels and possible decrease as export might be discontinued.

This implies that impacts from equipment operation, human presence, transportation and noise/vibration would is not expected to be altered significantly. However, the proposed extension the Halberstadt quarry will ultimately result in a significant increase in the size of the exposed areas associated with the quarry. The main potential cumulative impact of significance that the proposed extension will have are:

- Air Quality
- Noise/Vibration
- Increased surface run-off
- Increase loss of bio-diversity
- Aesthetics and Visual Impact

8.3 Air Quality

The increase in exposed/cleared surface will naturally increase the source of dust nuisances within the quarries. The air dispersion modeling result indicates that notwithstanding this increase all parameters is expected to be in compliance with the standards.

There exist numerous sources of potential dust nuisances within quarries (in addition to Bito gypsum quarry operations), including but not limited to:

☐ wind blowing across site;
☐ the grubbing (stripping) of topsoil;
☐ the excavation of sand and/or gravel;
☐ the crushing and screening of aggregates; and
☐ the transport of quarried material – fine materials deposited along public roads during transit.

As part of the air dispersion modeling analyses, a determination of the cumulative impact on ambient air quality of the nearby and the proposed quarry air pollutant sources was made. Table 8.1 shows the maximum predicted concentrations for the All Sources (including those at the proposed quarries operations) scenario, and their comparison with the JNAAQS.

The results revealed that the maximum predicted ground level concentrations for all the sources within the air shed plus the background concentrations (as recommended in the NRCA Ambient Air Quality Guideline Document) exceeded the respective JNAAQS with the exception of PM10 for the annual and 8-hr period. It should be observed that the main contributor to the cumulative air quality (TSP and PM10) impact concentration is CCCL, which have a number of instruments monitoring the particulate concentration within the air shed, for which reports are being submitted to NEPA.

Figure 8.2 through Figure 8.5 show the pollutant contour plot-files for TSP and PM10 within the entire air shed for the All Sources category. The plot files show the most impacted areas based on the predicted pollutant concentrations generated by the model runs. The colour coded scale in each figure indicates the various impact concentrations obtained up to the maximum predicted concentrations achieved.

Dust particles deemed respirable (less than 10 micrometres in diameter) have the potential to cause negative effects on human health depending on exposure levels. In addition to this air quality concern, there are also potential visual impacts of dust, including:

- ☐ coating/soiling of personal property with dust;
- ☐ coating of vegetation;
- ☐ contamination of soils (water pollution, altered pH balances);
- ☐ change in plant species composition; and
- ☐ increased inputs of mineral nutrients

8.4 Noise/Vibration

The cumulative noise impact takes into account all the existing background noise sources. Existing mining industries are associated with various noise-generating activities, some of which are daily:

- removal of topsoil and overburden;
- excavation with machinery;
- drilling and blasting of rock;

- crushing and screening of aggregates;
- the transport of quarried material.

More importantly, blasting can contribute to vibrations, audible noise, fly-rock and dust. However, the levels of vibration induced by the blasting are not significant enough to cause any damage to nearby structures. What is likely to happen is the vibration will be transmitted through the ground and pressure waves through the air may lead to buildings and/or individual experiencing these vibrations accompanied by audible noise.

Noise may cause nuisance, sleep disturbance and can also affect wildlife. There exist no noise-sensitive receptors such as schools, hospitals, nursing homes, churches, etc. in the immediate area to be affected by the operations of the proposed quarries site.

The site proposed for the extension of the Halberstadt Gypsum quarry is located away from any other source of noise/vibration and therefore cumulative impacts should not be significant.

8.5 Surface Run-off

The increase exposed surface area will result in increased run-off with the potential of flooding and sedimentation. It is therefore important that the control measures recommended in the drainage assessment report (Appendix 7) be fully implemented.

8.6 Loss of Bio-Diversity

The clearance of additional vegetation will result in decrease habitat for both flora and fauna. Given that the proposed extension at Halberstadt is three-fold what has already been approved it is critical that progressive rehabilitation be commenced without undue delay.

8.7 Aesthetics and Visual Impact

Quarries are known to be "eye-sours", disrupting aesthetically pleasing landscape and it is no difference for the Halberstadt quarry. The good thing about this location however is that it is not visible from surrounding areas.

9 RESIDUAL IMPACTS

Sections 7 (Impact Identification and Assessment) and Section 10 (Mitigation Measures) described the potential impacts that would occur as a result of the project and how the proposed mitigation measures would contribute to minimizing or eliminating the impacts. Not all impacts can be fully mitigated and therefore residual impacts will be experienced by the environment.

9.1 Air Quality

Although the Air Dispersion Modeling Assessment Report confirms that relevant parameters will be within regulatory limits, the project will still result in incremental increase in particulate released to and present in the atmosphere.

9.2 Loss of Bio-Diversity

There will be a net lost in available habitat and bio-diversity and hence the ecological services offered by the site at least until full rehabilitation occurs.

10 MITIGATION MEASURES

10.1 Harbour Head

10.1.1 Physical

- Sediment/silt trap should be placed along natural drainage features to protect the rivers/streams from pollution as a result of mining activities.

- During construction (site clearance) large, loose boulders should be selectively removed by mechanical means, so as to minimize the risk of rockfall during site clearance

- A buffer zone (20 - 30m) consisting of undisturbed woodland vegetation should be maintained around the quarrying area. To protect the structural integrity of the Yallahs pipeline and prevent damage to the system, a buffer is required between the quarry operations and the water infrastructure. The buffer must be sufficient to maintain a large strip of vegetation on the steep slope without compromising the safety of the pipeline. A minimum buffer zone of 50m is recommended between the footprint of the Harbour Head quarry and the pipeline as well as the JPS power line.

- Earth berms should be constructed on haul roads where they are located near the side of an existing gully, in order to:
    - Control storm water run-off
    - Prevent erosion and undercutting of the road and slope
    - Earth berms should also be constructed on the edge of the benches in the limestone quarry to prevent scouring of the bench floors and minimize erosion and slope movement on the bench quarry face. Safety to operators of moving machinery and equipment would also be improved as it also acts as a safety measure in such instances.
- Rockfall protection methods such as rock berms, wire/net mesh and catch fences should be employed as direct physical/structural mitigation measures.

- Phasing of quarry activity is strongly recommended, which implies that areas within the quarry footprint should only be disturbed where extraction is to be carried out within a specific period. This is stated against the fact that CCCL will be concerned with the extraction of high grade and low-grade limestone at different locations in the quarry based on demand. The phasing programme should be guided by a detailed quarry plan and be largely based on the spatial distribution of magnesium oxide (Mg0) content in the limestone.

- There are significant variations within the Newport Limestone with respect to the quality of the rock mass. Weak, marls and nodular limestone is evident within the project site that has a high erodability potential. Erosion and sediment control structures would therefore form a part of quarry planning and development. Since there will be continuous changes as quarrying progresses, an erosion and sediment control strategy should be devised to respond to the progressive changes in quarry activity in the medium to long term as part of the overall quarry development.

- Oils and other petrochemicals should be contained to prevent spills on site.

- Public health and safety training should be an integral part of the training programme for operators of equipment and machinery, particularly for earthworks and blasting.

- A detailed solid waste management plan should be developed and included as an integral part of the quarry operations.

- Peak Particle Velocity vibration should not exceed 30mm/sec.
- Detonation for each row of blast holes should be delayed, preferably by about 8 milliseconds.
- To reduce the occurrence of ‘fly rock’, stemming of the blast drill holes should be sufficiently deep so that the blast energy is dissipated mainly within the ground rather than above ground surface. Where necessary, the cover blast technique must be applied.

- With respect to safety at blast sites, precautionary measures such as appropriate safety and protective gears, blast warning signs and signals and the proper control and management of blast sites are extremely important.
- Seismographs should be used where necessary to monitor each explosion as a means of control.

- A Disaster Preparedness Management Plan or a Disaster Contingency Plan should be prepared for the Harbour Head quarry site. If not yet available, an Integrated Comprehensive Disaster Management Plan for the existing CCCL quarry and the proposed Harbour Head quarry should be developed to assist with hurricane preparedness during the on-set of a tropical storm or hurricane.

10.1.2 Biological

- Establish a site rehabilitation plan for the site.
- A buffer zone of minimal to no activity should be established surrounding the proposed area. The vegetation in this area may then become a natural seed-source to the mined-out lands after closure. If considered, seedlings may also be actively transplanted from this area as well.
- The staged and sequential clearing of vegetation over the life of the quarry should be contemplated.
- Monitoring of indirect impacts on threatened plant species surrounding the site should be considered.
- All staff on site should be made aware of the mitigation plans to be implemented.
- Consider the development of a conveyor-belt system for the transport of aggregate which would minimize the need for the construction of additional roads and minimize the impact of vegetation removal. It would also lead to a decrease in traffic through the area.
- The removal of endemic species, especially in the areas surrounding the site, should be avoided.

- If removal is necessary, a nursery or buffer should be established for the maintenance and propagation of the endemic species and other naturally occurring plants. These plants may later be reintroduced into the area based on a rehabilitation plan.
- Remove trees/vegetation only as necessary.
- A site preparation plan should be developed prior to project initiation.
- Leaving or planting strips of vegetation on steep slopes may help to prevent erosion.
- A phased approach to mining activities is recommended.
- Vegetation and soil should be removed together (mixed) so that the plant matter helps to hold the soil. Alternatively, vegetation can be stripped and stockpiled and then spread over the newly made stockpiles of soil.
- Where practical, rehabilitation of the quarry should be progressive: proceeding after the closure of mined out sections.
- As the quarry expands, the time between clearing and quarrying should not be protracted.
- When trucking material it should be covered for the duration of the trip and when idle.
- Fencing of exposed points to human and ruminant entry may be considered as this would reduce their intrusion.
- The public education as well as education of staff regarding the location of buffer-boundaries and other mitigative strategies would be beneficial.
- Clearing of the vegetation should not be carried out in the peak breeding season. Nesting activity in general usually follows rainy periods. The birds in Jamaica usually begin to nest as early as December; however, the peak of the local breading season is from April to June. It is recommended that the major clearing of vegetation be done before the breeding season or after the peak of the local breeding season.

10.2 Halberstadt

10.2.1 Physical

- Sediment/silt trap should be placed along natural drainage features to protect the rivers/streams from pollution as a result of mining activities.

- During construction (site clearance) large, loose boulders should be selectively removed by mechanical means, so as to minimize the risk of rockfall during site clearance

- Earth berms should be constructed on haul roads where they are located near the side of an existing gully, in order to:
    - Control storm water run-off
    - Prevent erosion and undercutting of the road and slope
    - Earth berms should also be constructed on the edge of the benches in the Gypsum quarry to prevent scouring of the bench floors and minimize erosion and slope movement on the bench quarry face. Safety to operators of moving machinery and equipment would also be improved as it also acts as a safety measure in such instances.
- Rockfall protection methods such as rock berms, wire/net mesh and catch fences should be employed as direct physical/structural mitigation measures.

