5.4 EXISTING POLLUTION SOURCES

5.4.1 Soil Contamination

5.4.1.1 Introduction

In February 2015, the CL Environmental conducted a site visit in order to ascertain the location of potential points of impact at the proposed site. During this visit, six main areas of interest were identified as follows (Figure 5-114):

- Presence of oily waste in one locality (1); the team was advised that this area was lined.
- One (1) storage area for resins.
- One (1) storage area for organic solvents.
- Three (3) storages areas for ash; the team was advised that two of the three areas were lined.

Upon identification of the potentially impacted areas, and, a determination of the potential contaminants, it was agreed that soil sampling would be subjectively carried out in these areas of impact, or at the nearest accessible points.

5.4.1.2 Methodology

Sampling

Soil samples were collected on May 4 and 5, 2015 from seven boring locations (Table 5-64, Figure 5-114) pre-determined based on the locations of areas thought to be potentially impacted.

Table 5-64 Borehole number and location in Jamaica Grid 2001 (JAD 2001)

BOREHOLE NUMBER	LOCATIONS	
	EASTINGS (JAD 2001)	NORTHINGS (JAD 2001)
BH 1	738507.418	638858.331
BH 2	738551.042	638849.366
BH 3	738566.489	638907.569
BH 4	738521.063	638918.850
BH 5	738545.128	638926.816
BH 6	738623.052	638963.144
BH 7	738594.671	638960.882

Drilling was done by hollow stem auger and soil samples collected at regular intervals until the maximum depth attainable was reached. Each sample collected was split in two portions. One portion was placed on ice immediately and retained for lab analysis if selected based on field readings using the Minirae 2000 Photo Ionisation Detector (PID). The second sample was analysed in the field then discarded. At least two samples per boring were retained for

analysis. One being the sample at the maximum depth reached and another sample at the point of the highest PID reading.

Laboratory Analysis

Samples were analysed by Test America Laboratories in Pensacola, Florida. The parameters analysed were:

- BTEX (benzene, toluene, ethyl-benzene and total xylenes).
- MTBE (methyl-tert-butyl-ether)
- The Resource Conservation and Recovery Act (RCRA) 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver).
- Iron
- Vanadium
- Total Petroleum Hydrocarbons (by Florida Residual Petroleum Organic (FL-PRO) method.

