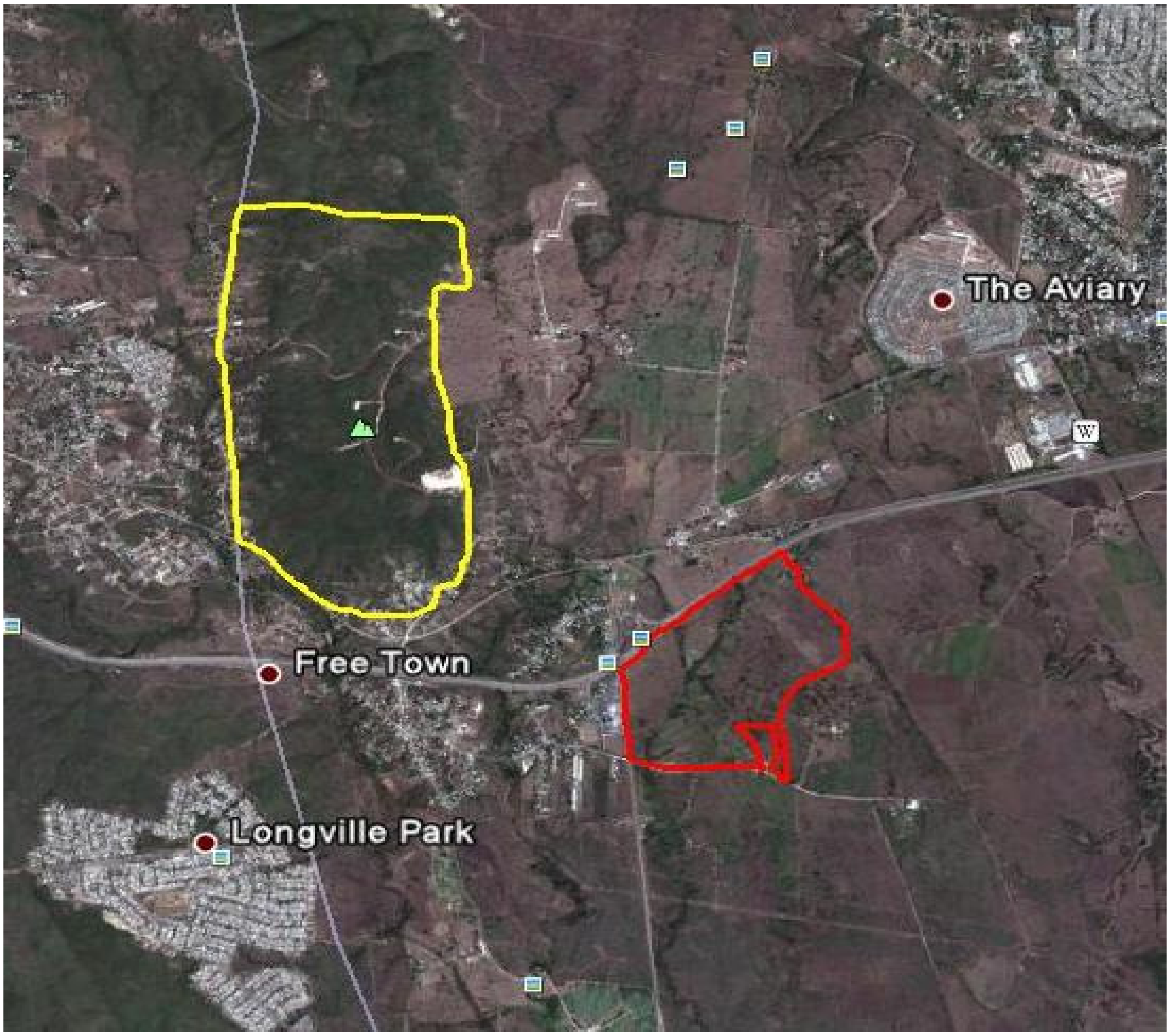
AIR DISPERSION MODELING REPORT
FOR THE PROPOSED
5000 MTPD CEMENT MANUFACTURING FACILITY
TO BE LOCATED AT BODLES, ST. CATHERINE, JAMAICA



NOVEMBER 2010

Prepared for:

CEMENT JAMAICA LIMITED

Prepared By:

AIR QUALITY CONSULTANTS LIMITED
27 Druesdale Avenue
Kingston 19

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

An air dispersion modeling exercise involving the AERMOD air dispersion model was conducted to predict the impact of the emissions on ambient air quality from the proposed cement manufacturing facility to be located in the Bodles area in the parish of St. Catherine, Jamaica. Other nearby sources including the Jamaica Public Service Company (JPS) Old Harbour Bay Power Plant, the Jamaica Energy Partners (JEP) Dr. Bird Power Barges, the Best Dressed Chicken Feed Mill facility, and the Jamaica Broilers Ethanol facility were also included in the modeling analysis in order to capture the cumulative air quality impact at the identified receptor locations.

The assessment identified the sources of air pollution at the proposed cement manufacturing facility, as well as those at JPS Old Harbour Bay, Dr. Bird Power Barges, Best Dressed Feed Mill and JB Ethanol facility. The contribution of mobile source emissions both on and off the facility was not considered in the modeling project, and moreover the emissions from these vehicles were considered as part of the background concentration value for particulates and nitrogen oxides.

The emission rates for particulate matter less than ten microns (PM_{10}), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and carbon monoxide (CO) from the proposed cement manufacturing facility were calculated based on the design pollutant rate and the volumetric flow rate associated with the vent from the respective fabric filter. The design pollutant rates were based on the World Bank standards for new cement manufacturing facilities, as well as new coal fired power plants. It should be noted that 400 mg/Nm^3 NO_x was used as the design pollutant rate for the cement kiln, while 80 mg/Nm^3 NO_x was used for the coal-fired power plant. For SO_2, 200 mg/Nm^3 design emission rate was used for the cement kiln, while 740 mg/Nm^3 was used for the coal-fired power plant. The PM design pollutant rate was less than 30 mg/Nm^3 for both the cement and coal-fired plants.

Emission rates for the other sources identified were obtained from the air dispersion modeling report as part of the application for an air pollutant discharge licence for the Jamaica Broilers Ethanol facility in Port Esquivel, St. Catherine. The air pollutant discharge licence documents were also reviewed to ensure the maximum emission rates.

Building and terrain effects were included as part of the modeling analysis, and the meteorological data set was defined using wind speed and direction from a weather station that was located just south of the proposed cement plant property boundary, and the use of other surface data (temperature, pressure, rainfall and relative humidity, solar radiation, cloud height and cover) from the Norman Manley International Airport (NMIA). The 2006 surface data was preprocessed, along with the 2006 upper air data that was obtained from the National Climatic Data Center (NCDC) to generate the meteorological input files required by the AERMOD air dispersion model.

The receptor grid system was then determined using a multi-tier grid system that included a 100-meter grid within 3 km from the centre of the proposed cement plant property boundary, a 500-meter grid spacing between 3 and 10 km from the property boundary centre, a two tier fence-line grid including a 25-meter grid spacing located at 100 m and a 50-meter grid spacing located at 200 m from the centre of the proposed plant boundary. Special receptors

inclusive of schools, health centres, churches, police stations, post offices and a court house, were included as part of 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 0.75, as recommended by Davis (2006). An ozone concentration of 107 ug/m^3, which is the maximum ozone concentration obtained at a site in Lauderwood, Clarendon for the year 2007, was applied to the OLM .

Table 1-1 shows the results of the model runs for the proposed cement manufacturing facility, and their comparisons with the Significant Impact concentrations and the ambient air quality standards. The Significant Impact concentrations are the incremental concentrations that should not be exceeded by any proposed facility. The other model targets are the predicted maximum concentrations plus the background concentrations in order to meet the National Ambient Air Quality Standard (NAAQS) and/or Guideline concentration.

It was determined that the predicted maximum concentrations as a result of the implementation of the proposed cement manufacturing facility (including the quarry footprint) would not exceed the concentrations that would have caused a significant air quality impact. Additionally, the proposed cement manufacturing facility also achieved compliance with the various ambient air quality standards for all applicable averaging periods.

Table 1-1 Summary of Model Results for the Proposed Cement Facility

Pollutant	Avg. Period	Background (µg/m^3)	Significant Impact Concentration (µg/m^3)	Jamaican NAAQS (µg/m^3)	Proposed Cement Plant Sources		
					Max Conc (µg/m^3)	UTME (m)	UTMN (m)
PM_{10}	24-hr	9	80	150	59	274385.27	1982412.37
	Annual	20	20	60	16	272744	1983247
NO_2	1-hr	0	N/A	400	369	272744	1991647
	24-hr	0	80	N/A	24.4	272744	1989147
	Annual	0	20	100	4.2	273444	1983447
SO_2	1-hr	0	N/A	700	424	272744	1989147
	24-hr	0	80	280	28	272244	1990647
	Annual	0	20	60	5	273344	1983147
CO	1-hr	0	2000	40000	3.44	272744	1991647
	8-hr	0	500	10000	0.67	272244	1990647

Additionally, it was determined that the contribution of the proposed cement manufacturing facility to the overall air quality impact in the local air shed was negligible (see Table 1-2). This was assessed based on the superior suite of air pollution control technology (fifty sets of fabric filters and a desulphurization unit) to be employed by the proposed facility, and the consequent reduced emission rates.

Table 1-2: Source Contributions to Peak Modeled Short-Term Concentrations

Facilities	Concentrations, µg/m^3						
	PM_{10} – 24h	**NO_2 – 1h**	**NO_2 – 24h**	**SO_2 – 1h**	**SO_2 – 24h**	**CO – 1h**	**CO – 8h**
Cemcorp	17.996	0	0.245	0.01	0.3	0.0002	0.006
JPS	1.3	0	0.028	6911.63	567.2	2128.4	0.052
JEP	0.4	0.0004	0.093	1056.36	84.5	107.5	0.003
Feed Mill	162.3	2904.74	679.157	0	0.0003	0	470.066
JB Ethanol	0.004	0.0236	0.02	0	0.0007	0	0.006
Totals	**182**	**2905**	**680**	**7968**	**652**	**2236**	**470**

1.0 INTRODUCTION

Cement Jamaica Limited proposes to construct and operate a cement manufacturing facility at Bodles, St. Catherine in the vicinity of the Best Dressed Chicken Feed Mill. As part of the Environmental Impact Assessment that is being conducted for the proposed facility, an air dispersion modelling analysis is being undertaken to determine the impact of the air pollutants from the proposed facility on the ambient air quality. A determination will also be made whether a significant air quality impact will be created based on the incremental contribution of the proposed facility to the cumulative air quality impact. According to the Natural Resources Conservation Authority (Air Quality) Regulations, 2006, a "significant air quality impact", means:

(a) the increment in the predicted average concentration of sulphur dioxide (SO_2), total suspended particulates (TSP), particulate matter less than ten microns (PM_{10}) or nitrogen dioxide (NO_2) is greater than an annual average of 21 $\mu g/m^3$ or a 24-hour average concentration of 80 $\mu g/m^3$; or

(b) the increment in the predicted average concentration of CO is greater than 500 $\mu g/m^3$ as a 8-hour average or 2000 $\mu g/m^3$ as a 1-hour average

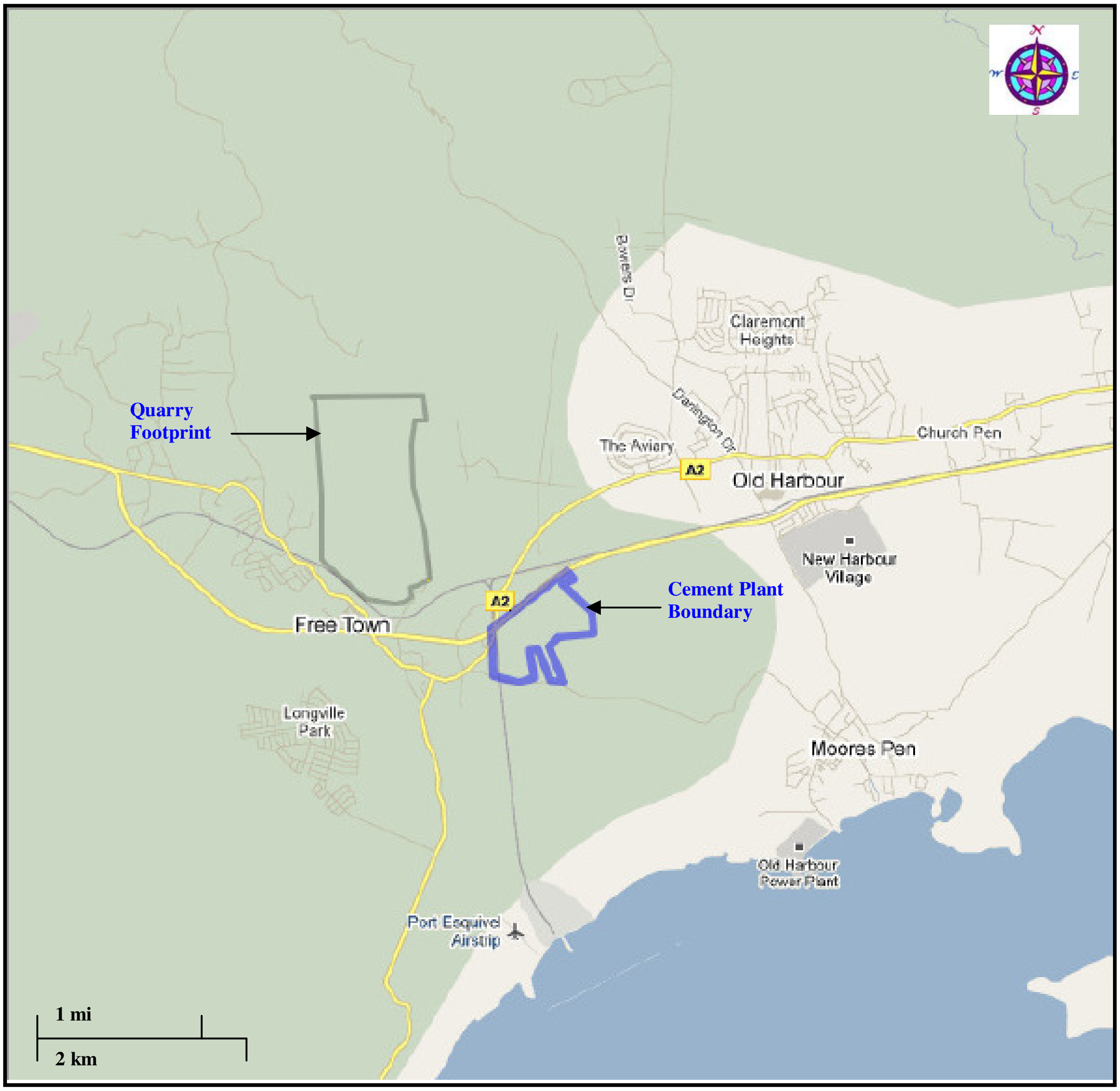
Additionally, the cumulative air quality impact of all sources within the project area (including the proposed cement manufacturing facility) will be determined.