- Phasing of quarry activity is strongly recommended, which implies that areas within the quarry footprint should only be disturbed where extraction is to be carried out within a specific period.

- Oils and other petrochemicals should be contained to prevent spills on site.

- Public health and safety training should be an integral part of the training programme for operators of equipment and machinery, particularly for earthworks and blasting.

- A detailed solid waste management plan should be developed and included as an integral part of the quarry operations.
- Peak Particle Velocity vibration should not exceed 30mm/sec.
- Detonation for each row of blast holes should be delayed, preferably by about 8 milliseconds.
- To reduce the occurrence of 'fly rock', stemming of the blast drill holes should be sufficiently deep so that the blast energy is dissipated mainly within the ground rather than above ground surface. Where necessary, the cover blast technique must be applied.
- With respect to safety at blast sites, precautionary measures such as appropriate safety and protective gears, blast warning signs and signals and the proper control and management of blast sites are extremely important.
- Seismographs should be used where necessary to monitor each explosion as a means of control.
- A Disaster Preparedness Management Plan or a Disaster Contingency Plan should be prepared for the Halberstadt quarry site. If not yet available, an Integrated Comprehensive Disaster Management Plan for the existing CCCL quarry and the proposed Halberstadt quarry should be developed to assist with hurricane preparedness during the on-set of a tropical storm or hurricane.
- Ensure that truck transporting material to thee CCCL plant is properly covered.
- As much as possible equip trucks transporting aggregate from the quarry with low-noise breaking system.

10.2.2 Biological

- Establish a site rehabilitation plan for the site.
- A buffer zone of minimal to no activity should be established surrounding the proposed area. The vegetation in this area may then become a natural seed-source

to the mined-out lands after closure. If considered, seedlings may also be actively transplanted from this area as well.

- The staged and sequential clearing of vegetation over the life of the quarry should be contemplated.
- Monitoring of indirect impacts on threatened plant species surrounding the site should be considered.
- All staff on site should be made aware of the mitigation plans to be implemented.
- Consider the development of a conveyor-belt system for the transport of aggregate which would minimize the need for the construction of additional roads and minimize the impact of vegetation removal. It would also lead to a decrease in traffic through the area.
- The removal of endemic species, especially in the areas surrounding the site, should be avoided.
- If removal is necessary, a nursery or buffer should be established for the maintenance and propagation of the endemic species and other naturally occurring plants. These plants may later be reintroduced into the area based on a rehabilitation plan.
- Remove trees/vegetation only as necessary.
- A site preparation plan should be developed prior to project initiation.
- Leaving or planting strips of vegetation on steep slopes may help to prevent erosion.
- A phased approach to mining activities is recommended.
- Vegetation and soil should be removed together (mixed) so that the plant matter helps to hold the soil. Alternatively, vegetation can be stripped and stockpiled and then spread over the newly made stockpiles of soil.
- Where practical, rehabilitation of the quarry should be progressive: proceeding after the closure of mined out sections.
- As the quarry expands, the time between clearing and quarrying should not be protracted.

- When trucking material it should be covered for the duration of the trip and when idle.
- Fencing of exposed points to human and ruminant entry may be considered as this would reduce their intrusion.
- The public education as well as education of staff regarding the location of buffer-boundaries and other mitigative strategies would be beneficial.
- Clearing of the vegetation should not be carried out in the peak breeding season. Nesting activity in general usually follows rainy periods. The birds in Jamaica usually begin to nest as early as December; however, the peak of the local breading season is from April to June. It is recommended that the major clearing of vegetation be done before the breeding season or after the peak of the local breeding season.

11 ANALYSIS OF PROJECT ALTERNATIVES

11.1 Harbour Head

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

- Alternative 1 - The "No-Action" Alternative
- Alternative 2 - The Harbour Head Quarry Extension as Proposed
- Alternative 4 – Obtaining Limestone with suitable Chemistry for an Alternative Quarry/Location.

11.1.1 No Action Alternative

The "No Action" alternative would mean the termination of all activities relating to the project resulting in the site being left in its existing condition. The main consequence of this alternative is examined for its physical, biological and socio-economic implications.

Physically, the site is unlikely to undergo any major changes from its present condition except for what may occur from natural phenomenon such as hurricanes.

Biologically, the vegetation present on the site is likely to remain the same, other than the potential for uncontrolled growth of vegetation associated with a dry limestone forest trees, weeds, bushes and trees introduced by avifauna, wind or other means on the proposed lot.

The socioeconomic implications for the mining and mineral processing industry and the country would be the most significant. The implementation of the project will provide the CCCL with the raw material it requires as input to continue the manufacturing of cement and by extension the employment of its workers, supply cement to the local construction sector and earn foreign exchange revenue from exports.

11.1.2 The Harbour Head Quarry Extension as Proposed

The following positive impacts are anticipated:

- Ability to meet market demand (national and regional) for Portland cement and Blended Cement for the next 50 years.

- Potential employment opportunities.

The following negative impacts are possible:

- Destruction of natural habitats from the vegetation clearance and excavation processes required during site preparation and operation
- Possible contamination of groundwater and noise/dust pollution

Obtaining Limestone with suitable Chemistry for an Alternative Quarry/Location

The following positive impacts are possible:

- Boost in economic activity at the identified supplier local
- CCCL could continue the manufacturing of Ordinary Portland Cement.
- Continued employment for employees

The following negative impacts are possible:

- High transportation cost and damage to roadway by heavy vehicles
- Potential motor vehicle mishaps and accidents
- Increase in cost of cement

11.1.3 Reduction in Proposed Mining Area – Harbor Head

Whilst this may seem a reasonable proposition however reducing the size of the quarry could impact on the long-term plans of the company where material supply is concerned. The CCCL is currently looking at a long-term plan for the supply of limestone for the next 80yrs and this area as proposed is the most suitable location with the low magnesium limestone required for the production of Portland Cement.

The site is relatively disturbed sections of which has been impacted and cleared in the past. The proposal is to secure the 50 acres and plan for same. Mining however will not occur on the entire area but in phases. The company is concerned about the long and short-term impact of mining on the natural environment and would rather concentrate effort on an area already in close proximity that conducting small scale mining operation at various sections in the region thus spreading the impacts to areas which are currently undisturbed. The 50 acres now proposed will serve the long-term plans of the company. In the future purchasing of material from overseas or locally may be an option if and when the reserves now owned by the company is exhausted.

11.1.4 Extraction of The Material

For Harbour Head blasting will be one of the options exercised in the removal of the limestone. It is anticipated that based on the type of material present blasting could be minimized.

11.2 Halberstadt

11.2.1 Importation of Gypsum

The gypsum deposit at Halberstadt is the only know commercially available deposit in Jamaica. The alternative to mining this deposit would be to import from available sources overseas. The Figure 11.2.1 below shows the gypsum producing countries and hence potential sources of imports.

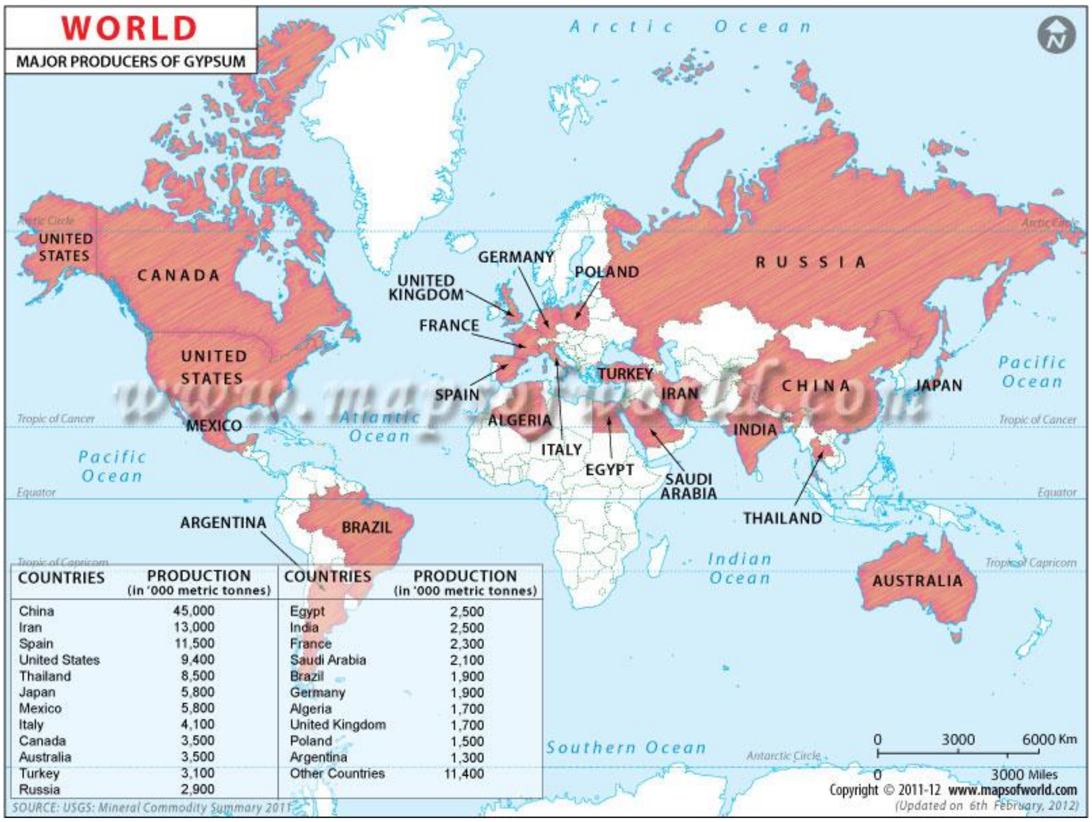

Figure 11.2.1: World Gypsum producing countries

11.2.2 Transportation/ Movement of Aggregates

Movement of material by trucks from the Mines to the processing facility at Rockfort has been practiced for a number of years, however that activity has resulted in significant environmental impacts on surrounding communities especially in the Bull bay region where residents often complain about the impact of dust and noise.

The Harbor Head operation will not involve the movement of trucks through the communities as the material once won will be transferred to an existing conveyor belt where it will be crushed and conveyed to the refinery. This operation also applies to the existing limestone quarry.

The Halberstadt operation and the pozzlan and shale quarries are the primary users of trucks. The implementation of a conveyor system starting from Halberstadt is an expensive venture which could have serious implications on the feasibility of the project nonetheless such operation would reduce or eliminate a significant amount of the environmental issues affecting the lower communities through which heavy trucks currently traverse. That conveyor system would be approximately 5km in length and could terminate at Bito or another site located away from the adjoining communities where a stockpile could be established. Material could then be transported from Halberstadt and some of the other quarries to this central location for storage after which trucks would have a shorter journey to traverse in removing the material to the refinery. The terrain would prevent the conveyor system from culminating at the refinery which would be the preferred option as far as environmental issues are concerned. The option to utilize a conveyor system would also work out cheaper over the long run with respect to fuel consumption.