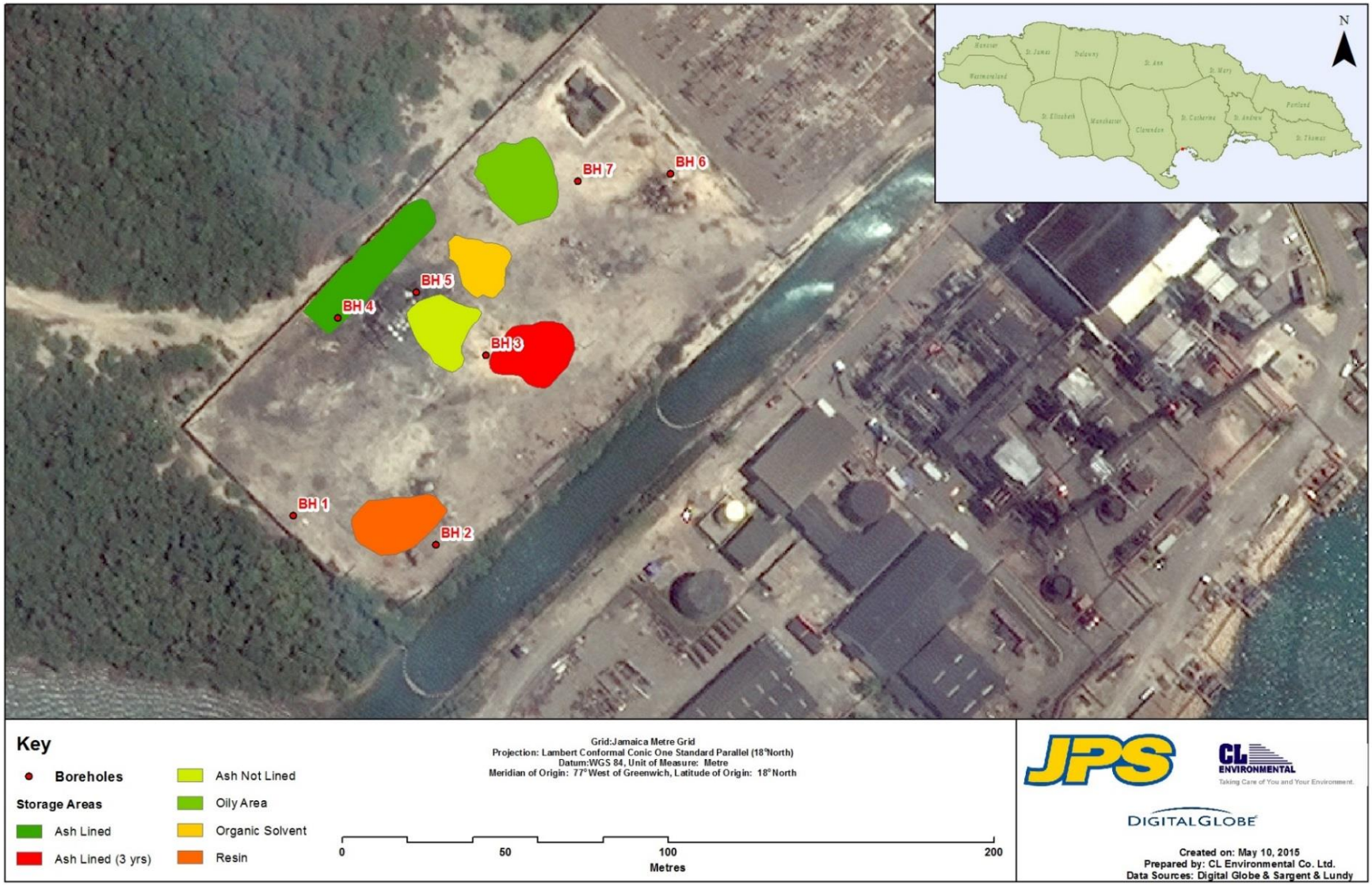


Figure 5-114 Satellite image depicting borehole locations and approximate areas of storage at the proposed 190 MW Site

Standards

The National Environment & Planning Agency (NEPA) does not have standards for all the parameters analysed, therefore the Florida Soil Cleanup Target Levels were used as a guide to ascertain potential impact levels. As shown in Table 5-65, clean up target levels vary between residential and commercial/industrial areas and are also based on the leachability of the contaminant of concern into groundwater as well as surface water (fresh or marine). Specifically considered is groundwater of low yield or poor quality.

5.4.1.3 Results and Discussion

Borehole Locations

Regarding the location of borehole locations:

- Borehole One (BH1) - this boring was located towards the western perimeter fence, approximately equidistance between the northern and southern perimeter boundaries. Information received from the JPS Co. suggested that no waste was stored in that general area.
- Borehole Two (BH2) - this boring was located within/ in close proximity to the area identified as the location where resins were stored. Due to the presence of presence of overhead high tension power lines, the location of the boring had to be shifted from that initially marked as a safety precaution. However the main resin area was sampled.
- Borehole Three (BH3) – this boring was located between two areas identified as areas where ash was stored. It was indicated that one area was lined and one area was not.
- Borehole Four (BH4) – this boring was located towards the northern perimeter fence in the vicinity of a third area identified as one where ash was previously stored. Information indicated that this area was lined.
- Borehole Five (BH5) – this boring was located within an area identified as the location where organic solvents were previously stored.
- Borehole Six (BH6) – this boring was located towards the eastern section of the site (close to the substation). This area was selected as an area thought not to be impacted, as information received suggested that no waste materials were stored in this area.
- Borehole Seven (BH7) – this boring was initially proposed to be within an area identified as a lined oil waste storage area. The area initially proposed, had to be changed as there were some changes to the landscape which restricted access. Therefore this boring was relocated on the periphery of the oil waste area, within what was considered a reasonable distance to detect impact if present and represent site conditions.

Table 5-65 Florida Soil Cleanup Target Levels for BTEX, RCRA 8 Metals and Iron, Vanadium and Nickel

	Direct Exposure		Leachability Based on Groundwater Criteria	Leachability Based on Freshwater Surface Water Criteria	Leachability Based on Marine Surface Water Criteria	Leachability Based on Groundwater of Low Yield/ Poor Quality
	Residential	Commercial/ Industrial				
Unit:	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Arsenic	2.1	12				
Barium	120	130000	1600			16000
Cadmium	82	1700	7.5		14	75
Chromium	210	470	38	4.2	19	380
Iron	53000					
Lead	400	1400				
Mercury	3	17	2.1	0.01	0.03	21
Nickel	340	35000	130		11	1300
Selenium	440	11000	5.2	0.5	7.4	52
Silver	410	8200	17	0.01	0.06	170
Vanadium	67	10000	980			9800
Benzene	1.2	1.7	0.007	0.5	0.5	0.07
Toluene	7500	60000	0.5	5.6	5.6	5
Ethlybenzene	1500	9200	0.6	12	12	6
Total Xylenes	130	700	0.2	3.9	3.9	2
Total Recoverable Petroleum Hydrocarbons	**460**	**2700**	**340**	**340**	**340**	**3400**

Sample Analysis

Table 5-66 presents a summary of the analytical data for soil samples.

TOTAL PETROLEUM HYDROCARBONS

Total Petroleum Hydrocarbons (TPH) were detected in samples collected from BH1, BH3, BH4 and BH7. All four of these borings were sampled at the 2.5ft depth interval, THP was detected. The National Environment & Planning Agency's standard for TPH in soil is 1000 mg/kg. All samples were below this standard and therefore complied. Concentrations were, BH1 - 2.5', 84 mg/kg, BH3 - 2.5', 53 mg/kg, BH4 - 2.5', 610 mg/kg and BH7 - 2.5' 95 mg/kg.

Both BH1 and BH4 confirmed TPH at the 7.5 feet depth interval and had concentrations of 55 mg/kg and 140 mg/kg respectively. No petroleum hydrocarbons were detected in the BH3 - 5' sample or the BH7 - 7.5' sample.

Petroleum hydrocarbons were not detected in the samples collected for BH2, BH5 and BH6.