This report describes the air dispersion modeling analysis for SO_2, PM_{10}, NO_2 and CO from the proposed facility only and the consequent comparison with the Jamaican National Ambient Air Quality Standards, as well as a determination whether the proposed facility's air emissions will create a significant air quality impact. The cumulative air quality impact analysis will also be included.

2.0 PROCESS DESCRIPTION & AIR POLLUTANT SOURCES

The proposed cement manufacturing facility will be located in the Bodles/Free Town area of St. Catherine, Jamaica (see Figure 1), in the vicinity of existing power plants, a feed mill and an ethanol dehydration facility. The proposed facility comprises the cement manufacturing facility and the limestone quarry footprint. The facility will be served by a power house that will provide process steam as well as electricity for its own use and for possible sale to the public grid.

Figure 2-1: Location Map



2.1 UNIT OPERATIONS

The cement production process commences with the acquisition of raw materials, with the main one, crushed limestone being transported from a nearby quarry via an overhead long conveyor belt. Once the raw materials are transported to the plant site, they are proportioned and blended to produce the raw meal for the pyro-processing in the kiln. Materials transport associated with dry raw milling systems can be accomplished by a variety of mechanisms, including screw conveyors, belt conveyors, drag conveyors, bucket elevators, air slide conveyors, and pneumatic conveying systems. The dry raw mix is pneumatically blended and stored in specially constructed silos until it is fed to the pyro-processing system.

The pyro-processing system being employed at Cement Jamaica Limited is a dry one that incorporates a pre-calciner/pre-heater at the back end of the rotary kiln. The raw material mix enters the kiln at the elevated end, with the combustion fuel to be introduced into the lower end of the kiln in a counter-current manner. The materials are continuously and slowly moved to the lower end of the kiln by rotation. As they move down the kiln, the raw materials are changed to cementitious or hydraulic minerals as a result of the increasing temperature within the kiln. Coal would be the fuel of choice for the cement manufacturing facility and this will go through its usual preparation stages prior to its use.

The pre-calciner/pre-heater vessels are arranged vertically, in series, and are supported by a structure known as the preheater tower. Hot exhaust gases from the rotary kiln pass counter-currently through the downward-moving raw materials in the preheater vessels. This pre-calciner/pre-heater system contributes to production efficiencies, as well as assisting with the increased efficiency in the collection of particulates in the main fabric filter.

The final step in cement manufacturing involves a sequence of blending and grinding operations that transforms clinker to cement. Gypsum is added to the clinker during the grinding process to control the cement setting time, and other specialty chemicals are added as needed to impart specific product properties. This finish milling will be accomplished in a closed circuit system, with product sizing by air separation. The finished product will then be stored and sent for packing in various dimensions and weights.

The entire cement manufacturing facility will be served by a dedicated power house that will generate process steam and electricity for plant usage, and possible sale of electricity to the generating grid. The power house will boast three 15 MW generating sets, that combust coal, with another 9 MW waste heat recovery power generating unit.

2.2 POTENTIAL AIR EMISSIONS

The primary air pollutant to ambient air quality from the proposed cement manufacturing facility will be particulates. Secondary air pollutants will include NOx, SO_2 and CO.

2.2.1 Particulate Pollution and Countermeasures

It is expected that particulate emissions will contribute the most to air pollution from the cement plant. The total uncontrolled particulate emissions from the entire facility is estimated to be 78kg/h, with the highest emission point being the 90m high pre-heater stack that will emit 27kg/h or 35% of the total expected particulate emissions from the entire plant. Consequently a major effort in reducing air pollution loads from the proposed cement manufacturing plant will be focussed on particulates.

In order to effectively control particulates at each dust emission point, specialized equipment will be incorporated in the design of the plant. The generation of particulates during material transfer points will be minimized, and exhaust streams containing dusts will be purified by highly efficient filters, while the dust collected by the filters will be recycled into the relevant unit operation. The entire facility will utilize fifty sets of high-efficient fabric filters. All particulate gas streams after treatment will be reduced to less than 30 mg/m^3 dust concentration.

2.2.2 Gaseous Pollutants and Countermeasures

The main gaseous pollutants to be emitted from the facility will include SO_2, NOx, and CO.

2.2.2.1 SO_2 Countermeasures

SO_2 will be emitted mainly from the burning of coal containing sulphur in rotary kiln, as well as the sulphur brought in with the raw meal while calcining clinker. The inclusion of the pre-calciner in the design of the plant will serve to enable the sufficient contact between materials and gases in order to better the sulphur absorption process and reduce SO_2 emission. This method has the potential to absorb more than 99% of sulphur compounds, and will result in a SO_2 emission rate less than 200 mg/m^3.

The SO_2 emissions from the coal fired generating units will be controlled by a desulphurization unit that will reduce the emissions to below 740 mg/m^3.

2.2.2.2 NO_X Countermeasures

NOx will be mainly generated during the high-temperature calcination of materials in the rotary kiln, and the amount being formed depends greatly on the combustion temperature. The higher the burning temperature and the more intense the oxygen concentration, the longer the reaction time would be and thereby generating more NOx emissions. Therefore, a specific strategy to reduce NOx emissions would be to utilize the calining technology, which transfer approximately 60% of coal into the pre-calciner that has a lower temperature. This technology, along with the possible inclusion of other treatment will reduce the NOx emissions from the cement process to less than 400 mg/m^3.

NOx emissions from the coal fired steam turbines will be controlled to less than 80 mg/m^3.

2.2.2.3 CO Countermeasures

CO emissions will be controlled from the entire facility based on the combustion design efficiencies to be achieved at the plant. The entire plant will be designed to achieve a maximum CO emission rate of 2.9 mg/m^3 from both the power generating sets and the cement plant.

3.0 AIR DISPERSION MODELING METHODOLOGY

3.1 MODELING 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 dispersion model, developed by Lakes Environmental. 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.

3.2 MODEL INPUTS

3.2.1 Source Emissions

A critical step for conducting air dispersion modeling is to quantify the emissions from the various sources at the facility. The emission rates from the sources identified were estimated in accordance with the recommendation outlined in the Ambient Air Quality Guideline Document. According to Davis & Associates (2006), emission rates should be estimated in the following order of preference:

- Continuous emissions monitoring data
- Stack Emission Testing data
- Manufacturer's emission data
- Mass balance calculations
- Emission factors
- Engineering calculations

Table 3-1 shows the source information data determined for the proposed cement manufacturing facility, while Table 3-2 displays the emission rates that were calculated based on the use of manufacturer's emission specifications.

Source information data for the Best Dressed Feed Mill, JB Ethanol dehydration facility and power plants operated by Jamaica Public Service Company and Jamaica Energy Partners are identified in Table 3-3, while Table 3-4 include the corresponding emission rates. These emission rates were based on the maximum emission rates as stipulated in the air pollutant discharge licences for the respective facility.

The locations of the sources at the proposed cement manufacturing facility were obtained from plant drawings and are identified in Figure 3-1.

Table 3-1: Source Information Data for Proposed Cement Plant

Source ID	Type	Description	X Coord, m	Y Coord, m	Elevation, m	Height, m	Diameter, m	Exit Velocity, m/s	Exit Temperature, K
PAREA1	AREA	Quarry - Drilling, loading, unloading, hauling	271733.33	1983463.33	39.57	5	N/A	N/A	N/A
QCP	POINT	Quarry crushing plant	272414.05	1984565.14	49.6	10.5[a]	1	13.98	303.15
CBELT	POINT	Bag Filter stack on Long Conveyor Belt to factory	273369	1983930	21.3	25	0.5	12.73	303.15
RLCSP	POINT	Limestone/clay storage	273751.87	1982899.21	18	27	0.56	10.15	303.15
RRCGSP	POINT	Additives and coal preblending	273994.94	1982635.88	18	8[b]	0.37	152.9	303.15
COALMV	POINT	Coal mill vent	274088.23	1982834.24	19.27	40	1.4	23.28	373.15
COALBV	POINT	Pulverized coal bin vent	274073.7	1982700.91	18.79	12	0.6	4.24	303.15
CCV1	POINT	#1 Coal crusher vent	274095.23	1982826.24	19.51	30	1	22.82	343.15
CCV2	POINT	#2 Coal crusher vent	274104.23	1982826.24	19.81	30	1	22.82	343.15
CPFBV1	POINT	#1 Coal pulverizer feed bin vent	274126.23	1982832.24	19.68	28	0.5	5.7	303.15
CPFBV2	POINT	#2 Coal pulverizer feed bin vent	274245.23	1982832.24	19.7	28	0.5	5.7	303.15
CPFBV3	POINT	#3 Coal pulverizer feed bin vent	274245.23	1982754.24	19	28	0.5	5.7	303.15
CPFBV4	POINT	#4 Coal pulverizer feed bin vent	274108.54	1982608.07	18	28	0.5	5.7	303.15
PPMS	POINT	Power plant main stack	273945.78	1982528.71	16.53	120	4.5	6.29	413.15
RMLCFBV	POINT	Raw mill limestone/clay feed bin vent	273974.23	1982834.24	19	38	0.5	12.73	303.15
RMRMEBV	POINT	Raw mill red mud and standby feed bin vent	273929.23	1982875.24	18.82	34	0.45	21	303.15
RMFBELT	POINT	Rawmill feed belt	273940.23	1982834.24	18.34	12	0.5	34.43	303.15
HOMSILV	POINT	Homogenizing silo vent	273995.23	1982837.24	19	71	0.6	17.68	333.15
HOMSILD	POINT	Homogenizing silo discharge	273991.23	1982830.24	19	10	0.6	11.95	333.15
KMS	POINT	Kiln main stack	274111.23	1982865.24	20	90	4.5	15.72	423.15
CCV	POINT	Clinker cooler vent	274066.23	1982876.24	19	40	3.75	18.11	473.15
CSPC	POINT	Clinker silo pan conveyor	274207.23	1982868.24	20	4	0.6	70.74	333.15
CSTOP	POINT	Clinker silo top	274212.23	1982868.24	20	27	0.4	66.37	333.15
CSBOTM	POINT	Clinker silo (bottom belts)	274212.23	1982846.24	19.93	8	0.5	101.86	333.15
CCFBV	POINT	Cement mill clinker feed bin vent	274336.23	1982952.24	20.19	36	0.5	17.21	303.15
CGFBV	POINT	Cement mill gypsum feed bin vent	274336.23	1982942.24	20.03	36	0.5	5.7	303.15
CLFBV	POINT	Cement mill limestone feed bin vent	274336.23	1982931.24	19.71	36	0.5	5.7	303.15
CSFBV	POINT	Cement mill standby feed bin vent	274336.23	1982921.24	19.37	36	0.5	5.7	303.15

Source ID	Type	Description	X Coord, m	Y Coord, m	Elevation, m	Height, m	Diameter, m	Exit Velocity, m/s	Exit Temperature, K
CMDV1	POINT	#1 Cement mill discharge vent	274310.23	1982893.24	19.33	45	1.25	16.5	383.15
CMDV2	POINT	#2 Cement mill discharge vent	274328.23	1982893.24	19	45	1.25	16.5	383.15
CMDV3	POINT	#3 Cement mill discharge vent	274357.23	1982893.24	19.11	45	1.25	16.5	383.15
CMSV1	POINT	#1 Cement mill separator vent	274450.23	1982893.24	19	45	1.25	36.22	383.15
CMSV2	POINT	#2 Cement mill separator vent	274464.23	1982893.24	19	45	1.25	36.22	383.15
CMSV3	POINT	#3 Cement mill separator vent	274492.23	1982893.24	19	45	1.25	36.22	383.15
CSTV1	POINT	#1 Cement mill silo top vent	274321.23	1982809.24	18.99	40	0.5	14.01	333.15
CSTV2	POINT	#2 Cement mill silo top vent	274342.23	1982809.24	18.73	40	0.5	14.01	333.15
CSTV3	POINT	#3 Cement mill silo top vent	274362.23	1982809.24	18.64	40	0.5	14.01	333.15
CSTV4	POINT	#4 Cement mill silo top vent	274321.23	1982788.24	18.96	40	0.5	14.01	333.15
CSTV5	POINT	#5 Cement mill silo top vent	274342.23	1982788.24	18.26	40	0.5	14.01	333.15
CSTV6	POINT	#6 Cement mill silo top vent	274362.23	1982788.24	18	40	0.5	14.01	333.15
CSDV1	POINT	#1 Cement silo discharge vent	274461.23	1982809.24	18	12.5	0.5	8.2	333.15
CSDV2	POINT	#2 Cement silo discharge vent	274482.23	1982809.24	18.26	12.5	0.5	8.2	333.15
CSDV3	POINT	#3 Cement silo discharge vent	274502.23	1982809.24	18.64	12.5	0.5	8.2	333.15
CSDV4	POINT	#4 Cement silo discharge vent	274461.23	1982788.24	18	12.5	0.5	8.2	333.15
CSDV5	POINT	#5 Cement silo discharge vent	274482.23	1982788.24	18	12.5	0.5	8.2	333.15
CSDV6	POINT	#6 Cement silo discharge vent	274502.23	1982788.24	18	12.5	0.5	8.2	333.15
CPMV1	POINT	#1 Cement packing machine vent	274327.23	1982747.24	18.76	18	0.7	22.06	333.15
CPMV2	POINT	#2 Cement packing machine vent	274337.23	1982747.24	18.43	18	0.7	22.06	333.15
CPMV3	POINT	#3 Cement packing machine vent	274347.23	1982747.24	18.09	18	0.7	22.06	333.15
CPMV4	POINT	#4 Cement packing machine vent	274357.23	1982747.24	18	18	0.7	22.06	333.15
CPMV5	POINT	#5 Cement packing machine vent	274367.23	1982747.24	18	18	0.7	22.06	333.15
CPMV6	POINT	#6 Cement packing machine vent	274377.23	1982747.24	18	18	0.7	22.06	333.15
CEMPFBV1	POINT	#1 Cement packing feed bin vent	274340.23	1982778.24	18.33	26	0.5	5.7	333.15
CEMPFBV2	POINT	#2 Cement packing feed bin vent	274343.23	1982778.24	18.23	26	0.5	5.7	333.15
CEMPFBV3	POINT	#3 Cement packing feed bin vent	274337.23	1982775.24	18.43	26	0.5	5.7	333.15
CEMPFV4	POINT	#4 Cement packing feed bin vent	274346.23	1982775.24	18.13	26	0.5	5.7	333.15
CEMPFBV5	POINT	#5 Cement packing feed bin vent	274346.23	1982772.24	18.13	26	0.5	5.7	333.15
CEMPFBV6	POINT	#6 Cement packing feed bin vent	274337.23	1982772.24	18.43	26	0.5	5.7	333.15

a Release height increased by 2m above original design value
b Release height increased by 5m above original design value