11.2.3 Extraction of The Material

Currently material is extracted at Halberstadt primarily by blasting. Where blasting can be avoided that option will be exercised such as the use of jackhammers/ excavators to remove the gypsum. This can result in less impact on the surrounding slopes which are susceptible to movement as evidenced during periods of heavy rainfall.

11.2.4 Crushing of Material

The type of crusher used to extract the gypsum can have a significant impact on the quantities of dust generated during mining.

During the initial operations at Halberstadt the crusher which was being used was generating a lot of dust. The company has since acquired a JAW Crusher which significantly reduces the amount of dispersed material added to the fact that this crusher is mobile and therefore can be transported at various points as required with minimal impact on air pollution. The company is committed to applying new technology when required to enhance the environmental stewardship of its operations.

12 ENVIRONMENTAL MONITORING AND MANAGEMENT

12.1 Introduction

An Environmental Management System (EMS) is an important tool which can be used to assist operations managers in meeting current and future environmental requirements and challenges. It can be used to measure a company's operations against environmental performance indicators, thereby helping the company to reach its environmental targets. A good management system will integrate environmental management into daily operations, long-term planning and other quality assurance systems.

The Monitoring Plan to be devised for the development should be implemented during the preconstruction and construction and operation phases of the project. Monitoring involves the observation, review and assessment of onsite activities to ensure adherence to regulatory standards and the recommendations made to reduce negative impacts. The Plan must be comprehensive and address relevant issues, with a reporting component that will be made available to the regulatory agencies based on a mutually agreed frequency. It is recommended for the initial stage, that a minimum monthly monitoring report be prepared and submitted to NEPA, as required. Based on the level of compliance, the frequency of reporting may be reviewed annually and increased or decreased based on performance.

The monitoring report will include at a minimum:

- Raw data collected
- Tables/graphs (where appropriate)
- Discussion of results with respect to the development in progress, highlighting parameters which exceed standards
- Recommendations
- Appendices with photos/data, etc.

At a minimum, the following basic activities will be monitored during specified phases of the project:

12.1.1 Pre-Construction Phase Monitoring

- During site clearing activities, any trees that will be saved must be identified and protected. The plants to be retained should be flagged, and if necessary fenced. An inventory and map (if applicable) of all trees to be retained must be developed. (Monthly Monitoring)

- Where identified, endemic and rare species should be preserved in place or collected for transplanting (As Observed)
- Stockpiles of soil and vegetative debris generated during site clearing activities should be monitored and maintained to eliminate generation of fugitive dust. (Daily Monitoring)

- Daily inspections to ensure that site clearance and preparation 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.

- Daily monitoring to ensure that the activity is not creating a dust nuisance. CARIB CEMENT‟s project engineer / construction site supervisor should monitor the site clearance. Particulate measurements should be taken especially during the excavation activity and compared with the baseline data outlined in this report to ensure that residents or workers are not being exposed to excessive dust. NEPA should conduct spot checks to ensure that this stipulation is followed.

- Background readings should be taken of all water quality parameters prior to site clearance. Readings should be conducted monthly.

- Undertake daily inspections of trucks carrying solid waste generated from site clearance activities to ensure that they are not over laden as this will damage the public thoroughfare and onsite lead to soil compaction.

- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards. (Monthly Monitoring)

12.1.2 Construction Phase Monitoring

- Sewage - Ensure that temporary portable chemical toilets are available for construction personnel and that the contents are disposed by an approved waste hauler in an appropriate waste disposal facility. (Weekly Monitoring)

- Solid Waste Management - Ensure that solid waste management plan is prepared, and that workers are aware that no solid waste material should be scattered around the site. Monitor availability and location of skips/dumpsters. (Weekly Monitoring)

  Routine collection of solid waste for disposal must be implemented, and disposal monitored to ensure use of approved disposal facilities. (Weekly Monitoring)

- Erosion/Siltation Management – Exposed areas must be monitored to determine potential for erosion, silting and sedimentation particularly during storm events. (Weekly Monitoring)

  If erosion, silting or sedimentation is a potential or occurs, immediate steps must be taken to negate the impact on the water body and other receptors where applicable. (As Needed)

- Equipment staging and parking areas must be monitored for releases and potential impacts. (Weekly Monitoring)

- If any cultural heritage resources are unearthed during excavation, activities should be stopped and the Archaeological Retrieval Plan included in this report implemented. (As Needed)

- If any unexploded materials are unearthed, work should be stopped immediately, the site vacated and professionals brought in to determine how to proceed. (As Needed)

- Daily inspections to ensure that activities are not being conducted outside of regular working hours (e.g. 7 am – 7 pm). In addition to noise environmental noise monitoring noise survey should be undertaken to determine workers exposure and construction equipment noise emission. Noise monitoring to be conducted monthly at the site and settlements near to site. Carib Cement project engineer /

site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that the hours are being followed

- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards. (Monthly Monitoring)

- Undertake monthly water quality monitoring or a frequency agreed to with NEPA to ensure that activities are not negatively impacting on water quality.
- Daily monitoring of vehicle refueling 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.

- Traffic should be monitored to ensure approved traffic management plans at critical areas are being followed. NEPA and Carib Cement should perform spot checks to ensure compliance. Monitoring should be conducted daily to ensure major disruption to the public transport is avoided. Reports should be made to Carib Cement on a fortnightly basis.

12.1.3 Operation Phase Monitoring

- Sewage - Monitor sewage disposal periodically to determine compliance with regulatory standards and appropriateness of disposal method. (Monthly Monitoring or as determined by regulatory standards)

- Solid Waste - Monitor solid waste skips/dumpsters and removal contractor to ensure proper waste handling and disposal. (Weekly Monitoring)

- Drainage - Regular inspections of drainage systems should be performed to ensure that the drains remain clear of blockages to safeguard against flooding or damage to slopes. (Monthly Monitoring).

- Noise, Dust (Air Quality) and Water Quality monitoring to be conducted quarterly.

- Monitoring of haulage trucks transport gypsum mineral from the Halberstadt Quarry to ensure the following

- o They operate only within the prescribe time (7:00 am – 7:00 pm)
- o Trucks are properly covered
- o Noise (especially from breaking) is minimized
- o Trucks are properly serviced to minimize pollution from exhaust.

• Monitor the haul roads to ensure proper wetting which is critical for dust control on the unpaved roads.

• Monitor implementation of the rehabilitation plan to ensure compliance with schedule

12.2 Detailed Environmental Monitoring Plan

It is recommended that several parameters be monitored before during and after the project implementation to record any negative construction impacts and to propose corrective or mitigation measures. The suggested parameters include but not limited to the following:

1) Water quality to include but not be limited to:
    a) pH
    b) turbidity
    c) BOD
    d) COD
    e) Total Suspended solids (TSS)
    f) Nitrates and Phosphates
2) Noise
3) Dust
4) Solid Waste Generation and Disposal
5) Sewage Generation and Disposal
6) Equipment Maintenance

The development of appropriate environmental management and monitoring programmes and methodologies are a vital part of the environmental management and monitoring control of the project. This section outlines the main environmental parameters to be monitored, timing of the monitoring work and the recommended frequency of monitoring for general aspects of the proposed project. A more detailed scope of work should be provided by CCCL before commencement of the proposed development, and will be subjected to NEPA 's approval.

The main objectives of the proposed management and monitoring protocol are:

a. to clarify and identify sources of pollution, impact and nuisance arising from the proposed projects;
b. to confirm compliance with legal and permit conditions;
c. to provide an early warning system for impact prevention;
d. to provide a database of environmental parameters against which to determine any short term or long term environmental impacts;
e. to propose timely, cost-effective and viable solutions to actual or potential environmental issues;
f. to monitor performance of the mitigation measures;
g. to verify the EIA predicted impacts;
h. to collate information and evidence for use in public, NEPA, and any other required regulatory consultation; and
i. to audit environmental performance

The proposed environmental monitoring will take the form of site inspection and supervision. The proposed monitoring will cover all the stages of the project preconstruction (baseline), construction and operation phases. Environmental monitoring for dust and noise during all phases is highlighted in order to ensure all proposed mitigation measures are implemented and effective.

Obtaining a suitable and representative baseline data set will be critical to the whole monitoring and audit process because it forms the standard against which environmental impacts are assessed. Thus, baseline monitoring for dust and noise will be required prior to the start of construction.

Mitigation to avoid the pollution of any water courses in the study area have also been recommended by the EIA, as have waste management procedures and thus, monitoring in the form of regular site inspections is also required to ensure mitigation measures are being implemented and are effective.

The monitoring proposed is summarised in **Table 12.1** below.

Table 12.2.1: Framework for Environmental Monitoring Plan

Monitoring	Period	Parameters	Monitoring Frequency
Noise	Baseline (1 occasion)	Leq* (30 mins) GPS location	One set of measurements at selected locations (within and surrounding project site)
	Construction Phase	Leq (30 mins) GPS location	One set of measurements between 0700-1900 hours on normal weekdays once per week.
	Operation Phase	Leq (30 mins) GPS location	One set of measurements between 0700-1900 hours on normal weekdays once per week.
Air Quality	Baseline (1 occasion)	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurements (24-hour sampling) at selected locations.
	Construction Phase	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurements (1-hour sampling) between 0700-1900 hours on normal weekdays once per week. At selected locations, identified and approved by NEPA

	Operation Phase	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurements (1-hour sampling) between 0700-1900 hours on normal weekdays once per week. At selected locations, identified and approved by NEPA
Water	Baseline	BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	One set of measurements
Monitoring	Period	Parameters	Monitoring Frequency
	Construction & Operation	Visual Survey of watercourses in area of active construction works and other areas with stockpiled materials on exposed ground surface BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	Once per week in areas Once per month
Waste	Baseline	Visual Survey of area around proposed sites	Once
	Construction & Operation Phase	Routine monitoring of site	Daily or as per site inspection schedule
Chemical Waste & Control of Spills	Construction & Operation Phase	Materials and chemicals that will be used during construction	Once per week

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14 APPENDICES

14.1 Appendix 1

TERMS OF REFERENCE
For An
ENVIRONMENTAL IMPACT ASSESSMENT

For The

Proposed Quarrying and Mineral Processing
(Limestone and Gypsum Quarries – CCCL)

At

Harbour Head and Halberstadt St. Andrew, Jamaica

By

Caribbean Cement Company Limited

Date: 9 December 2015

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Foreword

The purpose of this document is to establish the Terms of Reference (TOR) for the EIA. The Terms of Reference (ToRs) outlines the aspects of an Environmental Impact Assessment which when thoroughly addressed, will provide a comprehensive evaluation of the proposed site, in terms of predicted environmental impacts, required mitigation strategies and potentially viable alternatives to the proposed development/project.

Please be advised that consultations should also be had with the Mines and Geology Division (MGD) with respect to the requirements for a Quarry Licence.

The EIA report must be produced in accordance with the approved TOR.