A review of the concentrations related to leachability based on groundwater criteria and marine surface water criteria (Table 2), suggests that concentrations of 55 mg/kg and 140 mg/kg at 7.5 feet, which are below the 340 mg/kg cleanup level, should not result in petroleum hydrocarbons leaching into groundwater or marine surface water.

Petroleum hydrocarbons were detected in the C_{10}-C_{28} and C_{28}-C_{40}, carbon ranges which encompass diesel fuel, Bunker C Oil and Heavy fuel oils. No hydrocarbons in the gasoline range of C_8-C_{10} were detected.

BTEX

No components of BTEX (benzene, toluene, ethylbenzene, total xylenes) were detected in the fourteen samples submitted for analysis.

METHYL-TERT-BUTYL-ETHER

No MTBE (methyl-tert-butyl-ether) was detected in the fourteen samples submitted for analysis

8 RCRA METALS

The eight Resource Conservation and Recovery Act (RCRA) metals being reported on were selenium, silver, mercury, lead, chromium, cadmium, barium and arsenic. These will be reported on as individual parameters.

SELENIUM

Selenium was not detected in any of the samples submitted for analysis.

SILVER

Silver was not detected in any of the samples submitted for analysis.

MERCURY

The Florida Soil Cleanup Target Levels for Mercury is 17mg/kg specifically for Direct Exposure in Commercial/Industrial areas. Nine of the fourteen samples analysed confirmed the presence of mercury. Concentrations ranged between 0.017 mg/kg and 0.23 mg/kg. By comparison with the 17 mg/kg standard, the fourteen samples confirming the presence of mercury were found to be compliant with the standard. Mercury was detected in both samples for BH1, BH5 and BH7.

For boreholes BH3, BH4 and BH6 no mercury was detected in the upper level samples; 2.5', 2.5' and 5' respectively for BH3, BH4 and BH6. Mercury was detected only in the samples at furthest depth at 5', 7.5' and 7.5' for BH3, BH4 and BH6 respectively

Considering the elevated groundwater levels at the site the cleanup level for leachability based on groundwater criteria was considered. This standard is 2.1 mg/kg. When data were compared with this standard, it was revealed that samples were also compliant.

Mercury was not detected in the samples collected for BH2.

LEAD

The Florida Soil Cleanup Target Levels for Lead is 1400mg/kg specifically for Direct Exposure in Commercial/Industrial areas. All fourteen samples analysed confirmed the presence of Lead. Concentrations ranged between 2.1mg/kg and 18 mg/kg. Data revealed that samples collected at the furthest depths reached ranged between 12 mg/kg and 14 mg/kg.

With the exception of BH7 - 2.5' which had a concentration of 18 mg/kg the samples collected closer to surface had lower concentrations of Lead (ranging between 2.1 mg/kg and 13 mg/kg) when compared with the samples collected at furthest depths reached.

BH7 - 2.5' has the highest recorded concentration (18 mg/kg) and BH3 - 2.5' had the lowest recorded concentration (2.1 mg/kg).

The concentrations of lead in all borehole samples were compliant with the standard.

CHROMIUM

The Florida Soil Cleanup Target Levels for Chromium is 470 mg/kg, specifically for Direct Exposure in Commercial/Industrial areas. Chromium was detected in all fourteen samples submitted for analysis. Concentrations ranged between 3.3 mg/kg and 20 mg/kg and did not exceed the standard of 470 mg/kg.

Groundwater measurements recorded suggested that groundwater levels at the site are elevated, consequently the standard relating to leachability based on groundwater criteria was considered. This standard is 210 mg/kg. A comparison of the data and the groundwater leachability standard, also revealed that samples did not exceed that standard.

With the exception of BH7 - 2.5', for each boring the higher chromium concentration was recorded at the furthest depths sampled.

BH2 samples had comparable chromium concentrations at 11 mg/kg and 12 mg/kg at 2.5' and 5' respectively. BH5 at similar depths of 2.5' and 5' also had values which were comparable at 8.7 mg/kg and 9.0 mg/kg.

CADMIUM

The Florida Soil Cleanup Target Levels for Cadmium is 1700 mg/kg, specifically for Direct Exposure in Commercial/Industrial areas. Cadmium was detected in only one of the fourteen samples submitted for analysis. BH7 - 2.5' had a concentration of 0.84 mg/kg and was found to comply with the standard.

By comparison with the standard of leachability based on groundwater criteria, 7.5mg/kg, the BH7 - 2.5' sample was found to be compliant.

BARIUM

The Florida Soil Cleanup Target Levels for Barium is 130,000 mg/kg, specifically for Direct Exposure in Commercial/Industrial areas. The presence of barium was confirmed in all fourteen sample analysed. Concentrations ranged between 20 mg/kg and 350 mg/kg and were found to be compliant with the soil cleanup target level.

With the exception of BH2, which had the same barium concentration at the 2.5' and 5' depths (130 mg/kg), all other borings had lower barium concentrations closer to the surface.

Leachability based on groundwater criteria for barium is 1600 mg/kg. This standard was considered as it was realised that groundwater levels at the site are elevated. Comparison with this standards indicated that the samples analysed were compliant with this standard.