Table 3-2: Emission Rates for Proposed Cement Plant

Source ID	Description	PM_{10} Emission (g/s)	SO_2 Emission (g/s)	NOx Emission (g/s)	CO Emission (g/s)
CBELT	Quarry Activities (Long Belt Conveyor)	0.0619			
QCP	Quarry Crushing Plant	0.2719			
RLCSP	Limestone/Clay Storage	0.0619			
RRCGSP	Additives and Coal Preblending	0.4071			
COALMV	Coal Mill Vent	0.7209			
COALBV	Pulverised Coal Bin Vent	0.0297			
CCV1	#1 Coal Crusher vent	0.3920			
CCV2	#2 Coal Crusher vent	0.3920			
CPFBV1	#1 Coal pulverizer feed bin vent	0.0277			
CPFBV2	#2 Coal pulverizer feed bin vent	0.0277			
CPFBV3	#3 Coal pulverizer feed bin vent	0.0277			
CPFBV4	#4 Coal pulverizer feed bin vent	0.0277			
PPMS	Power Plant main stack (3 units)	1.4914	48.9153	5.2881	0.1917
RMLCFBV	Raw mill limestone/clay feed bin vent	0.0619			
RMRMFBV	Raw mill red mud and standby feed bin vent	0.0827			
RMFBELT	Raw mill feed belt	0.1674			
HOMSILV	Homogenizing silo vent	0.1127			
HOMSILD	Homogenizing silo discharge	0.0762			
KMS	Kiln main stack	4.4343	32.2695	64.539[a]	0.4679
CCV	Clinker cooler vent	3.1725			
CSPC	Clinker silo pan conveyor	0.4506			
CSTOP	Clinker silo (top)	0.1879			
CSBOTM	Clinker silo (bottom belts)	0.4506			
CCFBV	Cement Mill Clinker feed bin vent	0.0837			
CGFBV	Cement Mll Gypsum feed bin vent	0.0277			
CLFBV	Cement Mill Limestone feed bin vent	0.0277			
CSFBV	Cement Mill Standby feed bin vent	0.0277			
CMDV1	#1 Cement mill discharge vent	0.3967			
CMDV2	#2 Cement mill discharge vent	0.3967			
CMDV3	#3 Cement mill discharge vent	0.3967			
CMSV1	#1 Cement mill separator vent	0.8708			
CMSV2	#2 Cement mill separator vent	0.8708			
CMSV3	#3 Cement mill separator vent	0.8708			
CSTV1	#1 Cement silo top vent	0.0620			
CSTV2	#2 Cement silo top vent	0.0620			
CSTV3	#3 Cement silo top vent	0.0620			
CSTV4	#4 Cement silo top vent	0.0620			
CSTV5	#5 Cement silo top vent	0.0620			
CSTV6	#6 Cement silo top vent	0.0620			
CSDV1	#1 Cement silo discharge vent	0.0363			
CSDV2	#2 Cement silo discharge vent	0.0363			
CSDV3	#3 Cement silo discharge vent	0.0363			
CSDV4	#4 Cement silo discharge vent	0.0363			
CSDV5	#5 Cement silo discharge vent	0.0363			
CSDV6	#6 Cement silo discharge vent	0.0363			

Stack ID	Description	PM_{10} Emission (g/s)	SO_2 Emission (g/s)	NOx Emission (g/s)	CO Emission (g/s)
CPMV1	#1 Cement packing machine vent	0.1913			
CPMV2	#2 Cement packing machine vent	0.1913			
CPMV3	#3 Cement packing machine vent	0.1913			
CPMV4	#4 Cement packing machine vent	0.1913			
CPMV5	#5 Cement packing machine vent	0.1913			
CPMV6	#6 Cement packing machine vent	0.1913			
CPFBV1	#1 Cement packing feed bin vent	0.0252			
CPFBV2	#2 Cement packing feed bin vent	0.0252			
CPFBV3	#3 Cement packing feed bin vent	0.0252			
CPFBV4	#4 Cement packing feed bin vent	0.0252			
CPFBV5	#5 Cement packing feed bin vent	0.0252			
CPFBV6	#6 Cement packing feed bin vent	0.0252			

a NOx design specification for cement kiln adjusted from 800 mg/Nm^3 to 400 mg/Nm^3 in order to achieve compliance with NEPA's NOx 1-h Ambient Guideline Concentration

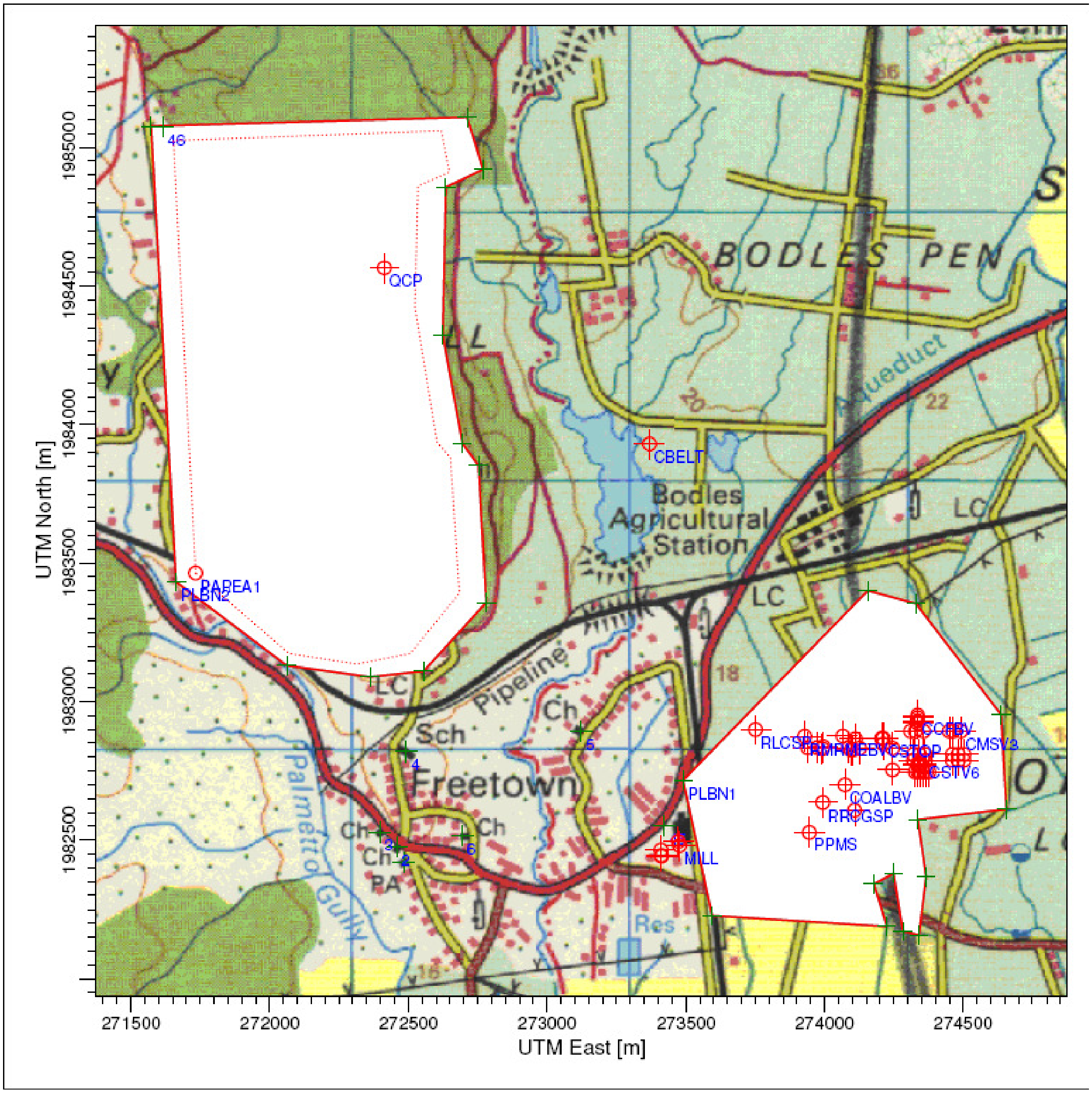
Table 3-3: Source Information Data for Nearby Existing Facilities

Source ID	Type	Description	X Coord, m	Y Coord, m	Elevation, m	Height, m	Diameter, m	Exit Velocity, m/s	Exit Temperature, K
JEP2	POINT	JEP2 Generators	276706	1980109	0.2	35	2.42	36.38	649.15
JEP1_6	POINT	JEP Existing Barge - 6 Generators	276813	1979972	3.9	30	2.66	43.01	602.15
JEP1_7	POINT	JEP Existing Barge - DG7	276772	1980003	3.97	30	1.08	43.01	602.15
JEP1_8	POINT	JEP Existing Barge - DG8	276772	1980003	3.97	30	1.08	43.01	602.15
JPS1	POINT	JPS Unit #1	276907	1980368	2	45.72	2.48	12.61	438.15
JPS2	POINT	JPS Unit 2	276895	1980346	2	45.72	2.84	15.04	438.15
JPS3	POINT	JPS Unit 3	276866	1980334	2	45.72	2.93	21.61	431.15
JPS4	POINT	JPS Unit 4	276849	1980310	2	45.72	2.93	21.61	431.15
FEEDE	POINT	Feed Mill Engine	273410	1982465	15.44	2.4	0.35	10	550
FEEDB1	POINT	Feed Mill Boiler 1	273412	1982445	15.27	9.14	0.46	15.3	449.5
FEEDB2	POINT	Feed Mill Boiler 2	273413	1982442	15.23	6.1	0.35	15.3	494.2
FEEDGR	POINT	Feed Mill Grain Receiving	273473	1982496	15.2	15.24	0.21	15	330
MILL	POINT	Feed Mill	273478	1982481	14.72	10.36	0.2	15	330
JBE	POINT	JB Ethanol Engine	274434	1979825	4	6.1	0.61	10	500
JBE1	POINT	JB Ethanol Boiler 1	274426	1979787	5	19.91	0.61	20.33	463
JBE2	POINT	JB Ethanol Boiler 2	274428	1979784	5	19.91	0.61	20.33	463
JBE3	POINT	JB Ethanol Boiler 3	274432	1979780	5	19.91	0.61	20.33	463

Table 3-4: Emission Rates for Nearby Existing Facilities

Source ID	Description	PM_{10} Emission (g/s)	SO_2 Emission (g/s)	NOx Emission (g/s)	CO Emission (g/s)
JEP2	JEP2 Generators	7.8	122.7	210	10.2
JEP1_6	JEP Existing Barge - 6 Generators	7.44	118.4	226.8	10.8
JEP1_7	JEP Existing Barge - DG7	1.24	19.7	37.8	1.8
JEP1_8	JEP Existing Barge - DG8	1.24	19.7	37.8	1.8
JPS1	JPS Unit #1	8.99	149.64	8.22	0.29
JPS2	JPS Unit 2	13.11	287.99	21.29	4.59
JPS3	JPS Unit 3	15.13	267.25	53.03	38.34
JPS4	JPS Unit 4	10.58	277.52	33.08	267.2
FEEDE	Feed Mill Engine	0.09175	0.36084	2.936	0.78
FEEDB1	Feed Mill Boiler 1	0.094	4.6057	0.517	0.047
FEEDB2	Feed Mill Boiler 2	0.01514	0.4441	0.1514	0.03785
FEEDGR	Feed Mill Grain Receiving	0.4			
MILL	Feed Mill	1.91			
JBE	JB Ethanol Engine	0.092	0.361	2.936	0.78
JBE1	JB Ethanol Boiler 1	0.26	7.97	1.429	0.13
JBE2	JB Ethanol Boiler 2	0.26	7.97	1.429	0.13
JBE3	JB Ethanol Boiler 3	0.13	3.985	0.715	0.065

Figure 3-1: Map showing the Proposed Cement Plant Sources



3.2.1.1 Comparison of Proposed Emission Rates with Emission Standards

Table 3-5 highlights the emission standards to be applied to the proposed cement manufacturing facility. These standards are based on the NRCA (Air Quality) Regulations, 2006.

Since the entire proposed cement manufacturing facility will be designed to accomplish a PM emission standard of 30 mg/m^3, it's therefore concluded that compliance would be achieved. Also, the same 30 mg/m^3 PM emissions will be applied to the coal fired power generating facility, and with a fuel (coal) heat input of 27.95 MJ/kg and a coal usage of 6.55 kg/s, a PM emission rate of 8.15 ng/J input is obtained, which complies with the stipulated standard.

Table 3-5: Emission Rate Comparison with Standards

Facility	Pollutant	Emission Standard	Emission Rate, mg/m^3 or ng/J
New Cement Manufacturing Plant	PM	100 mg/m^3 (20°C, 101.3 kPa, dry gas) from clinker cooler; 50 mg/m^3 from kilns, finish grinders and all other sources (20°C, 101.3 kPa, dry gas)	30 mg/m^3 for all unit operations
New Fuel Combustion - Coal Fired < 70 MW	PM	60 ng/J input, except during start-up, shut-down, soot-blowing or malfunction for each stack	8.15 ng/J
	SO_2	520 ng/J input	267.2 ng/J
	NOx	260 ng/J	28.9 ng/J

Also, the coal fired power generating facility will be designed to achieve a maximum emission rate of 740 mg/m^3 SO_2 and 80 mg/m^3 NOx. When these values are applied to a fuel (coal) heat input of 27.95 MJ/kg and a coal usage of 6.55 kg/s, emission rates of 267.2 and 28.9 ng/J are respectively determined and are in compliance with the designated emission standard.

3.2.1.2 Building Downwash Effects

Buildings located close to point sources (see Figure 3-2) may significantly affect the dispersion of the pollutants from the source. If the point source is 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.