Where the need arises to modify the TOR, the required amendments/modifications are to be made and submitted to the Agency. Approval for the TOR must be obtained from the Agency, in writing, prior to the commencement of the EIA study.

The National Environment and Planning Agency and the Natural Resources Conservation Authority reserves the right to reproduce, transfer and disclose any and all contents contained in the submitted environmental impact assessment report without the written consent of the proponent, consultants and/or its agents.

The Terms of Reference to conduct the Environmental Impact Assessment are as follows:

1. Executive Summary

Provide a brief statement on the content of the EIA report. The executive summary should provide a comprehensive overview and objectives for the project proposal, natural resources, justification for the project etc. In addition, it should include relevant background information and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses and conclusions in the report.

2. Introduction

Provide the context of the project and the EIA, the delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study.

The study area shall include at least the area within 1km radius of the boundaries of the proposed site.

3. Legislation and Regulatory Consideration

Outline the pertinent regulations, standards, government policies and legislation governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the Natural Resources Conservation Authority Act, the Public Health Act, the Town and Country Planning Act, Building Act and Codes and Standards and any Regulations promulgated under any of the previously mentioned Acts, Development Orders and Plans and all appropriate international convention/protocol/treaty where applicable. Describe traditional land use and advise of any prescriptive rights including public access rights.

4. Project Description

It should clearly demarcate the exact location of the proposed development/project and should clearly identify the areas which will be used for quarrying and those which will be used for mineral processing. If there are areas to be preserved in their natural state or if a buffer is to be established then these should also be clearly identified.

The description should detail all the elements of the development/project, highlighting the activities which will be involved in all the major aspects of the development/project. Therefore activities which will be involved in the construction, operation, decommissioning and rehabilitation phases should be addressed. These may include but are not limited to the following:

- ***Pre-operation***: exploration drilling and trenching; location of stockpiles, general access to site and access to extraction/dig sites, plant and accommodation/administrative office during initial development phase, duration, timing and working hours of the initial phase, comprehensive drainage assessment and design, method of sewage treatment and disposal, traffic impact assessment, road construction plan and methods to be employed, source(s) of potable water, electricity, solid waste disposal for site operations.
- ***Operation:*** actual quarry site, quarrying rate, quarrying method, processing methods, buffering, plant, machinery and auxiliary facilities e.g. fuel, storage, power supply, generators etc., duration and phasing, nature and quantity of material to be extracted, expected final depth of quarry area, methods for stabilization of quarry faces, storage area(s) (quarry material, spoils, overburden/topsoil), frequency of blasting and predicted vibration levels, dust generation and control (air quality), noise generation and control, drainage control, fuel and other chemical storage, power supply, transportation (internal and external), safety (worker), fencing and security and storage and disposal of excess topsoil, waste disposal (rock, boulders and unmarketable products), on-going/phased remediation/re-vegetation.
- ***Decommissioning:*** long term pollution potential and control (water), removal of administrative buildings, plant and machinery, monitoring and management and land use options after closure.
- ***Rehabilitation:*** methods for long term quarry face stabilization, methods and strategies for site rehabilitation, re-vegetation plan, list of species to be used in proposed rehabilitation, top soil cover to be used, closure plans for any waste treatment facilities associated with the development, monitoring and management for rehabilitated areas, including potential use of the rehabilitated area. long term pollution potential and control (water), removal of administrative buildings, plant and machinery and possible land use options after closure.

In light of the above, a comprehensive and detailed description of the proposed development/project should be provided. This section will provide information on the proposed project and should include but not be limited to:

- History and background of the project,
- A location map at a scale of 1:12,500 (or an appropriate scale)
- The total area of the site to be considered. It should clearly demarcate the exact location of the proposed development/project and should clearly identify the areas which will be used for quarrying, those which will be used for mineral processing (crushing plant) and those which will be used for the storage and stockpiling of material.
- A site layout plan showing the various components and design elements of the proposed development.
- The spatial allotments for the various design elements of the project.
- Buffers and areas to be preserved in their natural state should be clearly identified.
- Clearly indicate the intended use for the final quarried material, including destination i.e. local market distribution and sale versus export and transportation to said destination.
- Expected project components, i.e. pre-operation, operation, decommissioning and rehabilitation **(see above for details)**.
- Schematic plans, diagrams and drawings.
- A detailed landscape plan highlighting grading and proposed changes in topography.
- Details of proposed access(es) to the site to be used for pre-construction, construction and operational phases
- Details on infrastructure development including design plans for all components of the development including the proposed wastewater/sewage treatment system and disposal of treated effluent must be clearly outlined.
- A comprehensive drainage assessment. This assessment should take into consideration existing natural drainage channels, proposed man-made drainage/water features or any proposed changes in topography. Potential issues of increased surface runoff and sediment loading must also be addressed. Special emphasis should also be placed on the storm water run-off, drainage patterns, characteristics of the aquifer, including the level and status of the groundwater.
- In addition, plans for providing utilities, particularly details relating to the source of potable water and electricity generation, roads and other services should be clearly stated.
- A Waste Management Plan which clearly outlines expected quantities of construction waste during the construction phase, general waste arising from material consumption of the workforce, as well as, all expected waste during the operational phase should be completed. Details should also be provided for any central disposal area(s) being considered to serve the proposed development
- Details of equipment and machinery to be involved, how these will be mobilized and areas to be used for storage of machinery and material should be clearly indicated.
- Details of workforce, including proposals for mobilization and accommodation should be indicated.

- All phases of the project should be clearly defined, the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included in the Environmental Impact Assessment report.
- The study area should be clearly delineated and referenced. Taking into account the types of resources located in the area and the magnitude of the associated impacts, the study area should be large enough to include all valued resources that might be significantly affected by the project.

If there is potential room for growth or expansion with respect to the area, output or further processing then this should be discussed. Associated or ancillary activities/ developments should also be discussed. These may include machinery maintenance, haulage enterprises and the final repository of material.

It should be noted that the description should involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate and include information on location, general layout and size, as well as pre-construction, construction, operation, decommissioning and rehabilitation plans. For projects to be done on a phased basis, all phases must be clearly defined and the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included.

5. Description of the Environment

This section involves the generation of baseline data which is used to describe the study area as follows:

i) Physical environment
ii) Biological environment
iii) socio-economic and cultural environment

The methodologies employed to obtain baseline and other data should be clearly detailed in the EIA. The methodologies should be conducted for both the wet and dry seasons where applicable. This information will form the basis upon which impacts of the project will be assessed.

The following aspects should be described in this section:

5.1 Physical Environment

i. a detailed description of the existing
   a) **Geology** – rock type and formation, faults, slope stability issues
   b) **Geomorphology** – identified geomorphological features e.g. caves, caverns, soil type
   c) **hydrology** – sspecial emphasis should be placed on storm water run-off, drainage patterns, including projected discharge points for surface water runoff and actual quarry surface drainage, effect on groundwater, river, springs and availability of potable water. All slope stability issues and natural hazard issues that could arise should be thoroughly explored. Every effort should also be made to identify any existing karst topographic features including sinkholes, caverns and their hydrologic connectivity.

ii. **The extent of the BITO quarry zone as it relates to the proposed project should be discussed and included**.

iii. **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of quarrying and crushing activities. Quality Indicators should include but not necessarily be limited to nitrates, phosphates, faecal coliform, total organic carbon, suspended solids, dissolved solids and turbidity. **Water quality to be assessed upstream and downstream of the quarry.**

iv. **Climatic conditions and air quality in the areas of influence,** including particulate emissions from stationary or mobile sources, NO_x, SO_x, wind speed and direction, precipitation, relative humidity and ambient temperatures, (*a review of the Natural Resources Conservation Authority Air Quality Regulations and the implications of the regulations on the proposed project should be conducted and ascertained*). An air emissions inventory and a Fugitive Dust Emissions Control Plan should be included in the EIA

v. Noise levels of undeveloped site and the ambient noise in the area of influence.

vi. Sources of pollution existing and extent of contamination.

5.2 Ecological Services

- A statement of whether or not any percentage of the ecological services currently being offered by the site will remain or be recovered subsequent to quarrying.

5.3 Natural Hazards

Vulnerability assessment of the development in relation to the following must be undertaken

- Hurricanes, Earthquakes
- Natural hazard vulnerability assessment should take in account climate change projections.

Considerations in this section should capture the vulnerability of the site itself and the possible impact of the site on surrounding communities.

5.4 Biological Environment

Present a detailed description of the flora and fauna (terrestrial) of the area, with special emphasis on rare, endemic, protected or endangered species. In this section the emphasis is on a description of habitats, flora and fauna surveys inclusive of a species list; commentary on the ecological health, function and value in the project area, threats and conservation significance.

This should include:

- A detailed qualitative and quantitative assessment of terrestrial habitats in and around the proposed project sites and the areas of impact. This must also include flora and fauna surveys and should include species lists.
- Special emphasis should be placed on rare, endemic, protected or endangered species. Migratory species should also be considered. There may be the need to

incorporate micro-organisms and the existence of micro-habitats to obtain an accurate baseline assessment.

- Species dependence, niche specificity, community structure, population dynamics, carrying capacity, species richness and evenness (a measure of diversity) ought to be evaluated. **The ecological function of the site/s should be evaluated**.
  An assessment of nocturnal species, economically important species and micro-climatic conditions should be conducted and the finding included in the EIA

The field data collected should include, but not be limited to:

- Vegetation profile
- Species lists must be provided for each community
- A habitat map of the area

5.5 Heritage

- An assessment of artifacts, archaeological, geological and paleontological features for the site.

5.6 Socio-economic Environment

Present and projected population; Demography, regional setting, location assessment and current and potential land-use patterns (of neighboring properties); planned development activities, issues relating to squatting and relocation, community structure, employment, distribution of income, goods and services, recreation; description of existing infrastructure such as transportation, electricity, water and telecommunications, and public health (Health Impact Assessment) and safety; cultural peculiarities, aspirations and attitudes should be explored; and other material assets of the area should also be examined. A socio-economic survey to determine public perception of the project should also be complete and this should include but not be limited to potential impacts on social, aesthetic and historical/ cultural values.

Availability of solid waste management facilities especially as they relate to the quarry should be explored.

The historical importance of the area should also be examined including identification of culturally significant features e.g. archaeological finds. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development will be conducted and the use/benefit/value of the existing site will be explored/explained. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires.

A traffic management plan and road improvement/rehabilitation proposal to include the construction, operation, protection and maintenance of haulage roads should be included particularly in the context of the current state of access to the site. An estimation of the amount and types of trucks to be used in the operation should be included. A

tagging/tracking system to identify trucks to be used in the operation should be developed and outlined in the EIA.

Proposed methods of sewage treatment and disposal to serve the short term and long term needs of the quarry should be included and detail designs incorporated

6. Public Participation

Describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups meetings. The instrument used to collect the information must be included in the appendix. It may be useful and necessary to hold stakeholder meetings to inform the public of the proposed development and the possible impacts. This will also gauge the feeling/response of the public toward the development.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EIA should be outlined.