ARSENIC

The Florida Soil Cleanup Target Levels for Arsenic is 12 mg/kg, specifically for Direct Exposure in Commercial/Industrial areas. Arsenic was detected in all fourteen samples analysed. Concentrations detected ranged between 3.8 mg/kg and 19 mg/kg. BH6 - 5' had a concentration of 12 mg/kg, and BH7 - 2.5' had a concentration of 19 mg/kg. Comparison with the standard revealed that BH7 - 2.5' was non- complaint as it exceeded the standard, while BH6 - 5' was at the limit of the standard.

Regarding BH7, arsenic concentrations changed from 19 mg/kg at 2.5' to 5.0 mg/kg at 7.5'. BH6 arsenic concentrations changed from 12 mg/kg at 5' to 5.2 mg/kg at 7.5'.

Both BH3 and BH5 were sampled at the 2.5' and 5' depths. A review of the analytical data revealed that arsenic concentrations increased with depth for these borings only. For the other

borings BH1, BH2, BH4, BH6 and BH7 higher arsenic concentrations were detected closer to surface.

With the exception of BH6 - 5' and BH7 - 2.5' arsenic concentrations were below 10 mg/kg.

IRON

The Florida Soil Cleanup Target Levels for Iron is 53,000 mg/kg, specifically for Direct Exposure in residential areas (Table 2). The presence of Iron was confirmed in all fourteen samples. Concentrations detected ranged between 5,900 mg/kg and 41,000 mg/kg. A review of the data revealed that the higher concentrations of Iron for each boring was at the furthest depth sampled and lower concentrations closer to surface. The lowest concentration of Iron in soil recorded was 5,900 for BH3 - 2.5', while the highest concentration recorded was 41,000 mg/kg for BH2 - 5'.

While values of 29,000 mg/kg to 41,000 mg.kg may seem elevated, it should be noted that "Iron is the most abundant element in soils, ranging from 7,000 mg/kg to 500,000 mg/kg, with a mean concentration of 38,000 mg/kg (3.8%) in soils, (Lindsay 1979)" (*as reported in The Handbook of Soil Science; Summer, Malcolm E.; 1999*). This suggests therefore that the values recorded are within what is considered normal.

NICKEL

The Florida Soil Cleanup Target Levels for Nickel is 35,000 mg/kg, specifically for Direct Exposure in Commercial/Industrial areas. The cleanup level relating to leachability based on groundwater criteria is 130 mg/kg and that relating to leachability based on marine surface water criteria is 11 mg/kg. Nickel was detected in all fourteen samples submitted for analysis. Concentrations ranged between 5.8 mg/kg and 740 mg/kg.

By comparison with the target levels for commercial/industrial areas, all samples would have been found to be compliant with the Nickel standard of 35,000 mg/kg. However, as was observed groundwater levels are elevated and the site is within close proximity to the coastline. As a result the target level of 130 mg/kg relating to leachability based on groundwater criteria was also considered. A comparison of the analytical data with the groundwater criteria revealed that the BH7 - 2.5' sample was non-compliant with the standard as concentration was 740 mg/kg.

Natural concentrations of Nickel in soil vary, with the commonly accepted value of 100 mg Ni/kg of soil being the maximum permissible level (*Soil Quality, Sustainable Agriculture and Environmental Security in Central and Eastern Europe; Wilson, Michael; Maliszewska-Kordybach, B. 2012).*

Speciation of Nickel in Natural and Contaminated Soils. Potentiality of Phytoremediation (Barbafieri, M.; Lubrano, L.; Petruzelli, G.) in Conference Proceedings Contaminated Soil '98,

Vol 2; Sixth International FZK/TNK Conference Consoil '98 reports that in Italy Nickel is present in very high concentrations also in natural soils (over 300 mg/kg).

Literature suggests that there is variability in natural Nickel concentrations in soil with concentrations of 300 mg/kg being considered natural. It may be inferred that Nickel concentrations detected below 300 mg/kg or the groundwater leachability criteria of 130 mg/kg may be naturally occurring and not necessarily indicative of impact to soil. The recorded concentration of 740 mg/kg for BH7 however, may be indicative of impact to soil, as this value was significantly higher than the other recorded concentrations which ranged between 5.6 mg/kg and 57 mg/kg, however this cannot be categorically stated.

It should be noted that while BH7 - 2.5' was 740 mg/kg for Nickel, the 7.5' sample was 17 mg/kg. Other boreholes showing a decrease in Nickel concentrations with increasing depth were BH2 and BH3.

BH1, BH4, BH5 and BH6 all showed increases in concentration with increasing depth.

VANADIUM

The Florida Soil Cleanup Target Levels for Vanadium is 10,000 mg/kg, specifically for Direct Exposure in Commercial/Industrial areas. Leachability based on groundwater criteria is 980 mg/kg. Vanadium was detected in all fourteen samples analysed.

By comparison with the 10,000 mg/kg standard, all samples complied as concentrations ranged between 62 mg/kg and 3,500 mg/kg. When compared with the groundwater leachability criteria, at least one sample from all borings except BH6 exceeded this standard. BH 6 had concentrations of 62 mg/kg and 160 mg/kg

BH1, BH2 and BH4 were observed to have exceeded the groundwater leachability standard at 2.5', however complied at depths of 7.5', 5' and 7.5' for BH1, BH2 and BH4 respectively. BH7 was also observed to have exceeded the standard at 2.5'; while concentrations decreased at 7.5' the result of 1,100 mg/kg was still not compliant.