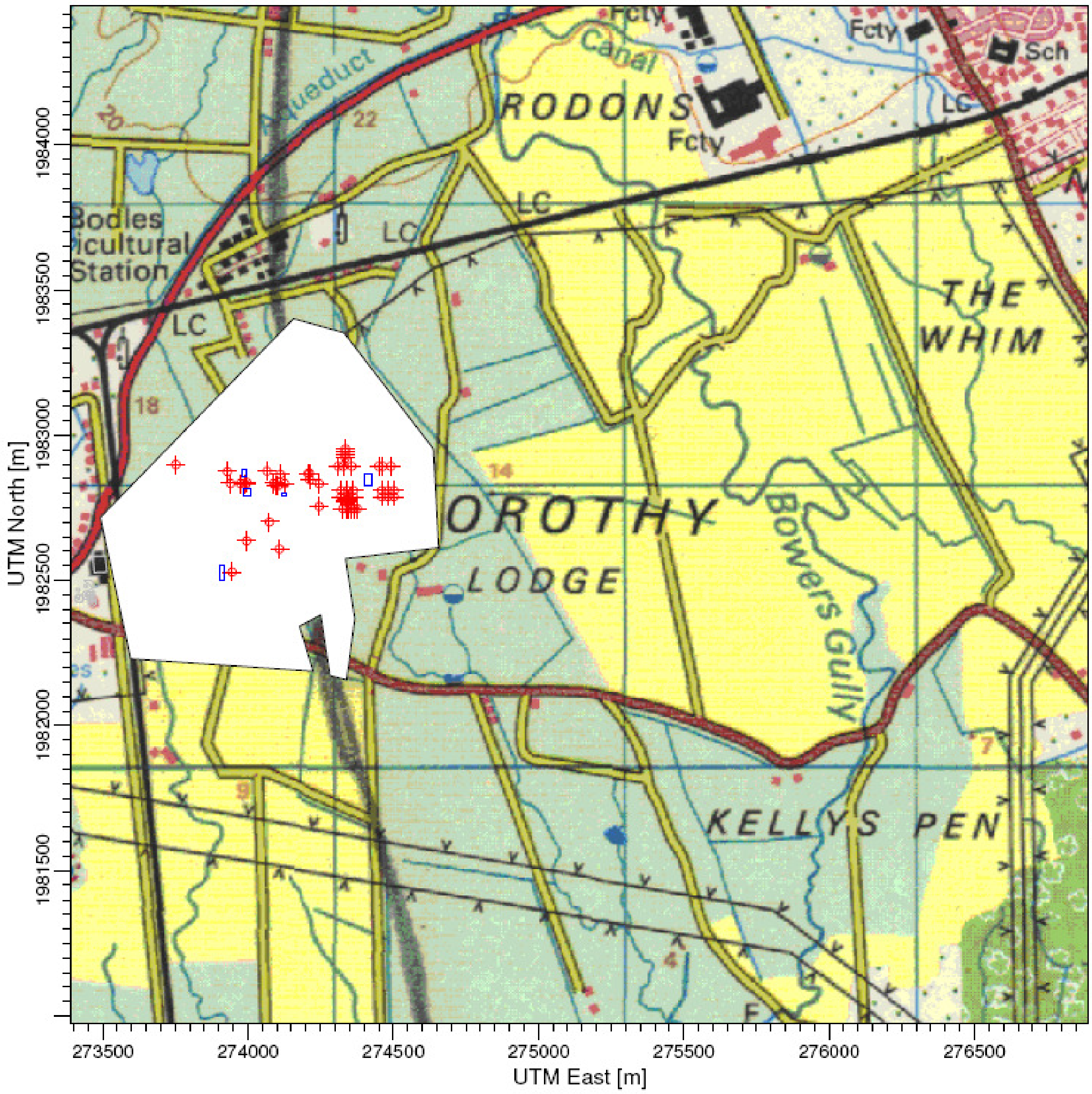
The GEP height formula is: $Hg = H + 1.5*L$ where Hg is the GEP height measured from ground level elevation at the base of the point source, H is the height of nearby structure(s) measured from the ground level elevation at the base of the point source, and L is the lesser dimension, height or projected width, of the nearby structure(s).

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

Figure 3-2: Proposed Facility Point Sources and Main Buildings

PROJECT TITLE:

Facility Point Sources & Main Buildings



COMMENTS:	SOURCES: 57	COMPANY NAME: **AIR QUALITY CONSULTANTS LIMITED**	
	RECEPTORS: **5887**	MODELER:	
		SCALE: 1:22,000 (0 — 0.5 km)	
			PROJECT NO.:

AERMOD View - Lakes Environmental Software   C:\Users\haughton\Documents\Lakes\AERMOD View\corptsp.isc 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 (and process vessels) 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.

Table 3-6 shows the calculated GEP stack heights and since at least one of the existing stack heights is below the corresponding calculated GEP stack height, the dispersion model had to address building downwash issues, utilizing the building heights and projected building widths that were calculated using part two of the BPIP program.

Table 3-6: Calculated GEP Stack Heights

PRELIMINARY* GEP STACK HEIGHT RESULTS TABLE
(Output Units: meters)

Stack Name	Stack Height	Stack-Building Base Elevation Differences	GEP** EQN1	Preliminary* GEP Stack Height Value
QCP	10.50	N/A	0.00	65.00
RLCSP	27.00	N/A	0.00	65.00
RRCGSP	8.00	2.00	125.10	125.10
COALMV	40.00	0.27	136.60	136.60
COALBV	12.00	2.79	125.38	125.38
CCV1	30.00	0.51	136.48	136.48
CCV2	30.00	0.81	136.04	136.04
CPFBV1	28.00	0.68	135.37	135.37
CPFBV2	28.00	0.97	81.53	81.53
CPFBV3	28.00	N/A	0.00	65.00
CPFBV4	28.00	2.00	133.00	133.00
PPMS	120.00	0.53	134.47	134.47
RMLCFBV	38.00	0.00	136.07	136.07

Stack Name	Stack Height	Stack-Building Base Elevation Differences	GEP** EQN1	Preliminary* GEP Stack Height Value
RMRMEBV	34.00	-0.18	136.18	136.18
RMFBELT	12.00	-0.66	137.76	137.76
HOMSILV	71.00	0.00	135.10	135.10
HOMSILD	10.00	0.00	129.99	129.99
KMS	90.00	1.00	131.76	131.76
CCV	40.00	0.00	134.96	134.96
CSPC	4.00	N/A	0.00	65.00
CSTOP	27.00	N/A	0.00	65.00
CSBOTM	8.00	N/A	0.00	65.00
CCFBV	36.00	1.46	81.04	81.04
CGFBV	36.00	1.30	81.20	81.20
CLFBV	36.00	0.98	81.52	81.52
CSFBV	36.00	0.64	81.86	81.86
CMDV1	45.00	0.60	81.90	81.90
CMDV2	45.00	0.27	82.23	82.23
CMDV3	45.00	0.38	82.12	82.12
CMSV1	45.00	0.27	82.23	82.23
CMSV2	45.00	0.27	82.23	82.23
CMSV3	45.00	0.27	82.23	82.23
CSTV1	40.00	0.26	82.24	82.24
CSTV2	40.00	0.00	82.50	82.50
CSTV3	40.00	-0.09	82.59	82.59
CSTV4	40.00	0.23	82.27	82.27
CSTV5	40.00	-0.47	82.97	82.97
CSTV6	40.00	-0.73	83.23	83.23
CSDV1	12.50	-0.73	83.23	83.23
CSDV2	12.50	-0.47	82.97	82.97
CSDV3	12.50	-0.09	82.59	82.59
CSDV4	12.50	-0.73	83.23	83.23
CSDV5	12.50	-0.73	83.23	83.23
CSDV6	12.50	-0.73	83.23	83.23
CPMV1	18.00	0.03	82.47	82.47
CPMV2	18.00	-0.30	82.80	82.80
CPMV3	18.00	-0.64	83.14	83.14
CPMV4	18.00	-0.73	83.23	83.23
CPMV5	18.00	-0.73	83.23	83.23
CPMV6	18.00	-0.73	83.23	83.23
CEMPFBV1	26.00	-0.40	82.90	82.90
CEMPFBV2	26.00	-0.50	83.00	83.00
CEMPFBV3	26.00	-0.30	82.80	82.80
CEMPFV4	26.00	-0.60	83.10	83.10
CEMPFBV5	26.00	-0.60	83.10	83.10
CEMPFBV6	26.00	-0.30	82.80	82.80
CBELT	25.00	N/A	0.00	65.00

* Results are based on Determinants 1 & 2 on pages 1 & 2 of the GEP Technical Support Document. Determinant 3 may be investigated for additional stack height credit. Final values result after Determinant 3 has been taken into consideration.

** Results were derived from Equation 1 on page 6 of GEP Technical Support Document. Values have been adjusted for any stack-building base elevation differences.

3.2.2 Meteorological Data

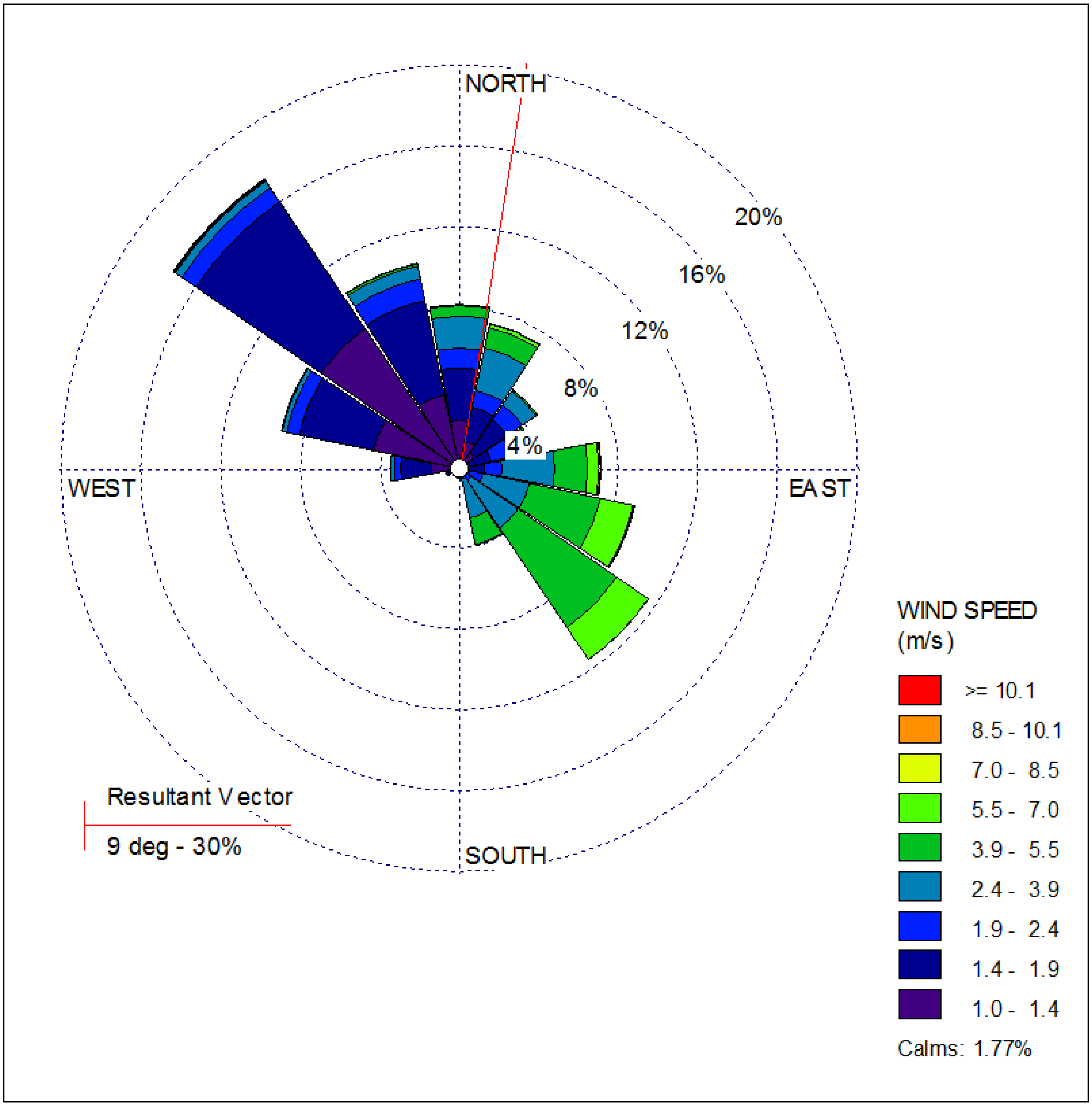
The AERMOD model requires hourly surface data values for wind speed, wind direction, temperature, rainfall, relative humidity, pressure, cloud cover and ceiling height and solar radiation and at least once daily mixing height data. Wind data (direction and speed) for year 2006 was utilized from a weather station located at Kelly Pen, less than 1 km east of the proposed plant site location. The data was supplemented with other surface data (temperature, rainfall, relative humidity, pressure, cloud cover and height, and solar radiation) from the Norman Manley International Airport (NMIA). The data obtained from the NMIA had some missing information, but were in excess of 90% complete. The missing data were filled using the guidance in "*Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models*" (Atkinson, 1992).

Upper air data for year 2006 were then obtained from the NCDC and these were utilized to generate the required mixing heights for the AERMOD model.

Both data files for the surface and mixing heights were then used to generate the meteorological file required by the AERMOD dispersion model using the AERMET meteorological preprocessor programme. This AERMET programme has 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 2006 meteorological preprocessed 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 northwest, with the secondary wind direction being from the southeast. This means that the emissions plume will be dispersed mainly in the southeast direction, and secondarily in the northwest direction from the proposed plant site.