Public Meetings should be held in accordance with the Guidelines for Conducting Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA). A public meeting will be held to present the findings of the EIA once the EIA is completed and submitted for consideration. All relevant documents are required to be made available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document. should be clearly outlined to the public.

This public presentation should be:

- Conducted at an appropriate location agreed to by the National Environment and Planning Agency (NEPA)
- Held in accordance with the NEPA's Guidelines for Conducting Public Presentations which is available on the Agency's website (www.nepa.gov.jm)

All **findings** must be presented in the **EIA report** and must reflect the headings which have been outlined in the body of the ToR. References should also be provided. Hard copies and an electronic copy of the report will be required for submission. The report should include an appendix with items such as maps, site plans, the study team, photographs, and other relevant information.

7. Impact Identification and Assessment/ Analysis of Potential Impacts

A detailed analysis of the project components should be done in order to: identify the major potential environmental and public health impacts of the project; distinguish between levels of impact, significance of impact (a ranking from major to minor/significant to insignificant should be developed), positive and negative impacts, duration of impacts (long term or short term or immediate), direct and indirect and impacts, reversible or irreversible, long term and immediate impacts and identify avoidable impacts.

Cumulative impacts should also be evaluated taking into account previous developments and any proposed development immediately adjacent to the subject development within the area. The identified impacts should be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental and public health issues should be noted and their relative importance to the design of the project and the intended activities indicated. The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should then be ranked as major, moderate and minor and presented in separate matrices for all the phases of the project (i.e. preconstruction, construction, operational and decommissioning/closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic and Cultural Impacts. All impacts should be listed, ranked and assessed.

The impacts to be assessed will include but not be limited to the following:

7.1 Physical

In general, for this proposed development, the physical impacts may include the effect on soil and geology (site clearance, storm water runoff, loss of topsoil, potential erosion, change in drainage patterns, flooding risks (as it pertains to the site and the surrounding environs/communities), air, particularly in the context of the potential impact that the proposed development may have on communities (generation of dust from processing, drilling, transportation, material storage and handling, fly rock from surface workings); water (possible contamination of surface and subsurface resources from improper waste disposal, storm water runoff); the landscape (loss of character of the area, impact of excavation); material assets (effects of vibration on surface structures as it pertains to the site and the surrounding environs/communities, damage to roads during transportation).

- The potential for flooding of settlements down slope of the project should be investigated and the associated mitigation measures such as cleaning of river channels and maintenance of storm water drainage culverts should be incorporated.
- Information should be provided on the existing watershed condition and the extent to which the proposed quarry will influence the watershed and existing drainage patterns which could affect the overall stability of the region.
- The impact of mining on the surrounding communities as it relates to noise, dust, vibration from blasting and other impacts.
- The impact that the mining activities may have on slope stability and the possible generation of landslides should be examined in details and should include the relevant hazard maps. Associated slope protection measures should be explored and provided. It is recommended that benching and terracing be explored as a method of mining.

The physical impacts should explore, but not be limited to the following:

- Impacts of construction activities such as site clearance, earthworks and spoil disposal.

- Impacts of accidental oil and chemical spills
- Impacts on Air Quality, with the use of Air Dispersion modeling to project cumulative impacts, incorporating data collected from current mining operations
- Impacts on Water Quality (pollution of potable, surface and ground water)
- Impacts/demands/requirements of the following must be quantified
    - Water Supply
    - Drainage
    - Sewage Treatment and Disposal - Empirical data must be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the Natural Resources Conservation Authority's Sewage Effluent Standards;
    - Wastewater Disposal
    - Trade Effluent Discharges and the Treatment and Disposal of same - Empirical data must be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the Natural Resources Conservation Authority's Trade Effluent Standards;
    - Solid Waste Disposal
    - Electrical Power (fossil fuels, wind, sun, wave and tidal)
    - Communications and other utility requirements
    - Transport Systems and supporting infrastructure required
- Operation and maintenance – waste disposal, site drainage, sewage treatment and disposal solution, and air quality;
- Impacts on visual aesthetics and landscape
- Noise
- Dust
- Vibration
- Change in drainage pattern
- Carrying capacity of the proposed site

7.2 Natural Hazard

Impact of natural hazards including but not limited to hurricanes, earthquakes, landslides and flooding potential shall be examined.

7.3 Biological

These will address the effects on flora and fauna, such as the loss of habitats, niches and species. Direct and indirect impact and associated risks on ecology and on the terrestrial aquatic habitats, where relevant. Emphasis should be placed on any rare, endangered, and endemic species found. This should include habitat loss and fragmentation, loss of species, niches and natural features due to construction and operation. The impact of noise, dust and vibration on floral and faunal species should be explored.

7.4 Heritage

Loss of and damage to artifacts, archaeological, geological and paleontological features

7.5 Human/Social/Cultural

Effects on the socio-economic status such as changes to public access and recreational use; impacts on existing and potential economic activities; contribution of the development to the national economy and development of surrounding communities should be examined. Socio-economic and cultural impacts to include land use/resource effects, health and safety of the potential workers as well as the residents of the surrounding environs should be described. Public perception as it relates to loss of property value, loss of aesthetic enjoyment among other things should be explored.

7.6 Public Health Issues of Concern

The impact of the proposed development particularly in the context of the potential impacts on human health, that is, air quality, noise pollution, water quality e.g. possible respiratory effects) should be examined, in terms of what is the identified impact and proposed mitigation.

7.7 Risk Assessment

Analyze the risks to the safety of the workers and persons in the surrounding environs who may be affected by the development activities. . This should include: 1) Identifying the hazards 2) Assessing the potential consequences 3) Assessing the probability of the consequences and 4) Characterizing the risk and uncertainty.

8. Cumulative Impacts

A cumulative Impact Assessment should be conducted for the operation given the number of quarries currently operating in the region with emphasis placed on the impact of noise, vibration, runoff, traffic, erosion, air emissions, flooding and drainage issues and impact on water resources.

9. Residual Impacts

Identify any residual negative impacts that potentially have no solution for mitigation, for example, change in aesthetics, habitat loss, etc.

10. Mitigation Measures

The EIA should seek to provide mitigation measures to address, as far as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development. The mitigation measures should endeavour to avoid, reduce and remedy the potential negative effects while at the same time enhancing the positive impacts projected. Mitigation and abatement measures should be developed for each potential negative impact identified. This should include recommendations for the enhancement of beneficial impacts and quantify and assign financial and economic values to mitigating methods. Green technology should be examined. A statement is to be made on strategies that will be used to conserve energy and water in relation to this development.

The EIA should also provide a restoration plan which speaks specifically to the re-vegetation of those areas which will be mined. The associated cost for restoration should be included.

A closure plan for the operation should be included.

The EIA should include a Ground Control Management Plan (GCMP). "A ground control management plan (GCMP) is a document in which the processes used to manage the mining environment are defined especially with regards to all aspects that affect the stability of the slopes. A ground control management plan is important tool for the safe, efficient and economical operation of the quarry".
Mitigation measures should also include a soil erosion and sediment management plan given the nature of the operation and the terrain.

11. Analysis of Project Alternatives

Alternatives to the proposed development/project including the no-action alternative should be examined. These should be assessed according to the physical, ecological and socio-economic parameters of the site. This examination of alternatives should incorporate the use of the history of the overall area in which the site is located and previous uses of the site itself. Alternatives should also address specific aspects of the project such as methods proposed in the execution of the project (works) that have been identified as being causes of major impacts.

The TOR should also examine the alternatives to trucking the material and the feasibility of implementing a conveyor system. The environmental impacts and cost benefit should be presented in considering the alternatives.

A rationale for the selection of any project alternative should be provided.

12. Environmental Monitoring and Management

An Environmental Monitoring and Management Plan should be developed which will detail the requirements for construction, operational and decommissioning/closure phases of the project. This should include, but not be limited to training for staff, as well as include recommendations to ensure the implementation of mitigation/compensation measures and long term minimization of negative impacts

A draft environmental monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development.

At the minimum, the monitoring programme should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit license(s) granted.
- The activity(ies) being monitored and the parameters for monitoring and reference standards.
- The area(s) being monitored (should incorporate a control site), the methodology and frequency of monitoring recommended.
- The name and qualifications of the person(s) proposed to undertake the monitoring programme.
- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA
- A sample of the report that is to be submitted

The Monitoring report should also include, at minimum:

- Raw data collected. Tables and graphs are to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

13. List of References

14. Appendices

The appendices should include but not be limited to the following documents:

1. Reference documents
2. Photographs/ maps
3. Data Tables
4. Glossary of Technical Terms used
5. Terms of Reference
6. Composition of the consulting team, team that undertook the study/assessment, including name, qualification and roles of team members
7. Notes of Public Consultation sessions
8. Instruments used in community surveys

ACTIVITIES

In order to effectively and efficiently conduct the Environmental Impact Assessment it will be necessary to carry out various activities which include:

14.1 Documentation Review

All documentation pertaining to the development will need to be reviewed. These should include, but not limited to, the project profile, site plan, drainage plan, vegetation clearance plan, applications made for financing or planning approval, and any technical and engineering studies that have been done.

14.2 Analysis of Alternatives

Alternatives to the site location, project design and operation conditions will be analyzed including the "no-action" alternative. These alternatives will be assessed based on the physical, ecological and socio-economic parameters of the site identified. The physical, biological and sociological settings will provide the framework in which to assess the different project alternatives. This would clarify, for instance, whether the site could be used for other purposes as well as whether there are any particular aspects of the development that can be sited differently, operated differently, etc.

14.3 Impact Assessment

The consultant should carry out a detailed impact assessment of the project components (preconstruction, construction, operational and decommissioning/closure stages) in order to identify the potential impacts (positive, negative and cumulative impacts) that will be associated with the project. The significance and magnitude (major, moderate and minor) of the impacts identified will also be evaluated through the use of a weighted matrix.

The impacts to be assessed will include but not limited to the following:

- Effects of project design and engineering;
- Effects on visual aesthetics and landscape;
- Effect of noise and vibration;
- Effects of operation activities such as site clearance and geological formation, earthworks, hurricanes, access routes, transportation networks and spoil disposal;
- Effects of operation and maintenance activities such as waste disposal, traffic management, site drainage, sediment, sewage, public access
- Effects on ecology including effect on terrestrial and other habitats
- Emphasis should be placed on any rare, endangered, and endemic species found
- Effects on socio-economic status such as changes to public access, recreational use, existing and potential agricultural activities, contribution of development to national economy and development of surrounding communities.

All findings must be presented in the EIA report and must reflect the headings in the body of the TORs, as well as, references. GIS references should be provided where applicable. One hard copy and an electronic copy must be submitted to NEPA for review after which ten (10) hard copies and an electronic copy of the report should be submitted. One copy of the document should be perfect bound.

The report should include appendices with items such as maps, site plans, the study team and their individual qualifications, photographs, and other relevant information. All of the foregoing should be properly sourced and credited.