BH3 and BH5 exceeded the leachability standard, at both depths sampled however it was observed that concentrations were higher at depth. In the case of BH3 concentrations changed from 1000 mg/kg to 2900 mg/kg and for BH5 concentrations changed from 1600 mg/kg to 2300 mg/kg.

Table 5-66 Summary of Results for Soil Samples Collected at the Proposed JPS 190 MW Site May 4 and 5, 2015

	BH1 -2.5'	BH1 - 7.5'	BH2 -2.5'	BH2 - 5'	BH3 - 2.5'	BH3 - 5'	BH4 - 2.5'	BH4 - 7.5'	BH5 - 2.5'	BH5 - 5'	BH6 - 5'	BH6 7.5'	BH7 - 2.5'	BH7 - 7.5'	Standard
C8 - C40	84	55	ND	ND	53	ND	610	140	ND	ND	ND	ND	95	ND	1000[2]
C8 - C10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
C10 - C28	43	21	ND	ND	23	ND	250	76	ND	ND	ND	ND	41	ND	
C28 - C40	52	41	ND	ND	36	ND	450	81	ND	ND	ND	ND	69	ND	
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7[1]
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	60000[1]
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9200[1]
Total Xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	700[1]
BTEX	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Methyl-tert-butyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Arsenic	7.7	6.7	7.9	3.8	5.9	8.6	7.0	5.5	6.0	7.3	12	5.2	19	5.0	12[1]
Barium	46	150	130	130	20	260	51	190	330	350	35	290	100	200	130000[1]
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.84	ND	1700[1]
Chromium	6.7	14	11	12	3.3	10	7.3	15	8.7	9.0	7.4	11	20	9.3	470[1]
Iron	19000	36000	25000	41000	5900	35000	15000	36000	37000	38000	17000	38000	29000	35000	53000[1]
Lead	5.3	13	7.4	12	2.1	13	4.9	13	13	14	5.8	12	18	13	1400[1]
Mercury	0.023	0.037	ND	ND	ND	0.020	ND	0.088	0.018	0.025	ND	0.025	0.23	0.017	17[1]
Nickel	8.6	57	12	8.2	17	9.9	10	44	10	13	5.8	10	740	17	35000[1]
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11000[1]
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8200[1]
Vanadium	1200	590	1200	210	1000	2900	1500	390	1600	2300	62	160	3500	1100	10000[1]

[1] Florida Soil Cleanup Target Levels - http://www.dep.state.fl.us/waste/quick_topics/rules/documents/62-777/62-777_TableII_SoilCTLs.pdf

[2] National Environment & Planning Agency - Interim Standards for Petroleum in Groundwater and Soil

5.4.1.4 Conclusions

- Samples analysed for petroleum hydrocarbons were found to be compliant with the NEPA 1000 mg/kg standard. Highest petroleum concentrations were recorded at the BH4 sample point with the 2.5' sample having the higher concentration of 610 mg/kg. The Florida Soil Cleanup Target Level leachability standard with respect to groundwater criteria is 340 mg/kg. With reference to this standard, it was realised that the BH4 - 2.5' standard was non-compliant. Specifically relating to BH4 groundwater was measured at approximately 3.5 feet below ground. It is recommended that in an effort to address issues of contamination and mitigate against the possibility of having contaminants leach into groundwater, remedial action be undertaken as soon as possible. It is anticipated that as part of site preparation for the construction of the 190 MW power plant, land preparation of some sort will be undertaken. It is recommended that impacted soil in the vicinity of BH4 be excavated to a depth of 3.0 feet, minimum, (not to reach groundwater), providing that excavated soil can be safely disposed of. Should soil excavation and proper disposal not be an option, in-situ remediation is recommended. Note however that in-situ remediation, while considered cost-effective, is a medium term action, which may impact on overall project timelines.
- No benzene, toluene, ethylbenzene, total xylenes (BTEX) or methyl-tert-butyl-ether (MTBE) were detected in any of the fourteen samples analysed.
- Metals including the RCRA metals occur naturally in soil. Therefore it was expected that metals would have been detected in soil. Seven of the RCRA metals were all observed to be within cleanup target levels for all sample points. Arsenic was found to exceed the cleanup target level at BH 7. For BH 6 Arsenic was at the target level of 12 mg/kg. Providing there is an approved facility to accept impacted soils it is recommended that soils be excavated from the BH 7 and BH 6 areas.
- Based on leachability standards (980 Mg/kg) Vanadium was found to be non-compliant. However in the absence of data characterising the naturally occurring metal concentrations for the Old Harbour Bay area, it cannot be categorically stated that these values indicate soil contamination as they may well be within what is normal.
- Regarding Nickel, literature suggests that concentrations vary in soils. The highest concentration of 740 mg/kg recorded by comparison with the results of the samples suggests that there may be impact at the BH7 sample point; however impact does not persist beyond 7.5 feet. Groundwater level was recorded at approximately 7 feet below ground. It is recommended that soils in the vicinity of BH 7 be excavated to a depth not to reach groundwater in an effort to remediate by means of excavation, providing there is an approved facility that can receive impacted soils.
- As it relates to concentrations of Iron recorded; while values of 29,000 mg/kg to 41,000 mg.kg may seem elevated, it should be noted that "Iron is the most abundant element in soils, ranging from 7,000 mg/kg to 500,000 mg/kg, with a mean concentration of 38,000 mg/kg (3.8%) in soils, (Lindsay 1979)" (*as reported in The Handbook of Soil Science; Summer, Malcolm E.; 1999)*. This suggests therefore that the values recorded are within what is considered normal and does not necessarily indicate soil contamination.