Figure 3-3: Wind Rose Plot - (2006) Preprocessed Met Data



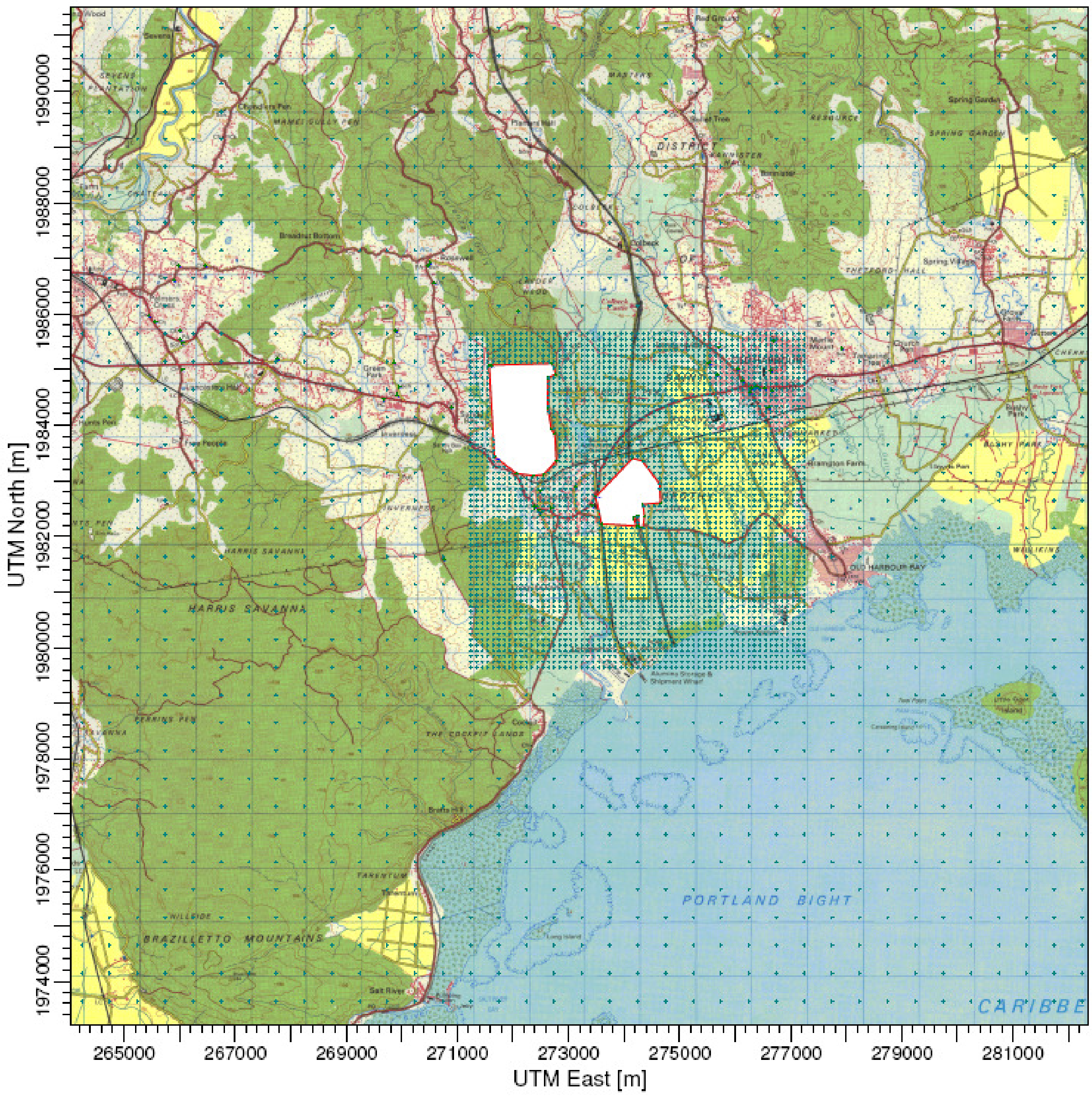
3.2.3 Model Domain, Receptor Network and Terrain Considerations

The selected model domain was 20 km in both the east-west and north-south directions, with the centre of the domain being the centre of the proposed cement manufacturing plant site, with coordinates 274244 m UTME and 1982647 m UTMN. Figure 3-4 shows the model domain that was utilized in the project, including the receptor grid and the plant boundary. The model domain is overlain on a Jamaica Metric Grid 1:50,000 topographic map.

Figure 3-4: Model Domain showing the Receptor Grid

PROJECT TITLE:

Cemcorp Model Domain



COMMENTS:	SOURCES: 75	COMPANY NAME: AIR QUALITY CONSULTANTS LIMITED	
	RECEPTORS: 5887	MODELER:	
		SCALE: 1:115,000 (0 — 4 km)	
			PROJECT NO.:

AERMOD View - Lakes Environmental Software

C:\Users\haughton\Documents\Lakes\AERMOD View\CJLpm10P.isc

3.2.3.1 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 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 centre of the proposed cement manufacturing facility. A two-tiered fence line grid was also included with spacing of 25 m and 50 m and at a distance of 100 m and 200 m away, respectively from the proposed facility fence line. Certain special receptor locations were also defined, including schools, church buildings, postal agencies, health centres, post offices, police stations and a courthouse.

The entire receptor network locations include the following:

- A 100-meter spaced grid within 3 km from the subject source; and
- A 500-meter spaced grid between 3 and 10 km from the subject source; and,
- A 25-meter spaced fence-line grid 100 m away from the facility fence line
- A 50-meter spaced fence-line grid 200 m away from the facility fence line
- A total of 45 special receptors that include schools, church buildings, postal agencies, health centres, post offices, police stations and a courthouse (see Table 3-7).

A total of 5,887 receptors were considered, and some of these are graphically depicted in Figure 3-3.

3.2.3.2 Terrain Considerations

The classification of the land use in the vicinity of the proposed cement facility is needed 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 rural dispersion coefficient be selected for this modeling project.

According to the land-use type methodology, a 3 km radius circle was circumscribed about the centre of the proposed cement facility. Then using the Auer land use types, only 33% (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). The majority of the area was cultivated land, and hence the rural option was selected.

Table 3-7: Special Receptors

Description	X Coordinate, m	Y Coordinate, m	Elevation, m
Freetown Postal Agency	272484	1982422	22.15
Freetown Church	272459	1982476	24.53
Freetown Church	272397	1982529	25.2
Freetown Primary School	272492	1982820	26.93
Freetown Church	273122	1982894	20.47
Freetown Church	272695	1982517	15.32
Sandy Bay Church	270905	1984336	47.17
Green Park Health Centre	269678	1984465	40.83
Green Park Church	269919	1984552	41.81
Green Park Primary & Junior High School	269956	1984693	42.9
Green Park Church	269861	1985136	53.71
Green Park Church	269889	1985700	62.7
Lancasters Church	267755	1985199	77.47
Lancasters Church	266052	1985000	93.4
Cross Primary & Junior High School	266046	1985479	93
Palmer's Cross Postal Agency	266015	1985541	93
Palmer's Cross Church	266008	1985703	93.01
Palmer's Cross Church	265567	1985858	96.09
Palmer's Cross Church	265437	1985970	94.1
Palmer's Cross Church	265897	1986610	97.84
Palmer's Cross Church	265990	1986865	97.17
Palmer's Cross Church	266469	1986878	96.45
Hazard Primary School	263553	1986859	78.37
Trenton School	263528	1986915	77.13
Staines Preparatory School	270509	1986927	108.87
Rosewell Postal Agency	270472	1986865	110.21
Rosewell Church	270584	1986567	95.9
Old Harbour Church	275706	1985398	37.93
Old Harbour Church	275532	1985125	35.23
Old Harbour Church	275681	1984920	32
Old Harbour Church	276042	1985007	31
Old Harbour Church	276123	1984808	29.24
Old Harbour Church	276266	1984590	29.87
Old Harbour Courthouse	276297	1984677	30
Old Harbour Post Office	276377	1984690	30
Old Harbour Police Station	276421	1984677	28.97
Old Harbour Church	276533	1984658	27.06
Old Harbour Bay Primary School	276663	1984621	24.9
Old Harbour High School	276595	1984323	25.25
Old Harbour Health Centre	276639	1984976	27.96
Monsignor Colin Bryan School	276701	1985522	32
Old Harbour Primary School	277925	1985386	44.2
Lauderwood Air Quality Station	272095	1986049	132.97
Longville Park Air Quality Station	270754	1981594	70.75
Proposed PM Monitoring Station	273422	1982554	16.12

Figure 3-5: Land Use Categories

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

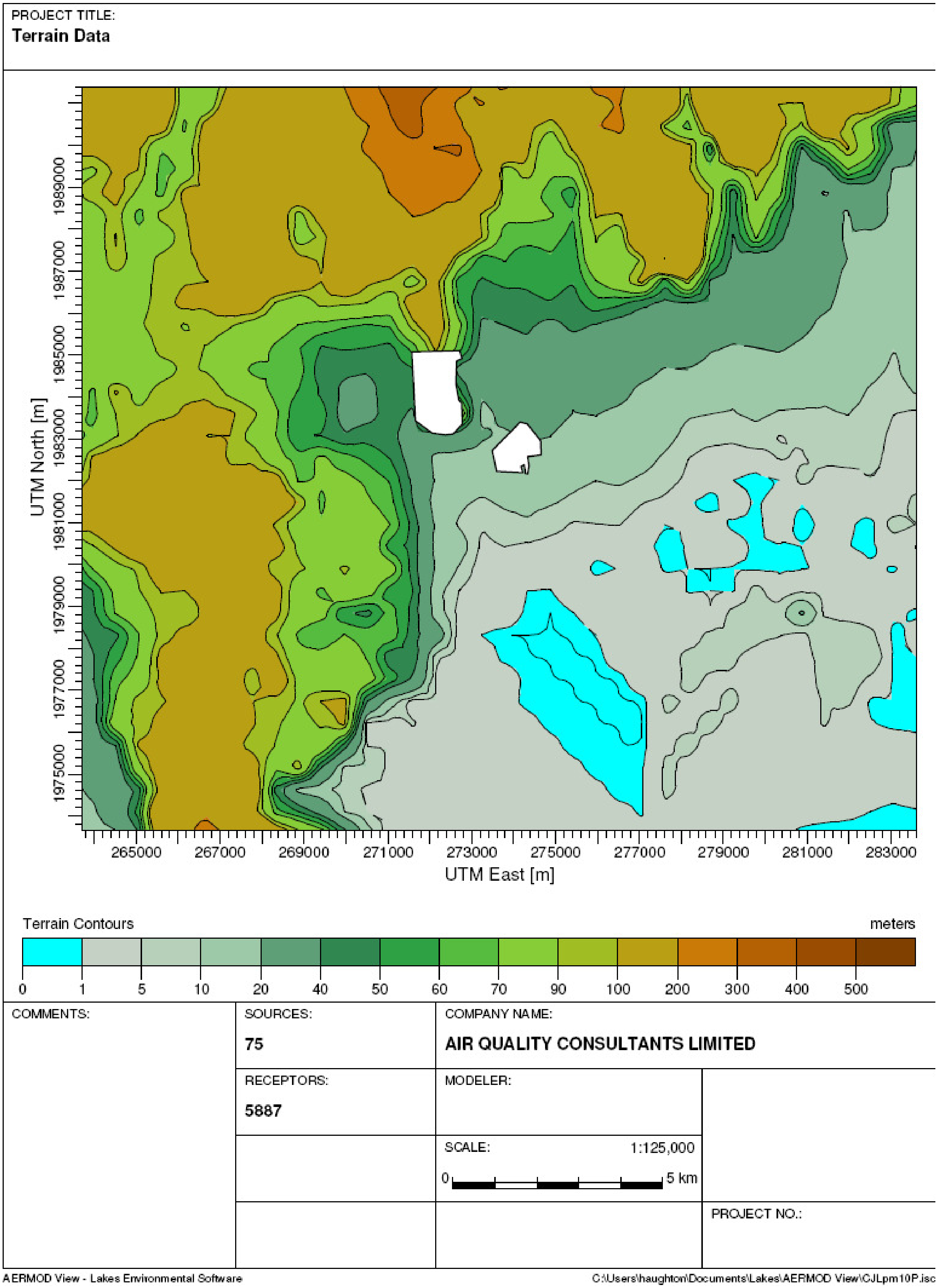
Type	Use and Structure	Vegetation
I1	Heavy Industrial	Grass and tree growth extremely rare; <5% vegetation
	Major chemical, steel and fabrication industries; generally 3-5 story buildings, flat roofs	
I2	Light-moderate industrial	Very limited grass, trees almost totally absent; <5% vegetation
	Rail yards, truck depots, warehouses, 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	Limited lawn sizes and shade trees; <30% vegetation
	Single, some multiple, family dwelling with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	

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 cement manufacturing facility is defined as either simple terrain (terrain lying below the stack top elevation) or complex terrain (terrain above the top of the stack). Measurements of the terrain in the area surrounding the proposed facility were made using terrain data obtained from Digital Elevation Maps derived from the Mona Informatix Limited. It was determined that the topography from the south to the north eastern directions up to 10 km have terrain elevations above 20 m (see Figure 3-6). The areas from northeast through to the southern direction are for the most part flat, and include the marine environment.

Therefore, since terrain elevations extend above the facility's highest top stack elevation, complex terrain algorithms were included as part of the dispersion modeling analysis.

Figure 3-6: Terrain Data for the project area



4.0 MODEL RESULTS

With the various sources identified, a model domain established of 20 km in the east-west direction and 20 km in the north-south direction and centred in the middle of the proposed cement manufacturing facility, and the necessary input files created, model predictions were made for the pollutants SO_2, NO_x, PM_{10} and CO for averaging periods for which there are Jamaican National Ambient Air Quality Standards or Guideline Concentrations. Model runs were conducted for the proposed cement facility's air pollutant sources alone, as well as the cumulative air quality impact in combination with the other defined sources in the vicinity of the proposed facility.

During the NO_x model runs, the Ozone Limiting Method (OLM) was applied to convert NOx to NO_2. According to the Davis, 1999, the in-stack NO_2/NOx ratio should be set to 0.75 and this was applied to an ozone concentration of 107 ug/m^3 which was the maximum ozone concentration obtained at the Lauderwood air quality station in Northern Clarendon for the year 2007.

4.1 Proposed Cement Facility Impacts Only

Table 4-1 summarizes the maximum predicted concentrations for the proposed cement facility sources and their comparison with the Significant Impact Concentrations, as well as the Jamaican National Ambient Air Quality Standards (NAAQS). The results revealed that the maximum predicted ground level concentrations from all the proposed sources of the cement facility (including the quarry) did not exceed the Significant Impact Concentrations. Additionally, the maximum predicted ground level concentrations from all the proposed cement facility sources plus the background concentrations (as recommended in the Air Quality Guideline Document) were all less than the NAAQS.