14.2 Appendix 2

Environmental Impact Assessment Study Team

NAME	QUALIFICATION
Balfour Denniston (PE, PMP)	Chemical Engineer
Roberto Machado (PE)	Civil Engineer
Timon Waugh (PhD)	Environmental Consultant
Peter Wilson-Kelly (MPhil)	Coastal Zone Management Specialist
Norman Harris (MSc)	Geologist
Lawrence Barrett (PE)	Hydrologist
Stephen Haughton	Air Quality Specialist

14.3 Appendix 3

Jamaica National Heritage Trust Letter

Where service means on-time and on-budget performance

ENVIROPLANNERS LTD

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Kingston 6
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Phone : (876) 977-7590
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November 8, 2016

Mr. Dorrick Gray
Executive Director
Jamaica National Heritage Trust
79 Duke Street
Kingston

Dear Mr. Gray

RE: Proposed Expansion of Limestone Quarry at Harbour Head; St. Andrew by Caribbean Cement Company Limited.

EnviroPlanners Limited has been contracted to conduct an environmental impact assessment (EIA) of the above captioned proposed development.

Pursuant to the determination of the project's impact on Jamaica's heritage, we have attached maps of the proposed project sites and is requesting your assistance to determine if there are heritage sites/interest at this locations.

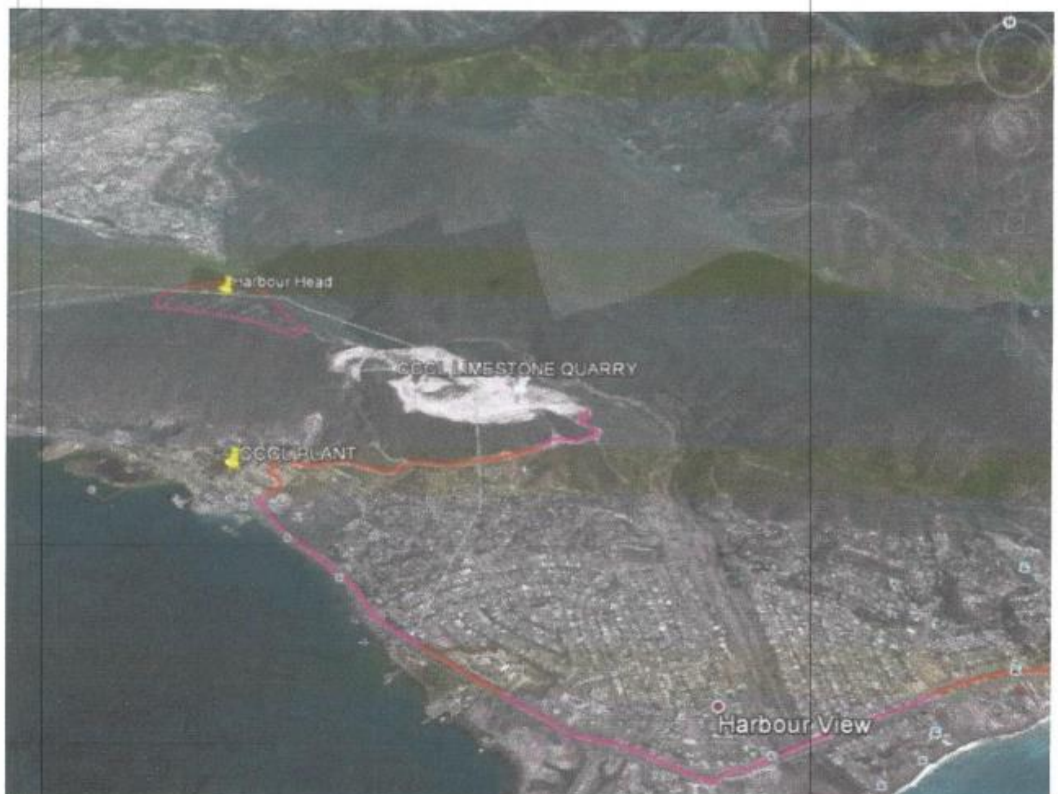
For clarifications or any further information you may contact Timon Waugh – General Manager, EnviroPlanners Limited at 383-6658.

Your usual prompt response would be highly appreciated.

Yours truly,

for Balfour Denniston
Chief Executive Officer
EnviroPlanners Limited

Location Map for the Proposed Limestone Quarry Expansion.



14.4 Appendix 4

Community Consultation

on

Gypsum & Limestone Quarrying Mining Expansion Projects

CARIBBEAN CEMENT COMPANY LIMITED
PROPOSES TO EXPAND THE HALBERSTADT GYPSUM QUARRY AND THE HARBOUR HEAD LIMESTONE QUARRY IN ST ANDREW, JAMAICA

November 2016

Caribbean Cement Company Limited

Rockfort, Kingston 2, Jamaica

Tel: (876) 928-6231; Fax: (876) 928-7381

Website: www.caribcement.com

Project Background

Caribbean Cement Company Limited (CCCL), through its subsidiary Jamaica Gypsum and Quarries Limited (JGQ), operates quarries all within close proximity (< 7 km radius) of the cement plant at Rockfort St. Andrew. These quarries supply the raw material inputs to the cement manufacturing process which includes; limestone, shale, gypsum and pozalano.

Supplies at the Gypsum Quarry in Halberstadt and the Limestone Quarry in Harbour Head are at a critical level and as such additional deposit needs to be secured. Additional deposits have been identified in areas adjacent to the respective quarries and this community consultation is being conduct to engaged the communities that could be affected by the operations and ensure that they are aware of the project and receive any concerns with a view of addressing same.

Halberstadt Gypsum Quarry: In 2013 Supplies at the Bito Gypsum Quarry was depleted of mineable ore and reclamation activities began in 2014. As a result, CCCL having obtained the relevant permit re-opened the Halberstadt Gypsum Quarry, approximately 2 km northeast of the Bito Quarry. Though dormant for 40 years, this quarry is the only known economical reserve of gypsum remaining and it is intended for this quarry to supply the cement plant with the gypsum required in the manufacturing of Ordinary Portland and Blended Cements.

Caribbean Cement Company Limited (CCCL), through its subsidiary Jamaica Gypsum and Quarries Limited (JGQ), had applied to the National Environment Planning Agency (NEPA), for permit to operate a quarrying and mineral processing facility at Halberstadt in St. Andrew. Based on a thorough Environmental Impact Statement which was prepared by CL Environmental the Agency approved a permit to mine one hectare of the possible 6.7 hectares. The information presented in this report is related to the total 6.7 hectare however extensive reference has been made and where applicable information used from the EIS of 2013.

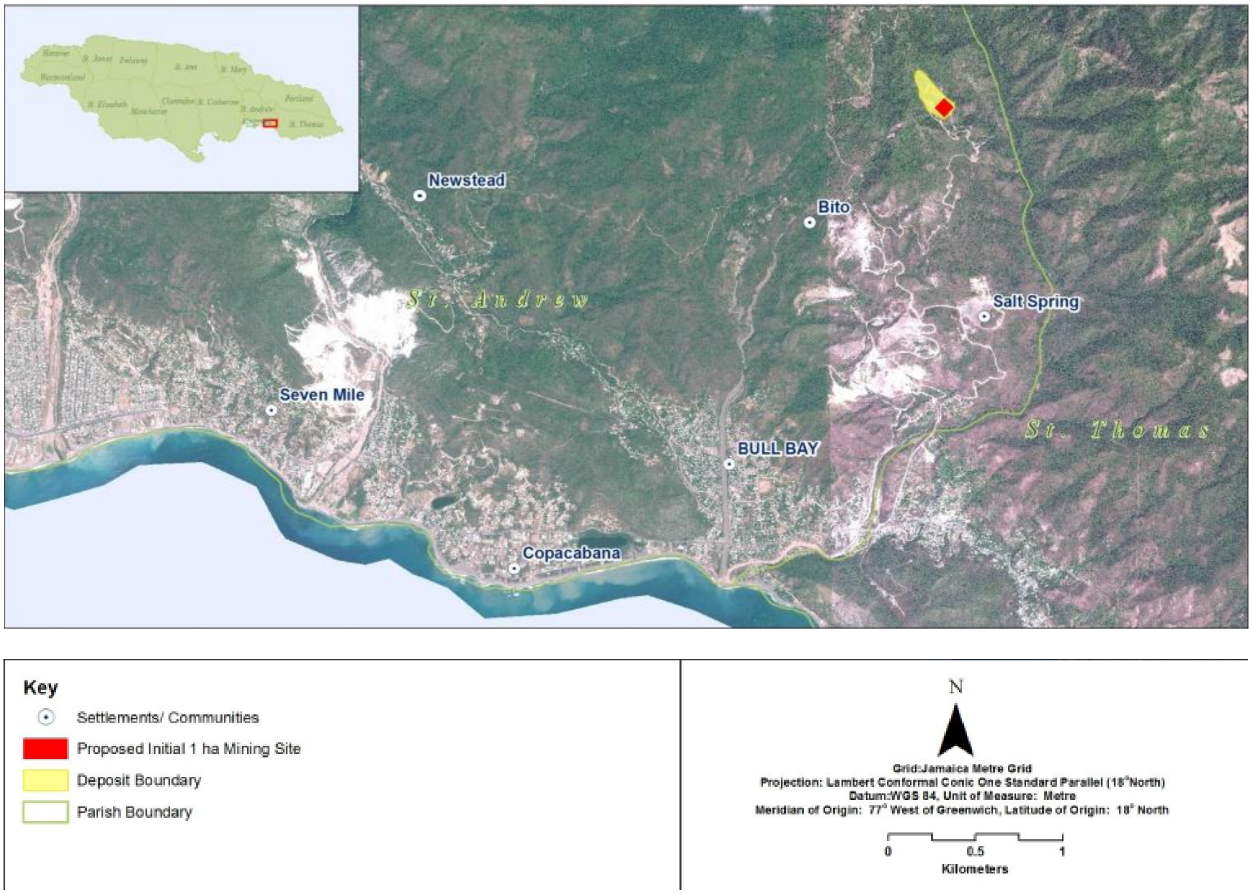


Figure 1: ***Proposed Halberstadt Gypsum Quarry Location – Source 2013 EIS***

Harbour Head Limestone Quarry: Limestone represents 80% of the raw material necessary for the production of clinker and by extension, cement. Given that the chemistry directly affects the quality of the end products, it is necessary to plan ahead to ensure the limestone reserves are optimized. As such the following parameters must be taken into consideration:

(i) The quantities of Limestone present in the area;

(ii) The quality of said Limestone; based on both Calcium Carbonate ($CaCO_3$) and the Magnesium Oxide content, (MgO).

(iii) Quality maps; these maps are necessary as they provide a guide to the spatial variations of the above-mentioned quality indicators in the limestone.

The mineral currently available from the existing Limestone Quarry poses a serious challenge to derive to correct blend proportion. Based on borehole sample analysis the chemistry of the mineral from the proposed Harbour Head Quarry is ideal for blending with Limestone form the existing Quarry.