5.4.2 Cooling Water Discharge

The marine area in proximity to the proposed JPS power plant is used for cooling water discharge by the existing JPS Old Harbour Power Plant and the JEP Doctor Birds 1 and 2 Power Barges. These three sources represents potential thermal pollution to the marine environment.

Over the years the cooling water discharge from the JPS Old Harbour plant flume has been a source of concern as it was a source of elevated water temperature which tended to hug closely to the shoreline in a westerly direction. The JPS has worked consistently in improving this situation and while not in total compliance with the NEPA standard (± 2 ^{o}C of ambient water temperature) or World Bank guidelines (> 3^{o}C at 100m from the point of discharge), has improved the situation tremendously. The proposed new power plant will however, result in the cooling water discharge becoming compliant.

The JEP barges cooling water discharges since there commissioning have been compliant with the World Bank guidelines, however, at times they are non-compliant with the NEPA standard at certain depths (most times at the surface).

5.4.3 Runoff from the Bowers Gully

Bower's Gully, which is located west along the proposed site area has water depths exceeding 1.5 meters towards the sea and is affected by tidal influences from the sea. A sediment bar at the mouth of the Gully reduces channel depths to less than 0.5 meters. The influence of the Gully and the sediment type results in water that is very turbid resulting in poor visibility (Plate 5-48) (C. L. Environmental Co. Ltd. 2012). During heavy rains the water becomes very turbid owing to sediment resuspension.

The sediments that the Bowers Gully also influence silting in the bay, evidenced by the increased maintenance dredging frequency of the Windalco Port Esquivel facility.