Table 4-1 Model Results – Proposed Cement Facility

Pollutant	Avg. Period	Background (μg/m^3)	Significant Impact Concentration (μg/m^3)	Jamaican NAAQS (μg/m^3)	Proposed Cement Plant Sources		
					Max Conc (μg/m^3)	UTME (m)	UTMN (m)
PM_{10}	24-hr	9	80	150	59	274385.27	1982412.37
	Annual	20	20	60	16	272744	1983247
NO_2	1-hr	0	N/A	400	369	272744	1991647
	24-hr	0	80	N/A	24.4	272744	1989147
	Annual	0	20	100	4.2	273444	1983447
SO_2	1-hr	0	N/A	700	424	272744	1989147
	24-hr	0	80	280	28	272244	1990647
	Annual	0	20	60	5	273344	1983147
CO	1-hr	0	2000	40000	3.44	272744	1991647
	8-hr	0	500	10000	0.67	272244	1990647

Figures 4-1 through 4-10 show the pollutant contour plot-files for PM_{10}, SO_2, NO_x and CO. 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 PM_{10} Concentrations – Proposed Cement Plant Only

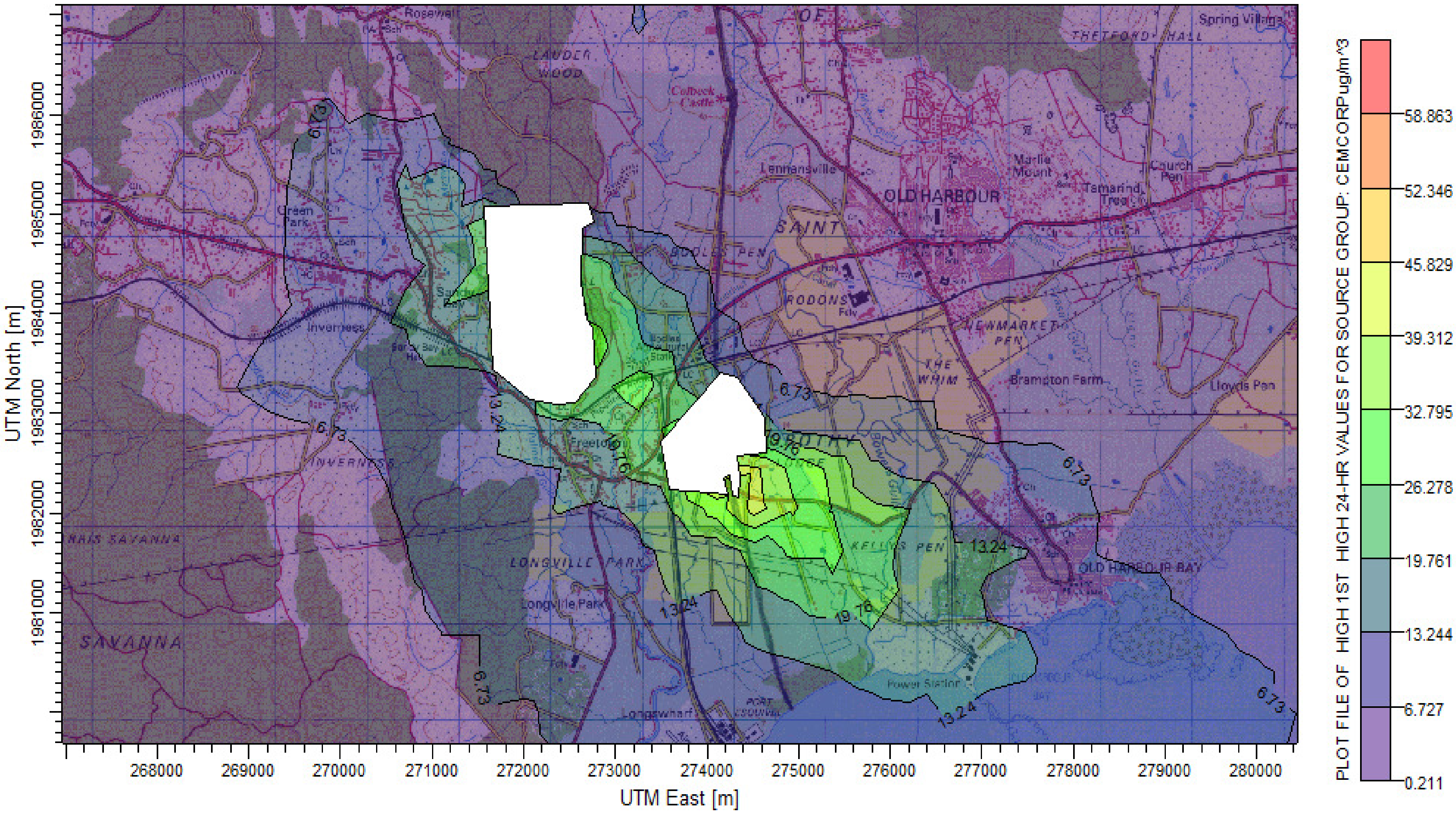


Figure 4-2: Predicted Annual PM_{10} Concentrations – Proposed Cement Plant Only

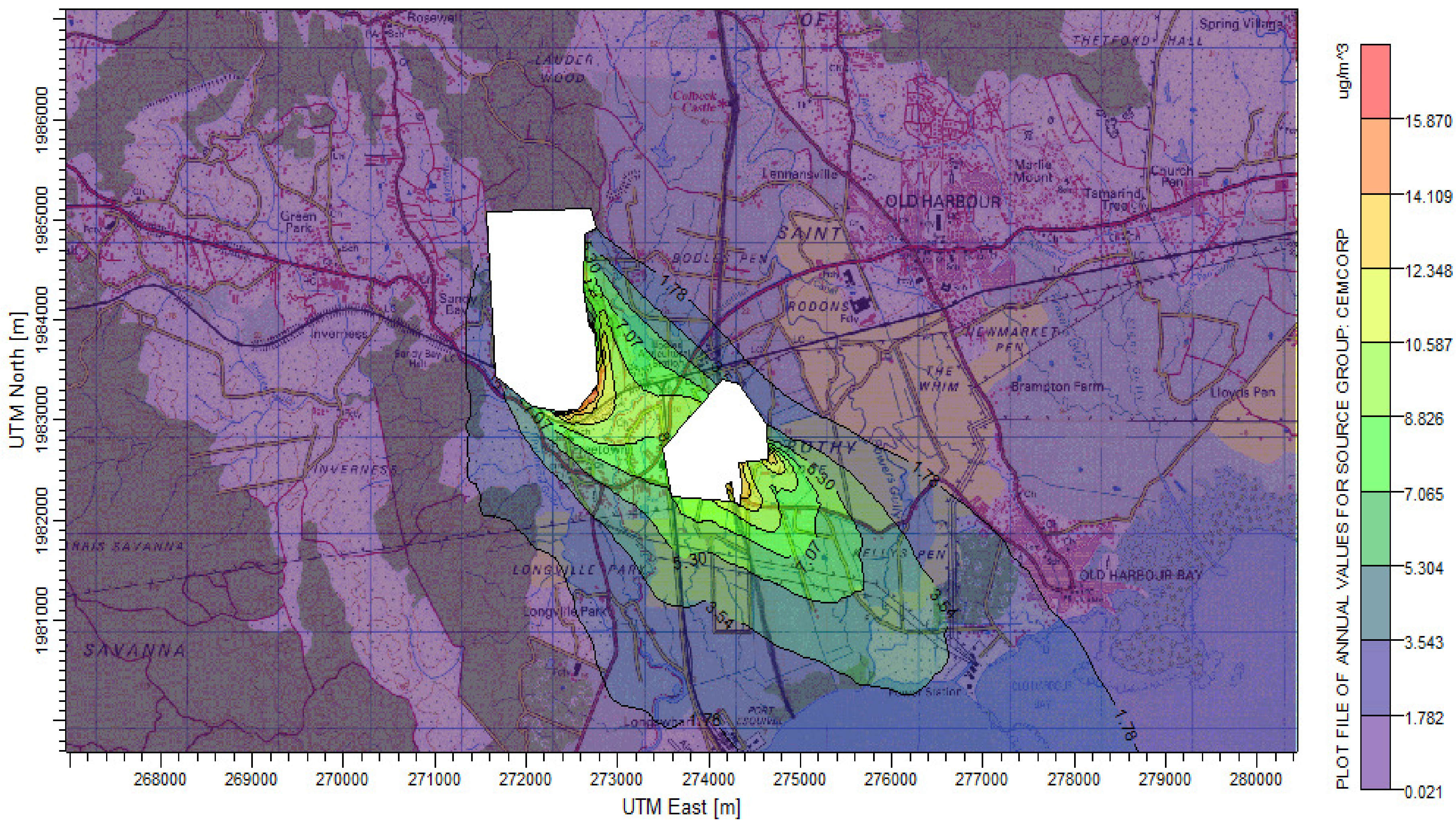


Figure 4-3: Predicted 1-h SO_2 Concentrations – Proposed Cement Plant Only

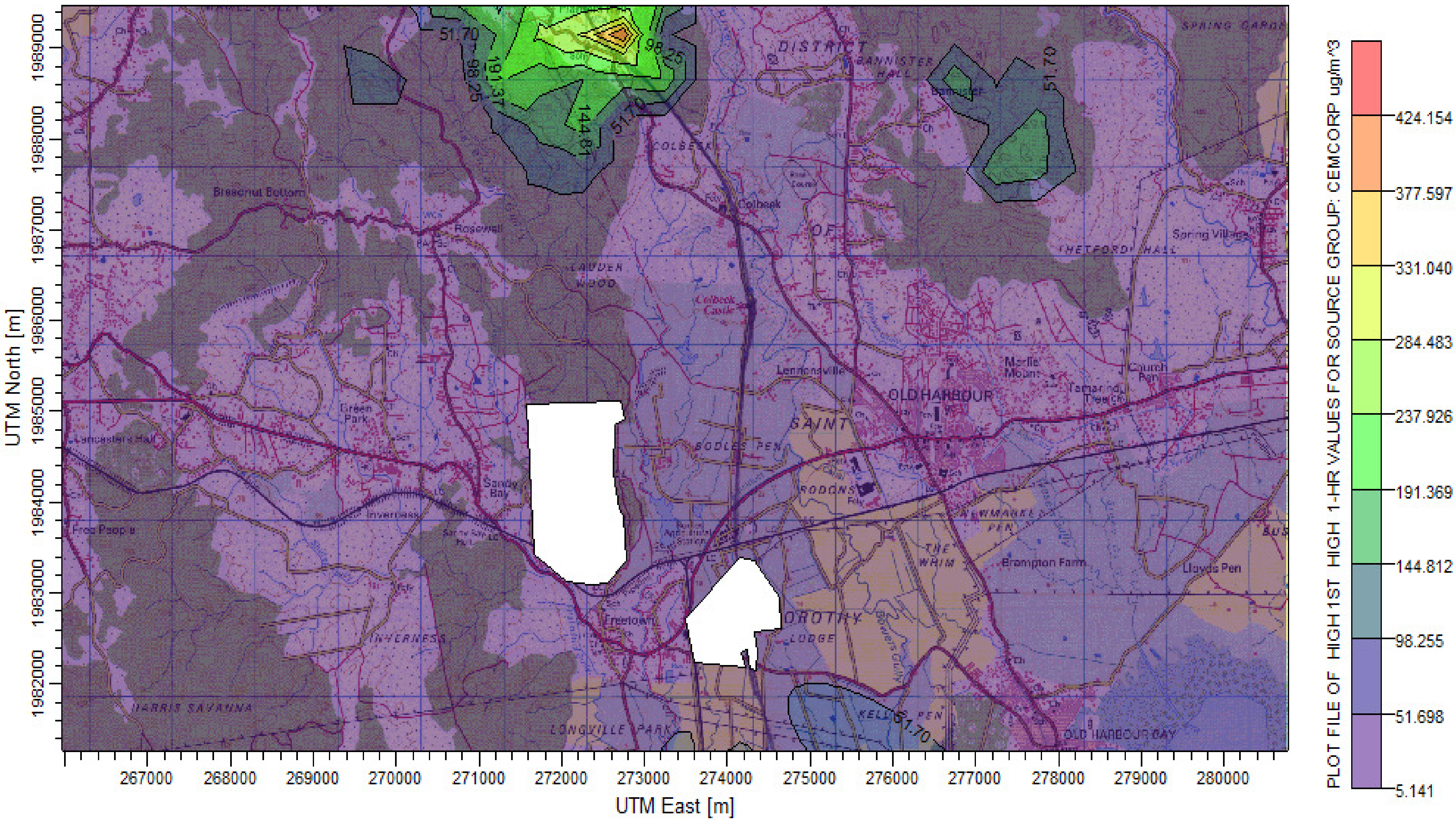


Figure 4-4: Predicted 24-h SO_2 Concentrations – Proposed Cement Plant Only

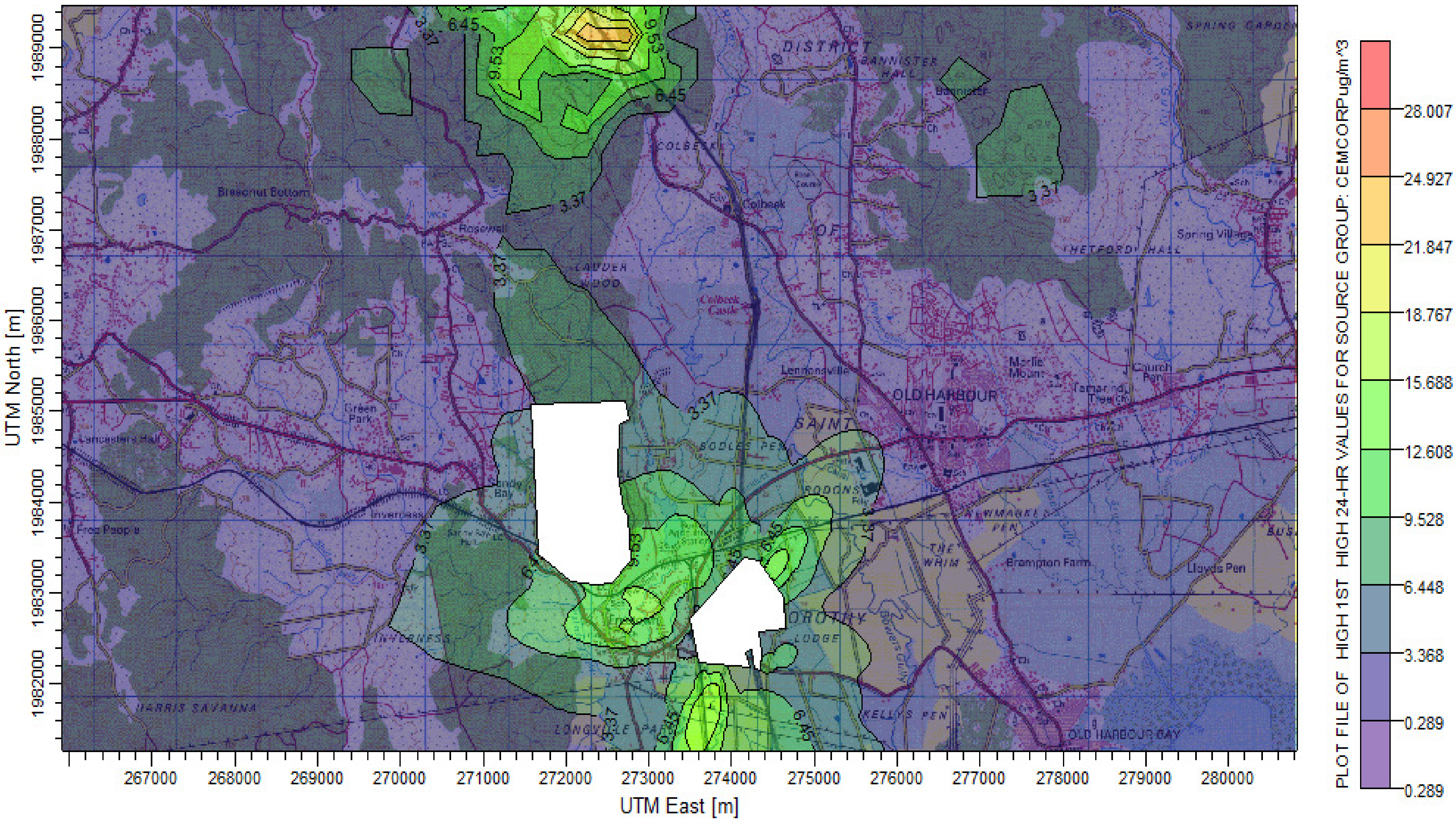


Figure 4-5: Predicted Annual SO_2 Concentrations – Proposed Cement Plant Only

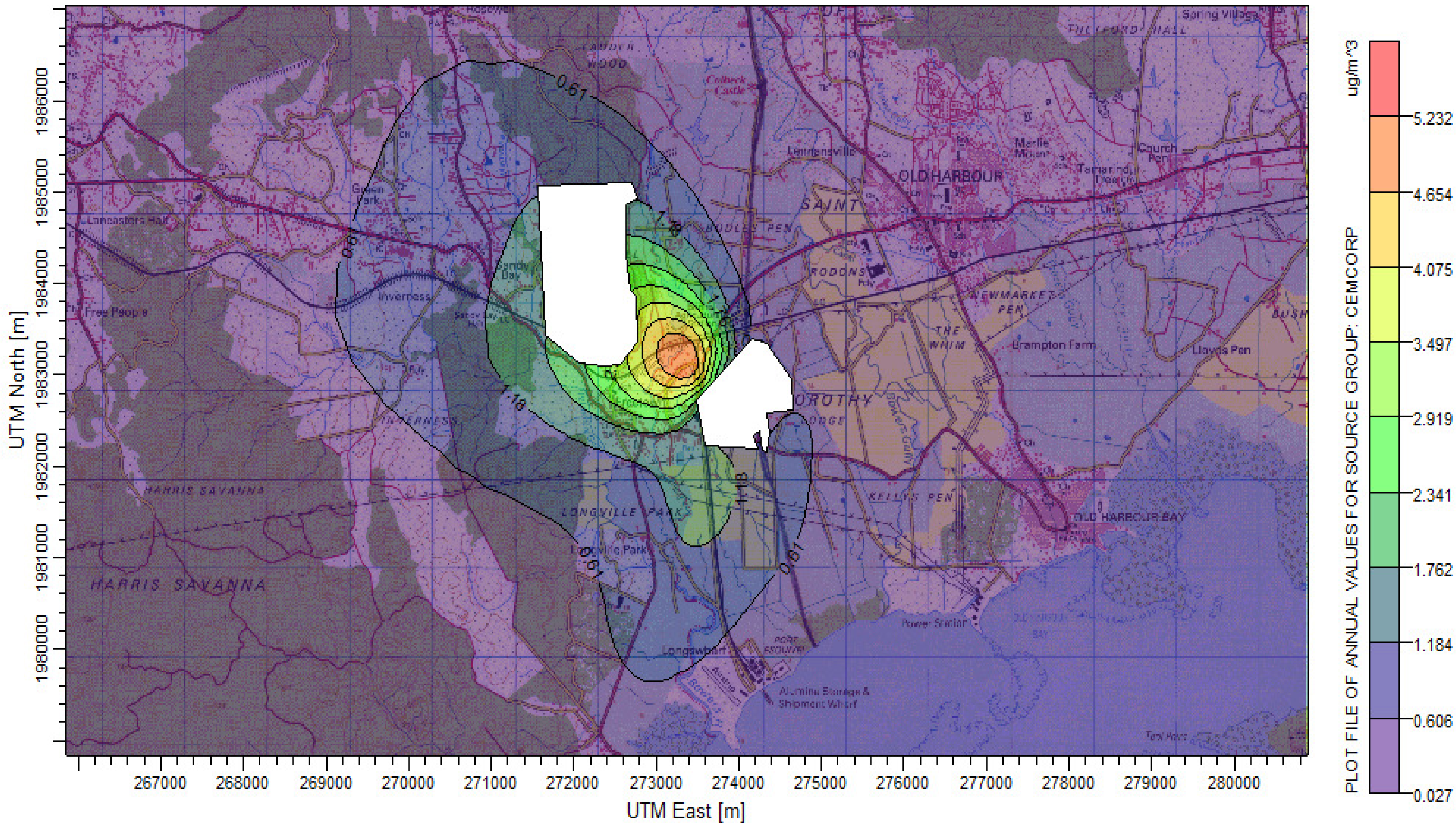


Figure 4-6. Predicted 1-h NO_2 Concentrations – Proposed Cement Plant Only

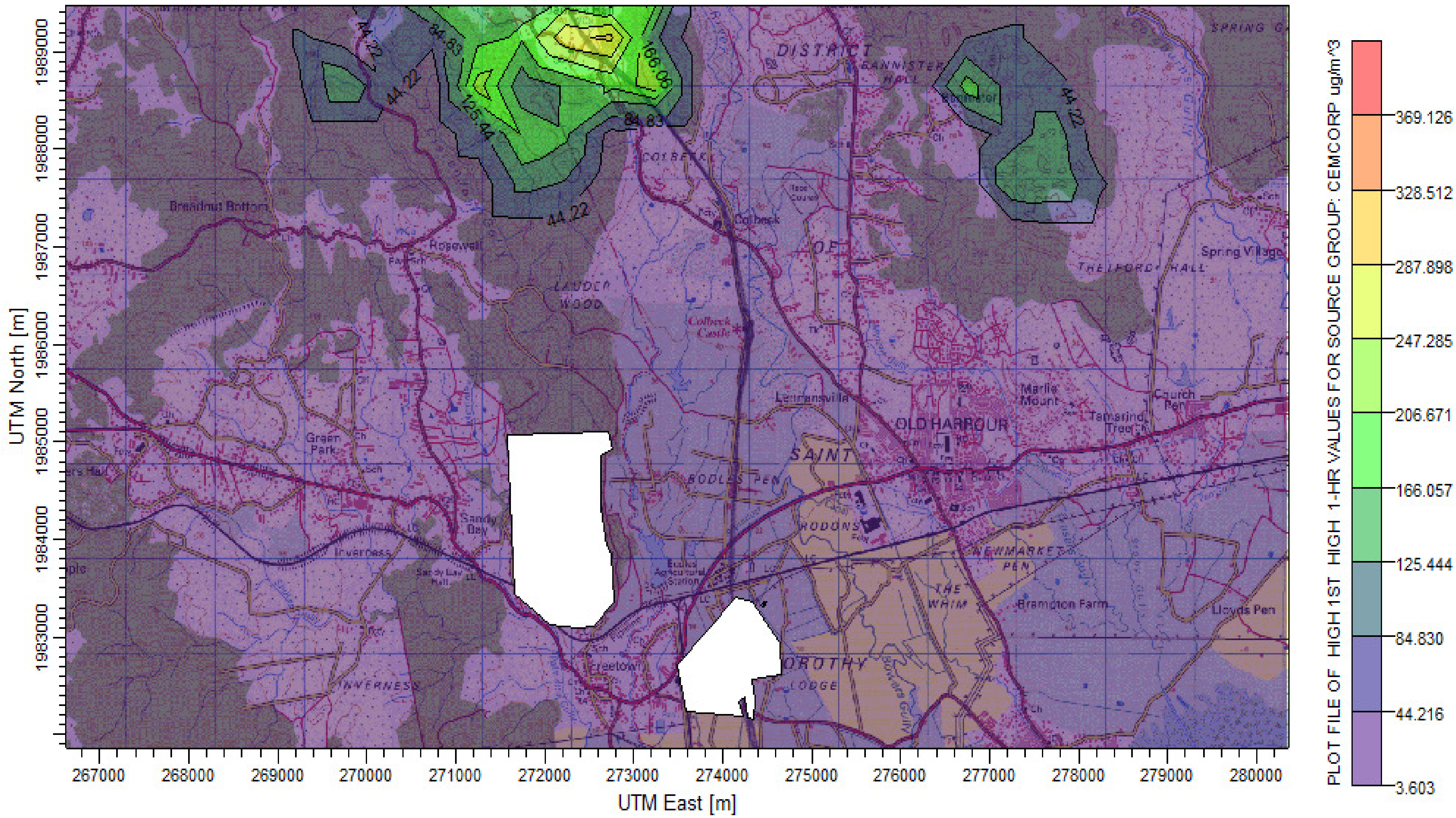


Figure 4-7: Predicted 24-h NO_2 Concentrations – Proposed Cement Plant Only

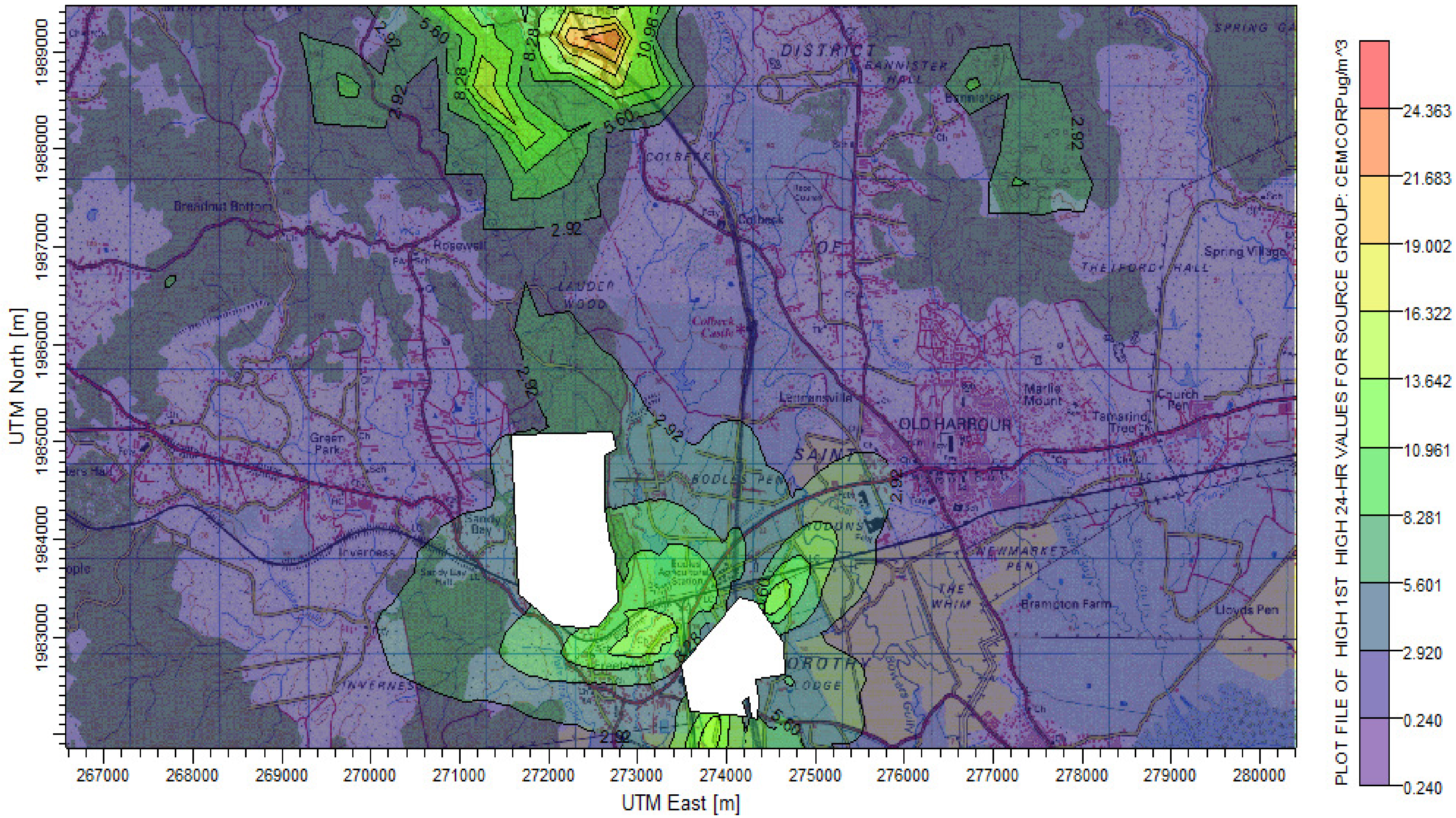


Figure 4-8: Predicted Annual NO_2 Concentrations – Proposed Cement Plant Only

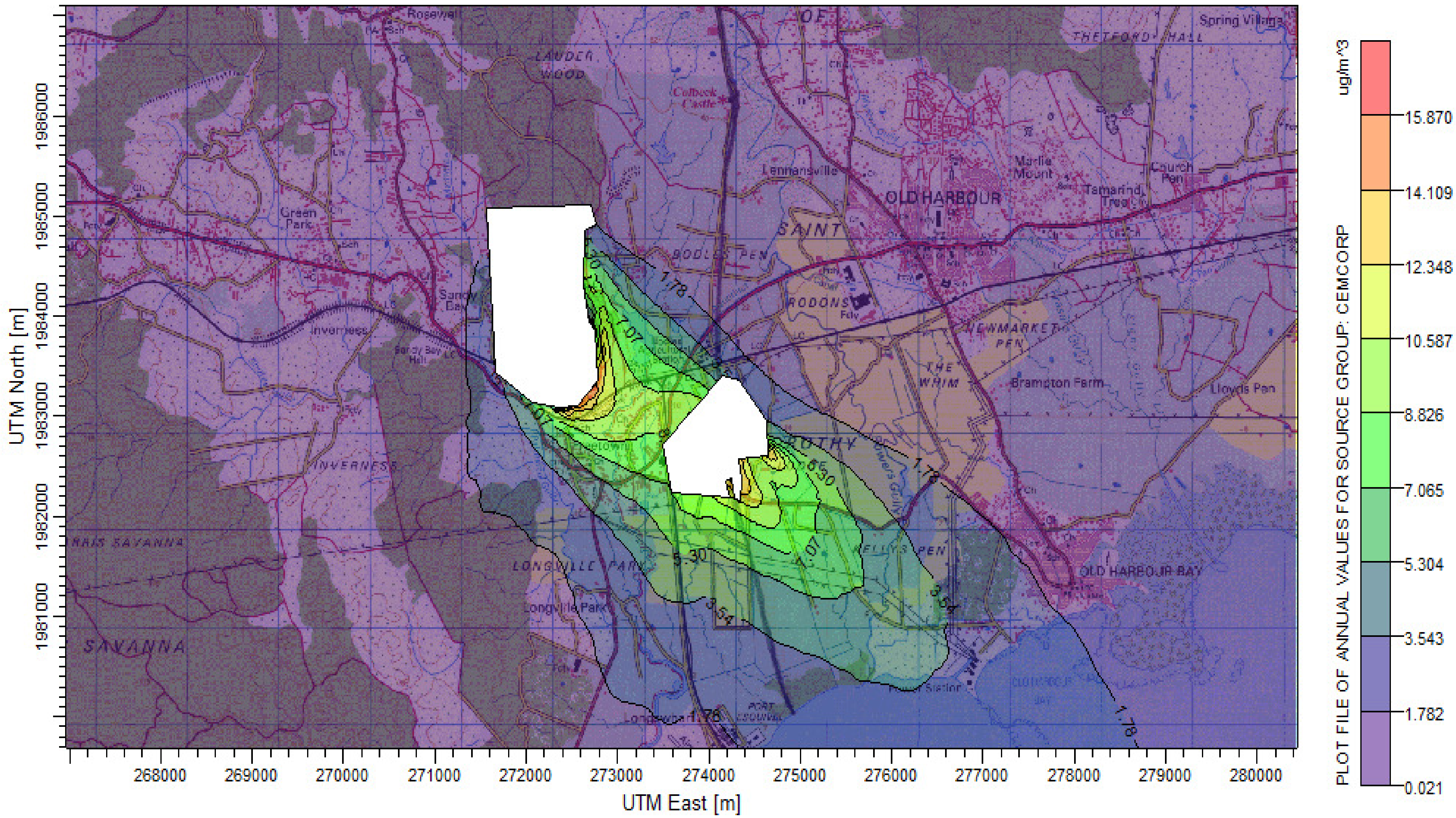


Figure 4-9: Predicted 1-h CO Concentrations – Proposed Cement Plant Only

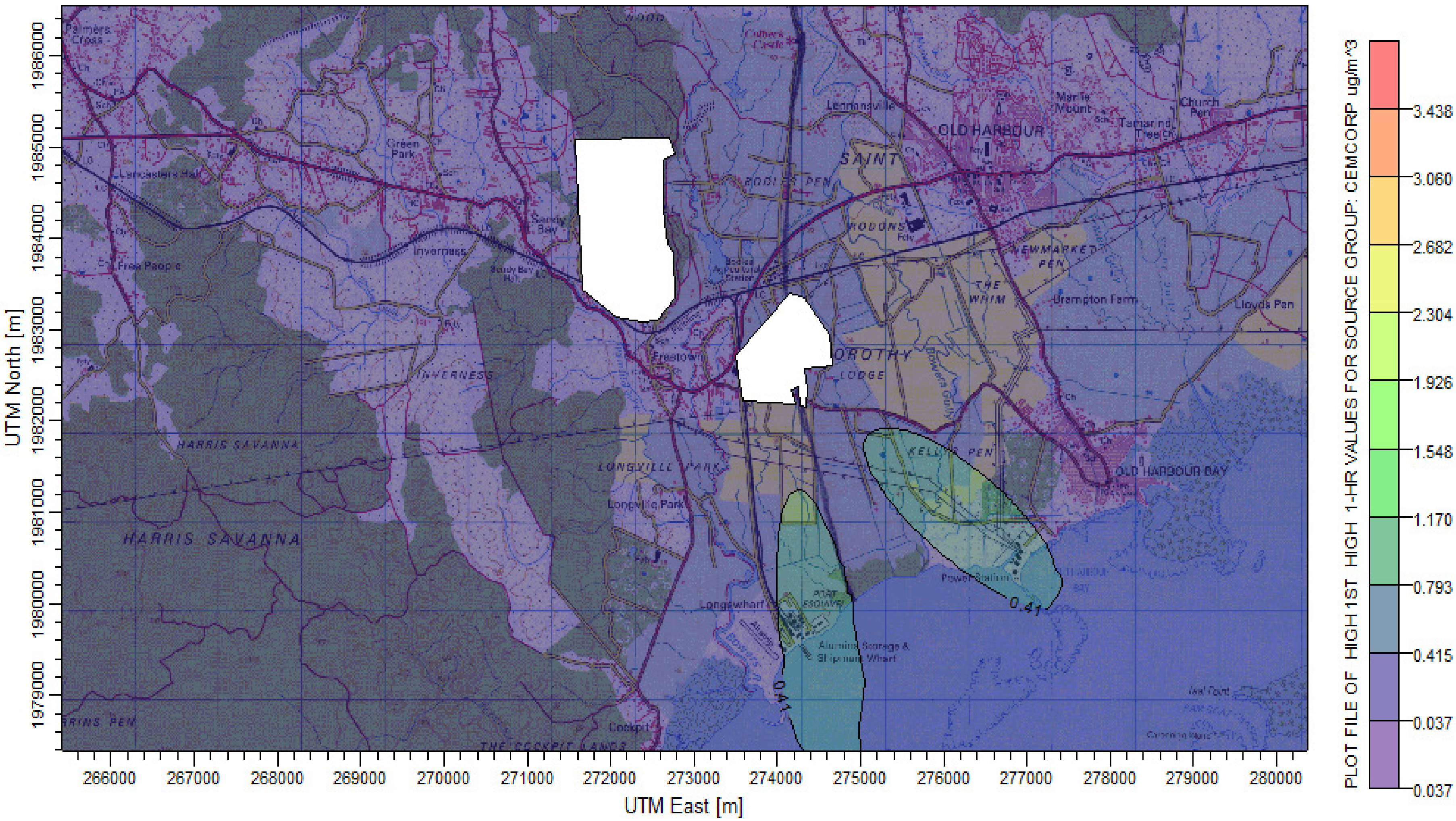
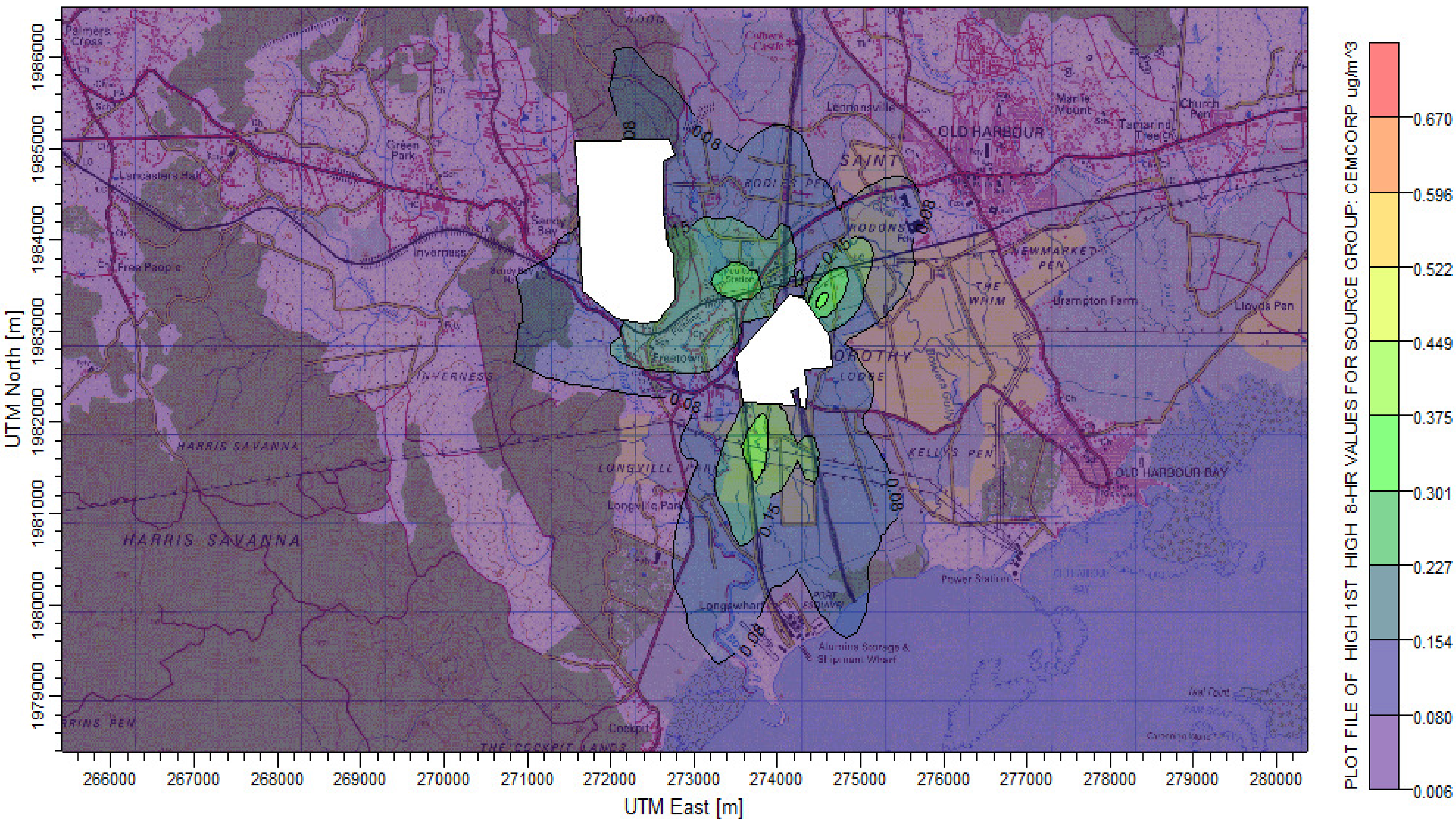


Figure 4-10: Predicted 8-h CO Concentrations – Proposed Cement Plant Only



4.2 Cumulative Impacts

As part of the air dispersion modeling analyses, a determination of the impact of the existing sources on the ambient air quality was made, as well as the cumulative impact with the addition of the air pollutant sources associated with the proposed cement manufacturing facility. Table 4-2 shows the model results for the existing sources, and the all sources category. The results for the existing sources revealed predicted high concentrations that exceed the respective ambient air quality standards for PM_{10} (24h averaging period), NO_2 (1-h averaging period), and all averaging periods for SO_2. Additionally, the predicted annual average concentration for PM_{10} would be exceeded once the background concentration is added.