The proposed Caribbean Cement Company Limited (CCCL) Harbour Head quarry site is located at the top of Long Mountain in the eastern section of St Andrew (Figure 1.1). The project site stretches from the top of the ridge to the north-eastern side of the mountain slope. The south-western section is situated on gentle sloping terrain, while the north-eastern section is dominated by steep topography. The south-western boundary is defined by a Jamaica Public Service Company (JPSCo) service road for its transmission towers which is aligned with the Long Mountain Ridge. Similarly, the north-eastern boundary is defined mainly by the Yallahs pipeline which is routed along the steep north eastern slope

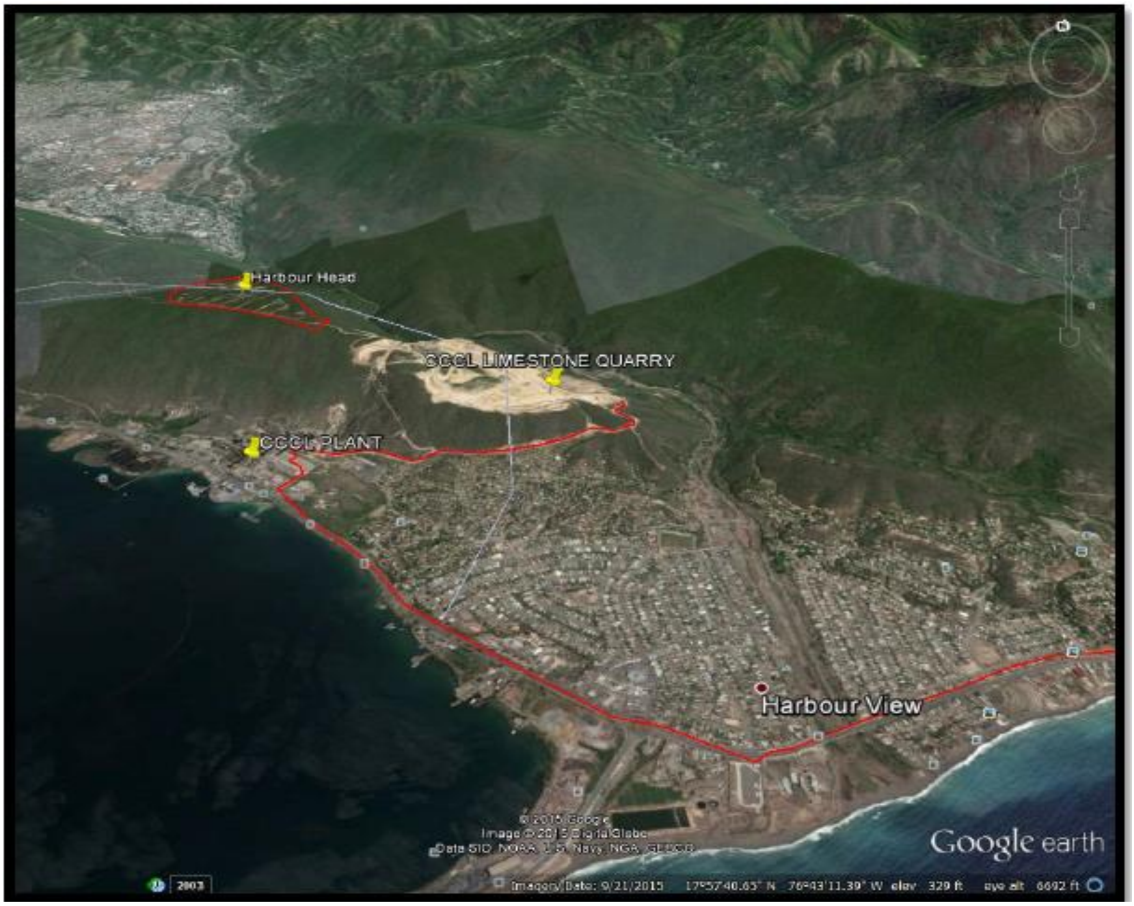


Figure 2: ***Proposed Harbour Head Limestone Quarry Location***

Project Design – Harbour Head

The development of the CCCL Harbour Head quarry is planned in three phases: Pre-operation phase; Operation phase and Rehabilitation phase. The pre-operation phase provides information on the site including the physical and chemical characteristics of the geological material to assist with the development of the quarry and design of the mining plan. This will include construction of access roads, subsurface exploration work (drilling and sampling) and physical and chemical analysis.

<u>Drilling and Sampling</u>

Preliminary exploration drilling and sampling was conducted at the Harbour Head Project site to gather information in order to ensure that the material meets the required specification for the cement plant.

Exploration was carried out across a large section of the delineated area to provide a holistic representative set of results. A total of 30 exploratory boreholes were drilled to a depth ranging from 45m (150ft) to 52.5 (175ft) with samples collected at 1.5m (5ft) intervals. Geological log profiles were then created for each hole using the samples recovered. Following this, the samples were then chemically analyzed by CCCL's lab. Drillhole site layout plan is shown in Figure 1.4.

Project Design – Halberstadt

NHL Engineers Ltd conducted a subsurface geological survey based on drilling of boreholes, to determine the reserve capacity of the gypsum deposits at the Halberstadt quarry. Information from the drill holes indicated the following:

- Clays, sand and gravel to depths ranging from 0-15m
- Clayey shales, Sandstone of variable depth
- Gypsum/anhydrite at depths ranging from 10m-60m

Results of laboratory analysis for the gypsum showed an average percentage gypsum of approximately 50% with a high of 90%. The reserve estimation was obtained by a simplified representative cross-sectional area of the deposit which varies from 5,625m^2 to 3600m^2. The presumptive profile indicates that the effective depth of length of gypsum deposit is about 450m. A conservative volumetric estimate of the deposit is 2,586,500m^3.

The average content of the gypsum is approximately 52% based on laboratory test which therefore gives a volumetric reserve estimate of 1,350,804m^3. In applying the in-situ densities (bulk densities) of gypsum and anhydrite (2.33t/m^3 and 2.9t/m^3 respectively), it gives a reserve estimate of 3,147,373 tonnes of gypsum and 3,586,418 tonnes of anhydrite. This compares favourably with CCCL's internal reserve estimate of 6.3 million tonnes.

Project Operations and Maintenance – Harbour Head

The life of the Harbour Head limestone deposits will depend on the rate at which material is extracted. The rate of extraction of the reserves will be a direct result of the following:

- The demand for the limestone based on 2016 production budget (Table 1.2) and on the 5-year production budget (Table1.3).
- The ability of the established and current Quarry to meet the demands and estimated targets.
- The blending systems implemented to optimize reserves.
- Whims of the weather. Mining is planned throughout the year, although it is expected that mining will be reduced in the peak of the rainy season.

The quality of the Limestone in the Harbour Head area is not homogenous. The chemistry of the limestone acts as a direct influence on the quality of the material mined. Thus blending is necessary to achieve optimum quality standards before materials are entered into production. The mining sequence will therefore be determined firstly by the quality requirements, then by quantity requirements and the required stipulations for mining best practices.

Mining is projected over a 5-yr period, from year 2016 -2020, with yearly extraction figures ranging from 970,000.60 Tonnes to 1,091,780.46 Tonnes and total extraction of 5,150,030.68 Tonnes (Table 2). Harbour Head will account for approximately 80% of the material mined from both quarries.

Project Operations and Maintenance - Halberstadt

Development Stage

The Halberstadt quarry had been dormant for many years commenced mining operations on a 1 hectare block in 2014. The accessible mineral in the 1 hectare was only recently exhausted and therefore the infrastructure is still in place and will not require any significant work to restart. Test holes drilling has already been done at a spacing of 30 m. This information has been used to develop a mining progression plan.

Mining Schedule

The mine schedule will be for the benches containing BH 103 and BH 105 to be mined in 2013, down to a depth of 12 m each.

Mining Method

The mining method to be employed is open-pit mining, by benching. Material will be extracted by drilling and blasting and subsequent to this an excavator will be used to load the material into a mobile crusher.

Communities Which Could be Impacted

Halberstadt

The Halberstadt gypsum quarry is located at least 1 km from the nearest community and therefore the mining operation at the quarry should not have a direct impact on any community. However, the transportation of the mineral to the cement plant traverses several which are likely to be impacted.

The communities which will potentially be affected are:

1. Bito
2. Bull Bay
3. Benoa
4. Bloxbourgh

Meetings were held with representatives of all the above communities and the details of the project explained and concerns received from community member.

Harbour Head

There are no communities within the radius of influence for this project site and no community will be traversed to access same.

Acknowledgement of Engagement and Consultation

The community representatives and member below have signed this document as an acknowledgement that the projects described above was presented to them and they were given the opportunity to ask questions and express their concerns.

Bull Bay

Name	Contact	Comments	Signature

Bloxbourgh

Name	Contact	Comments	Signature

Bito

Name	Contact	Comments	Signature

Communities Engagement Re: Halberstadt Gypsum Quarry & Harbour Head Limestone Quarry

Acknowledgement of Engagement and Consultation

The community representatives and member below have signed this document as an acknowledgement that the projects described above was presented to them and they were given the opportunity to ask questions and express their concerns.

Bull Bay

Name	Contact	Comments	Signature
		Please settle outstanding concerns.	[signature]
ANTHONY STEWART	8861349	Community ok mining by CCL as long as measures	[signature]
Antoinette Stewart	857-6950	taken to protect our community, safety, & livelihood.	[signature]
Justin Duncan	512-6488		

Bloxbourgh

Name	Contact	Comments	Signature
CAROL Williams	2923182		[signature]

Bito

Name	Contact	Comments	Signature
Richard Henry	4232941	NO	[signature]
Rupert T Bennett	6311690	NO	[signature]

ATTENDANCE REGISTER

TOWN HALL MEETING HELD ON FEBRUARY 16, 2017, ST. MARTIN'S MISSION

No.	NAME/FROM	CONTACT NO:/EMAIL
1.	Christopher Hemmings (APM) NWA St Andrew	384-9621 christopherhemmings@nwa.gov.jm
2.	Warren Wilson (Customer service) NWA	433-4183 warrenwilson@nwa.gov.jm
3.	Laval Samuels Yallahs Police Station	3894460 samuels.lavala@hotmail.com
4.	Marsha-Ann Palmer Ministry of health	317-8624 palmerm@moh.gov.jm
5.	Collin Cooper Ministry of health	317-7979 cooperco@moh.gov.jm
6.	Juliet Holness	jaholness@gmail.com
7.		
8.		
9.		
10.		
11.		
12.		
13.		
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17.		
18.		
19.		