Plate 5-48 Photograph showing general conditions of Bowers Gully

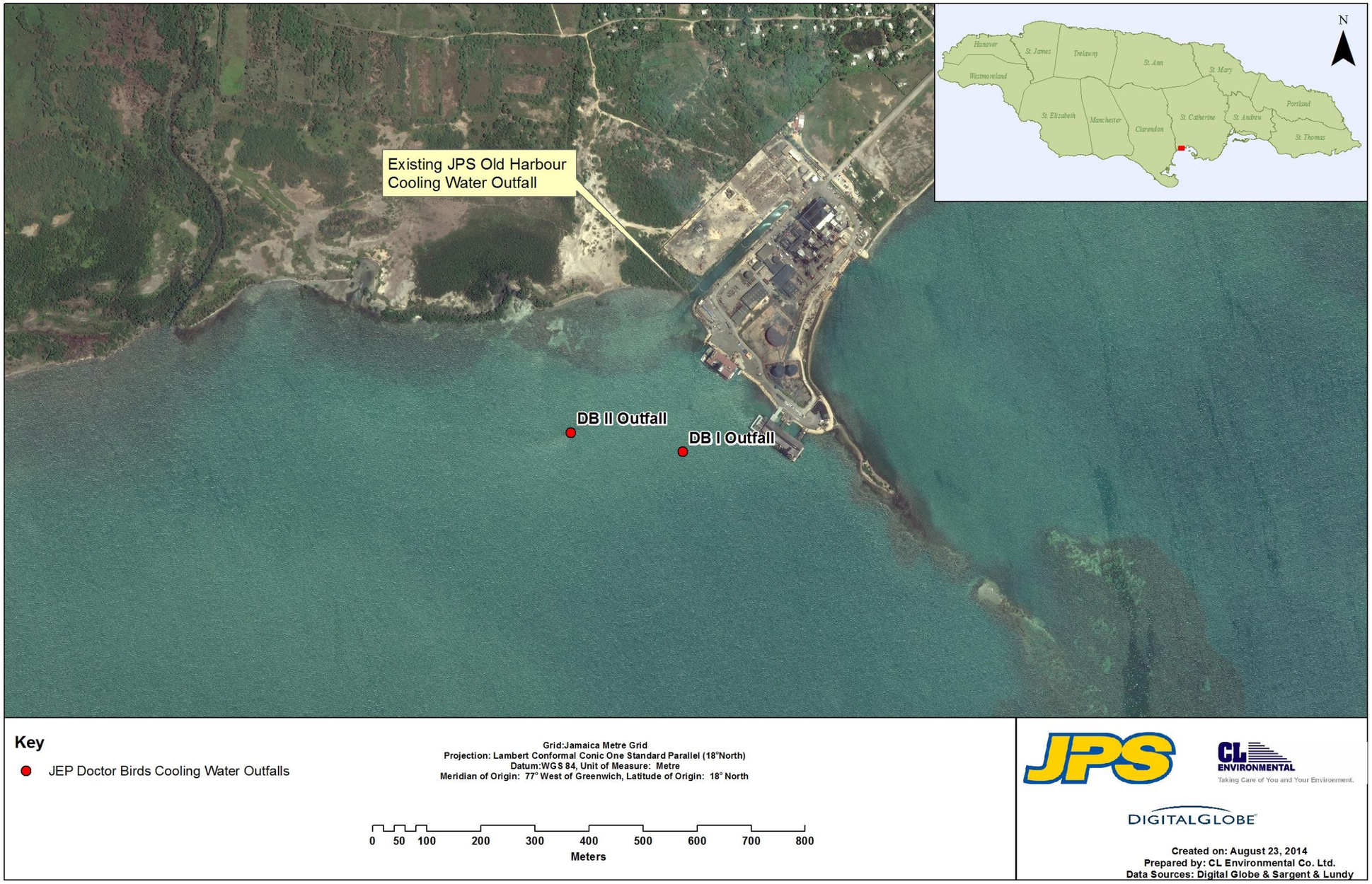


Figure 5-115 Map depicted JPS and JEP Doctor Birds cooling water discharges

5.5 HERITAGE

The Jamaica National Heritage Trust (JNHT) conducted an Archaeological Impact Assessment (AIA) on the site of the proposed South Jamaica Power Company Limited (SJPC) 360MW Power Plant. The field survey was conducted over a 2 day period, May 16 and 17, 2012.

Historically, the area contains historic and archaeological sites dating back to Jamaica's first known inhabitants (The Taíno) and later those who came the Spanish, the Africans and the British. The area has seen various land uses over the past centuries. Cattle rearing were the main activity in the area during pre and post emancipation periods. It should be noted that all the plantations, pens and estates in the area had plantation houses and enslaved villages. In the more recent past aquaculture was done on some areas of the property.

Currently the sections slated for development are in ruinate with charcoal burning occurring and presently the waste storage area for the existing JPS Old Harbour Bay power plant.

No pre-historical or historical cultural material or feature was observed in the area designated for the construction of the plant. It is worth noting, however, that survey of the area was restricted by the dense vegetation cover. Pre historical cultural material in the form of pottery shards, both Spanish and English bricks and concrete troughs associated with cattle rearing were found to the immediate east and west of the site. Detailed results of the assessment may be found in the Archaeological Impact Assessment report submitted in conjunction with the EIA for the South Jamaica Power Company Limited (SJPC) 360MW Power Plant.

5.6 HUMAN SOCIAL

5.6.1 Demography, Services and Infrastructure

5.6.1.1 Approach

Social Impact Area

In order to assess the various social elements of the proposed project, a Social Impact Area (SIA) was established. An SIA may be described as the estimated spatial extent of the proposed project's effect on the surrounding communities. Demographic analyses are carried out utilising this SIA demarcation, and social services, infrastructure and industrial facilities are described in relation to the SIA as well. For the purposes of this project, the SIA was demarcated as two (2) kilometres from the proposed development area. As seen in Figure 5-116, the SIA is located in Old Harbour Bay, in the parish of St. Catherine. Old Harbour Bay community consists of twenty-four (24) small communities, which include Blackwood Gardens, Kelly Pen, Thompson Pen, Bay Bottom, Terminal, Dagger Bay, More Pen Lane, Peter's Land, Sal Gully, Cross Road and Panton Town. Bordered by the Colbeck Castle community to the east and Bourkesfield to the southeast. The settlements of Port Esquivel, Brampton Farm and Lloyd's Pen surround the demarcated SIA.