It should be noted that the addition of the cement manufacturing facility with its superior suite of air pollution control technology, including fifty sets of fabric filters, and a desulphurization unit, will only contribute a small percentage of the overall air quality impact. Table 4-3 lists the specific contribution of the proposed cement manufacturing facility to the peak modeled concentrations within the air shed.

Table 4-2: Cumulative Impacts

Pollutant	Avg. Period	Background ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Existing Sources			All Sources		
				Max Conc ($\mu g/m^3$)	UTME (m)	UTMN (m)	Max Conc ($\mu g/m^3$)	UTME (m)	UTMN (m)
PM_{10}	24-hr	9	150	**164**	273435.5	1982501.21	**182**	273435.5	1982501.21
	Annual	20	60	41	273435.5	1982501.21	49	273435.5	1982501.21
NO_2	1-h	0	400	**3021**	273309.43	1982372.49	**3021**	273309.43	1982372.49
	Annual	0	100	95	273386.59	1982490.86	96	273386.59	1982490.86
SO_2	1-hr	0	700	**7968**	275244	1991147	**7968**	275244	1991147
	24-hr	0	280	**652**	268244	1986647	**652**	268244	1986647
	Annual	0	60	**185**	276444	1980647	**185**	276444	1980647
CO	1-hr	0	40000	2236	275244	1990647	2236	275244	1990647
	8-hr	0	10000	470	273309.43	1982372.49	470	273309.43	1982372.49

Bold type indicate exceedances above the respective standard

Table 4-3: Source Contributions to Peak Modeled Short-Term Concentrations

Facilities	Concentrations, $\mu g/m^3$						
	PM_{10} – 24h	NO_2 – 1h	NO_2 – 24h	SO_2 – 1h	SO_2 – 24h	CO – 1h	CO – 8h
Cemcorp	17.996	0	0.245	0.01	0.3	0.0002	0.006
JPS	1.3	0	0.028	6911.63	567.2	2128.4	0.052
JEP	0.4	0.0004	0.093	1056.36	84.5	107.5	0.003
Feed Mill	162.3	2904.74	679.157	0	0.0003	0	470.066
JB Ethanol	0.004	0.0236	0.02	0	0.0007	0	0.006
Totals	**182**	**2905**	**680**	**7968**	**652**	**2236**	**470**

5.0 CONCLUSION

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

1. The emission rates for PM, NO_x and SO_2 that will be emitted from the proposed cement manufacturing facility are in compliance with their respective emission standards (see Table 3-5). It may be inferred that these emission standards would not be exceeded based on the superior suite of air pollution control technology (fifty sets of fabric filters and a desulphurization unit) to be employed by the proposed cement manufacturing facility.

2. The model predictions for the proposed cement manufacturing facility revealed compliance with the CO, PM_{10}, NO_2 and SO_2 ambient air quality standards and guideline concentration for the requisite averaging periods. The incremental impact of these air pollutants were also less than the established values that would have created a significant air quality impact. It should be noted that certain design changes would be necessary for the achievement of compliance with the PM_{10} and NO_2 ambient air quality standards and guideline concentration.