[signature]
6/3/17

ATTENDANCE REGISTER

TOWN HALL MEETING HELD ON FEBRUARY 16, 2017, ST. MARTIN'S MISSION

No.	NAME/FROM	CONTACT NO:/EMAIL
59.	Noreen Hoyle / Store	862-8568
60.	Sanya Davis / entreperiner	891-8933
61.	Camala Thomas / Entrepeneur	346-7348 9 miles Bull Bay
62.	Melissa Johnson	885-1688 -
63.	Noreta Lewis	5247370 lewisnoreta@gmail.co
64.	Ouida Grant	866-8783 ouidagrant@yahoo.co
65.	Xavier Bryan / J.P.S.	Xavierbryan56@yahoo.com
66.	Fiona Thorpe	fionathorpe30@gmail.com
67.	MONIQUE GRANT	MONIQUEALICIA@YAHOO.COM
68.	Yandeon Banton	yandeanb@gmail.com
69.	Racquel Newton	403-8727 / 8062948
70.	Benton Melbourne	—
71.	V. Carl Dixon	296-4338 / vindi573@gmail.co
72.	Suzanne Stanley	9603693 sstanley.jet@gmail.com
73.	Felicia Wong	9603693 fwong.jet@gmail.com
74.	Kimone Thompson	~~EVONDONNA@GMAIL.COM~~ 564.5316
75.	EVON E. MULLINGS	8166003 / EVONDONNA@GMAIL.COM
76.	LAMAR CLARKE	8794703 ROCKHEAVEN2006@YAHOO.CO
77.	Muriel Cavis	4265579

ATTENDANCE REGISTER

TOWN HALL MEETING HELD ON FEBRUARY 16, 2017, ST. MARTIN'S MISSION

No.	NAME/FROM	CONTACT NO:/EMAIL
21.	D. La Monte	561-5054
22.	A. Stephenson / Caribbean Cement	367-5141
23.	C. Downer (J.C.F)	886-3336
24.	D. E. HARRIS [illegible]	377-0674
25.	B. Melbourne - Bull Bay	5618231
26.	M. Morgan Bull Bay	375-5937
27.	Kensa Darby	469-4177
28.	K. BARNABY JP	889-5671
29.	A. Stewart	857-6950
30.	Anthony Stewart Chairman Basket Brigade	886 1349
31.	Sandra Stewart	879 4547
32.		
33.		
34.		
35.		
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38.		
39.		

Concerns arising out of the 'Community Consultation on Gypsum & Limestone Quarrying Mining Expansion Projects' between the Ten Miles Bull Bay Bucket Brigade and the Caribbean Cement Company Limited held in November 2016.

1. We require trucks conveying quarried material through the Community to be clearly marked as contractors to the Caribbean Cement Company. This will aid in the effective monitoring of the conveyances so as to ensure compliance with the conditions of their permits.

2. The speed at the trucks enters and exits the Gypsum Road which is a shared entry with Bull Bay All Age School. This presents not only a traffic violation but also a serious to the lives and well being of the school children and citizenry. It must noted that these trucks continue speed while navigating the St. Thomas Main Road.

3. Truck Drivers to maintain appropriate decibel levels from the truck exhaust system.

4. Dust mitigation - Haulage roads are dirt roads, this needs to be remedied especially in close proximity of homes.

5. Structured and transparent approach to the social and infrastructural development and restoration of the Community.

6/3/17

Carib Cement Company Limited and the Communities within the Halberstadt Gypsum Mining Area Meeting
On September 6, 2016, at3:00pm
At the CCCL Sales and Marketing Conference Room

In Attendance:

Caribbean Cement Representatives,
Ten Mile and Eleven Mile Community Representatives
Jack's Vales community Representatives
Bennoah Community Representatives
Bito and Bloxbourgh community representatives.
(The list of attendees is attached)

1. Goals:

The meeting was a follow-up meeting from previous meetings held in May, 2016 and June 8, 2016 with the community members of the various communities in the quarry area. The objective of the meeting was to maintain dialog with the communities whereby strengthening the relationship which exist between them and Carib Cement (CCCL). The meeting was also used to update the communities on the various project planned by CCCL as well as to highlight on the progress of the EIA for the proposed expansion of the Gypsum and Limestone Quarry and to solicit continued feedback.

2. Welcome and Opening Remarks

The meeting was called to order by Chairman Andrew Stephenson, Quarry Manager of Carib Cement Group. The Chairman welcomed everyone to the meeting and thanked them for coming. Members present introduced themselves.

3. Meeting Discussion

Carib Cement proceeded with a presentation outlining:

- The need to increase reserves of both limestone and gypsum
- Planned improvements in contractor and vehicular management
- The CSR initiatives to be implemented that will directly impact the community

4. Open Discussion

The presentation was followed by open discussions. The points raised are highlighted below:

- Members of the communities present pointed out that they are in need of jobs and better roads, but more importantly jobs and would be appreciative of any assistance CCCL may render.
- All community representative present shared that they understood CCCL's need for additional land in the halberstadt. They added that they support the initiative and looked forward to continued dialog on this matter. The members pointed out that tighter control is required regarding truck traversing throughout the area. They added that the trucks need identification marks and should not travel in convoy. CCCL agreed with this request. The

community members also pointed out that improvement is required in the roadway in the Jacks vale and Halberstadt area.

- CCCL informed the meeting that the CSR initiatives being planned for the communites will take a different form from those implemented in the past. The focus of the new CSR projects will be strongly geared at being self – sustainable following startup efforts. The main project highlighted was for the establishment of a greenhouse for the communities, beekeeping and scholarship programs.
- Other project discussed include:
  - Continuation of the sidewalk project
  - The establishment of a community monitoring program
  - Agricultural education programs
- The Jacks Vale community representatives highlighted that the sidewalk is a critical project for their community, which is required in the short term. CCCL agreed to continue the implementation of sidewalks and to pave the roadway.
- The Bloxbourgh community members requested donation of cement to assist in road repairs
- Jack vale community requested the establishment of a football filed in their community.
- A community member stated that the school PTA discussed a plan to request assistance with land surrounding the school for development of the school. A proposal will be sent to CCCL.
- The community members were concerned about the equitable distribution of scholarships between the communities and the level and criteria for which the scholarships are granted.

The meeting presentation as well as the list of attendees are attached.

Prepared by:

Andrew Stephenson

CCCL Quality, Quarry and Environment Manager

CARIBBEAN CEMENT COMPANY LIMITED & BLOBOROURGH COMMUNITY MEETING HELD AT THE BLOXBOURGH COMMUNITY (ON THE PRIMARY SCHOOL PREMISES) ON SEPTEMBER 19, 2016

Attendees:

Meeting Chair: The meeting was chaired by Mr. Bartley, Bloxbourgh Citizen's Association leader
Community Members: (citizens association; approximately 20 individuals),
Andrew Stephenson, CCCL
Stephen Bachan, TCL

Call to Order

The Meeting was called to order at 11:00am

Goal: the purpose of the meeting included CCCL drive to further engage the communities in the mining area and ensure that they are aware of planned mining activities as well as for CCCL to increase its awareness of the community challenges and assess potential partnerships for resolution.

Discussion:

The community meeting was already in session on the arrival of CCCL representative with the main discussion being the requirement for road repairs regarding assess to the community. CCCL was invited to take the floor shortly after arrival.

The community was updated on the intended restarting of mining operation in Halberstadt. CCCL noted that the community was already aware of this development as the community leaders had attended a previous meeting with CCCL and had ensure that all items discussed were passed on in the local community meetings. The general feedback was in regards to satisfaction with how the initial mining was carried out and the expectation that CCCL will continue to follow good mining practices. The community members highlighted that they were desirous of using a part of CCCL haulage road to access the community. They stated that the CCCL haulage road was in a better condition than the parochial. The community members also requested that CCCL assist in some way in the repairs to the parochial roadways.

Additionally comments/ discussions

- The community members informed the meeting that Castor oil plants are growing abundantly in the area from which they generate Castor oil form the seed. They shared that at present they extract the oil without the appropriate equipment. They have requested for CCCL to assist with the procurement of a press machine. No cost was given for the machine at the meeting.
- The community is also requesting CCCL assistance with the pumping of water from a spring to the community. The requirement is for approximately 200ft uphill.

- Members of the community shared that they are often not included in works carried out in various areas. They enquired if CCCL could involve the members of the community in the projects being executed in the area.
- Reference was made by CCCL in regards to the assistance with sustainable projects. They also enquired of CCCL establishment of a greenhouse for the Bullbay communities. The Bloxbourgh community is requesting that a greenhouse be established particularly in that area.
- The community members reiterated that their main issue is the condition of the parochial roadways leading to the community and requested that CCCL assist them in any way possible.

End of meeting notes.

Prepared By:
Andrew Stephenson
CCCL Quality, Quarry and Environment Manager

Email Correspondence with JET

Subject: Re: Community Consultation on Gypsum and Limestone Quarrying Mining Expansion Project

From: Felicia Wong (fwong.jet@gmail.com)

To: timonwaugh@yahoo.com;

Cc: AStephenson@caribcement.com; enviroplanners2010@hotmail.com; sstanley.jet@gmail.com; jamaicaenvironmenttrust@gmail.com;

Date: Tuesday, February 21, 2017 11:37 AM

Thanks so much, Timon.

Best,
Felicia

Felicia Wong
Project Coordinator
Jamaica Environment Trust
Earth Cottage
123 Constant Spring Road, Unit #5,
Kingston 8,
Jamaica, W.I.
Tel: (876) 960-3693
Email: fwong.jet@gmail.com

Donate to JET online: www.jamentrust.org/get-involved/donate

On Tue, Feb 21, 2017 at 11:26 AM, timon waugh <timonwaugh@yahoo.com> wrote:

Dear Felicia

Kindly see attached document. Please note that this is a draft document.

Regards

Timon

From: Felicia Wong <fwong.jet@gmail.com>
To: timon waugh <timonwaugh@yahoo.com>
Cc: Andrew Stephenson <AStephenson@caribcement.com>; EnviroPlanners Limited <enviroplanners2010@hotmail. com>; Suzanne Stanley <sstanley.jet@gmail.com>; Jamaica Environment Trust <jamaicaenvironmenttrust@ gmail.com>
Sent: Monday, February 20, 2017 3:44 PM
Subject: Re: Community Consultation on Gypsum and Limestone Quarrying Mining Expansion Project

CARIB CEMENT
BUILDING A GREATER JAMAICA

From: Felicia Wong [mailto:fwong.jet@gmail.com]
Sent: Friday, February 17, 2017 2:28 PM
To: Andrew Stephenson <AStephenson@caribcement.com>
Cc: Suzanne Stanley <sstanley.jet@gmail.com>; Jamaica Environment Trust <jamaicaenvironmenttrust@gmail.com>
Subject: Community Consultation on Gypsum and Limestone Quarrying Mining Expansion Project

Hi Mr. Stephenson,

As discussed over the phone, can you please provide us with the full document that was circulated to community members in Bull Bay titled "Community Consultation on Gypsum and Limestone Quarrying Mining Expansion Project".

I look forward to hearing from you.

Regards,

Felicia Wong
Project Coordinator
Jamaica Environment Trust
Earth Cottage
123 Constant Spring Road, Unit #5,
Kingston 8,
Jamaica, W.I.
Tel: (876) 960-3693
Email: fwong.jet@gmail.com