3. Necessary design changes will be needed to ensure the overall compliance of the proposed cement manufacturing facility. The vent height of the fabric filter associated with the quarry crushing plant will need to be increased from 8.5m to 10.5m, while the vent height of the fabric filter associated with the additives and coal pre-blending area will need to be increased from 3m to 8m. Additionally, the design NOx specification for the cement kiln will need to be changed from 800 mg/Nm^3 to 400 mg/Nm^3.

4. The proposed cement manufacturing facility only has a minor contribution to the overall peak modeled short term concentrations for CO, PM_{10}, NO_2 and SO_2.

5. Since the proposed cement manufacturing facility sources demonstrated compliance with the ambient air quality standards and the guideline concentration, as well as the significant impact incremental values, it is envisaged that approval will be granted for the establishment of the facility.

6.0 REFERENCES

Air Quality Consultants Limited. 2009. Air Dispersion Modeling Report for Jamaica Broilers Feed Facility as part of their Application for an Air Pollutant Discharge Licence

Auer, A.H., 1978. Correlation of Land Use and Cover with Meterological Anomalies. Journal of Applied Meterology, **17**:636-643

Davis, Claude. November 2006. Natural Resources Conservation Authority Ambient Air Quality Guideline Document.

Geological Survey Department. Jamaica Metric Grid Map for St. Catherine

Google Earth Maps. 2010.

Lakes Environmental Software. 1996-2005 *User's Guide for ISC-AERMOD View.*

Mona GeoInformatics Institute. October 2008. *XYZ DEM File for the island of Jamaica at 30 m resolution in UTM Zone 18.*

National Environment & Planning Agency. 2009. Air Pollutant Discharge Licence Documents

Sinoma International Engineering Company Limited. 2010. Plant Layout Drawings

Sinoma International Engineering Company Limited. 2010. Plant Design Information

Thé, J.L., Lee, R., and Brode, R.W. Worldwide Data Quality Effects on PBL Short-Range Regulatory Air Dispersion Models

United States Environmental Protection Agency. 1985. *Guideline for Determination of Good Engineering Practice Stack Height*, EPA-450/4-80-023r, June, 1985

United States Environmental Protection Agency. 1995a. *User's Guide to the Building Profile Input Program*. EPA-454/R-93-038, U.S. EPA, Research Triangle Park, NC

U.S. Environmental Protection Agency, 1998. *Revised Draft User's Guide for the AERMOD Meteorological Preprocessor (AERMET)*. U. S. Environmental Protection Agency, Research Triangle Park, NC.

U. S. Environmental Protection Agency, 2006. *Addendum User's Guide for the AERMOD Meteorological Preprocessor (AERMET)*. EPA-454/B-03-002. Office of Air Quality Planning and Standards, Research Triangle Park, NC