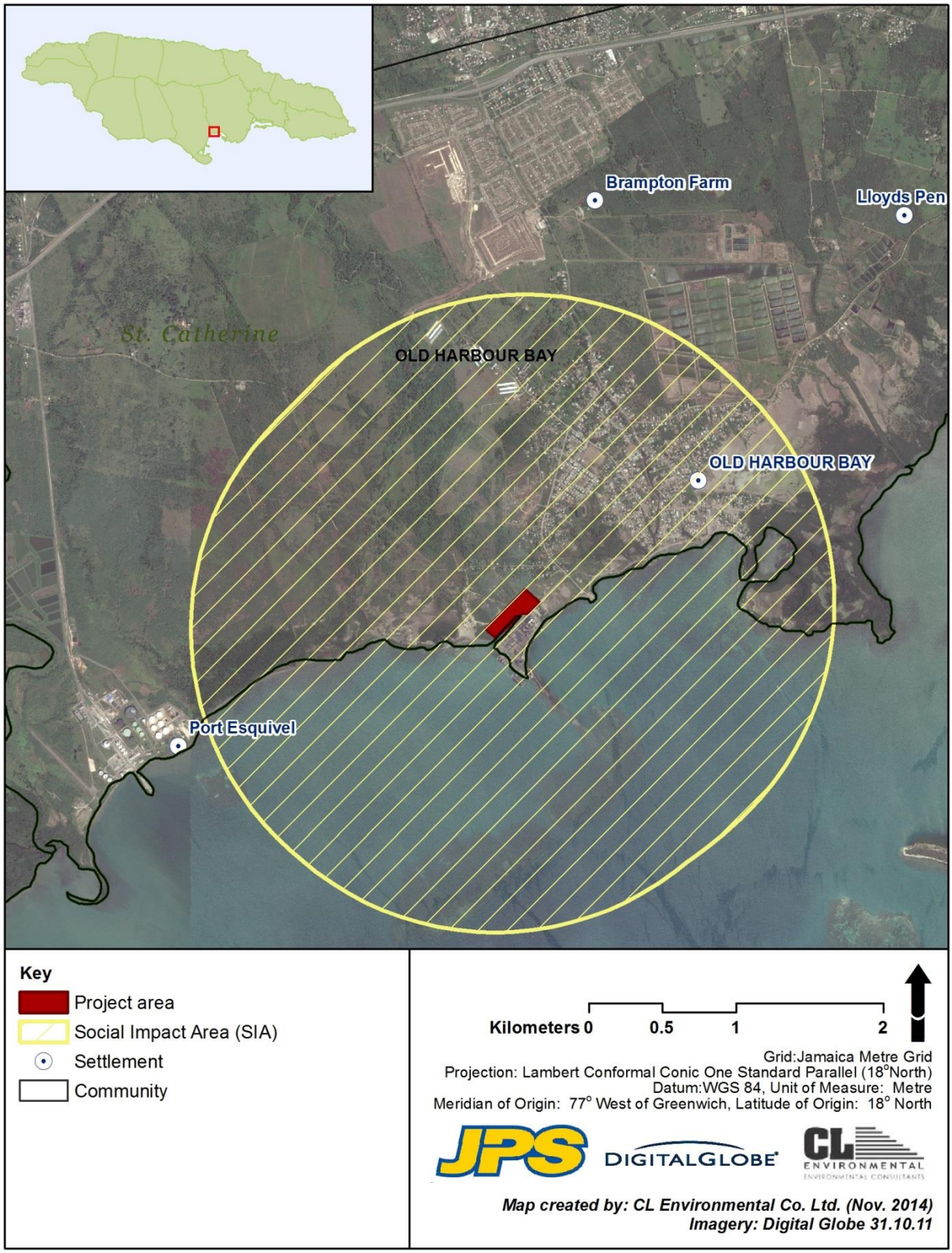


Figure 5-116 Map showing the Social Impact Area (SIA)

Demographic Analyses and Census Database

Population data were extracted from the STATIN 2011 Population Census database for the SIA by enumeration district. This was undertaken using Geographic Information Systems (GIS) methodologies, which were also used to derive visual representations of the data. In order to derive information from the census data the following computations were made:

- ***Population growth*** - was calculated using the formula [$i_2 = i_1 (1 + p)^x$]; where i_1 = initial population, i_2 = final population, p = actual growth rate and x = number of years.
- ***Population density*** – was derived by dividing the population by the land area. This is useful for determining the locations of greater concentrations of population.
- ***Dependency ratio*** – was calculated using the formula [child population + aged population /working population X 100], where the child population is between ages 0-14, the aged population is 65 & over and the working population is between ages 15-64 years. This ratio is useful for understanding the economic burden being borne by the working population.
- ***Male sex ratio*** – was calculated by using the formula [male population / female population X 100]. This in effect denotes the amount of males there are to every 100 females and is useful for determining the predominant gender in a particular area.
- ***Domestic water consumption*** - was calculated based on the assumption that water usage is 227.12 litres/capita/day and sewage generation at 80% of water consumption. Water consumption for workers in Jamaica is calculated at 19 litres/capita/day and sewage generation at 100% water consumption.
- ***Domestic garbage generation*** - was calculated at 4.11 kg/household/day (National Solid Waste Management Authority).

Other GIS Data

Geospatial data for various services and infrastructure, including schools, health centres, hospitals, police stations, fire stations and post offices were obtained from Mona GeoInformatics Institute. Additional data were also gleaned from the 1984 national topographic maps (metric series) and satellite imagery available for the project.

5.6.1.2 Demography

Population Growth Rate

The total population within the SIA in 2011 was approximately 5,026 persons (STATIN 2011 Population Census). Examination of the 2001 population data showed that there were approximately 5,601 persons within the 2 km radius of the proposed development area in 2001. From this population, and that calculated for the year 2011 (5,026 persons), it was estimated that the actual growth within the SIA between 2001 and 2011 was approximately -1.08% per annum. Based on this growth rate, at the time of this study (2014), the population was approximately 4,866 persons and is expected to reach 3,712 persons over the next twenty five years if the current population growth rate remains the same. The annual SIA growth rate of -1.08% differs greatly from the regional rate of 0.72%

for St. Catherine (2001-2011)[12]; at the regional rate, the population within the SIA is estimated at 5,136 persons in 2014 and 6,145 persons in 2039.

Age & Sex Ratio

Table 5-67 shows the percentage composition of each age category of the population. This is compared on a national, regional and local (SIA) level. Percentage age for the 0-14 years age cohort is highest in the SIA (28.1%), when compared to the regional and national figures of 26.1%. Elderly persons aged 65 years and greater make up 5.5% of the SIA population; this is lower than both the national figure (8.1%) and the St. Catherine figure of 7.0%. Within the SIA, the 15-64 years age category accounted for 66.4% and can therefore be considered a working age population. This SIA percentage was slightly lower than that for the nation (65.9%), and comparable to the parish of St. Catherine (66.9%) (Table 5-67). A Social Development Commission (SDC) Community Profile for the community of Old Harbour Bay in 2007 indicated the population can be considered as a working age population with 63% of the community's population being between the ages of 15-64 years; this is similar to the 2011 Census data presented here.

Table 5-67 Age categories as percentage of the population for the year 2011

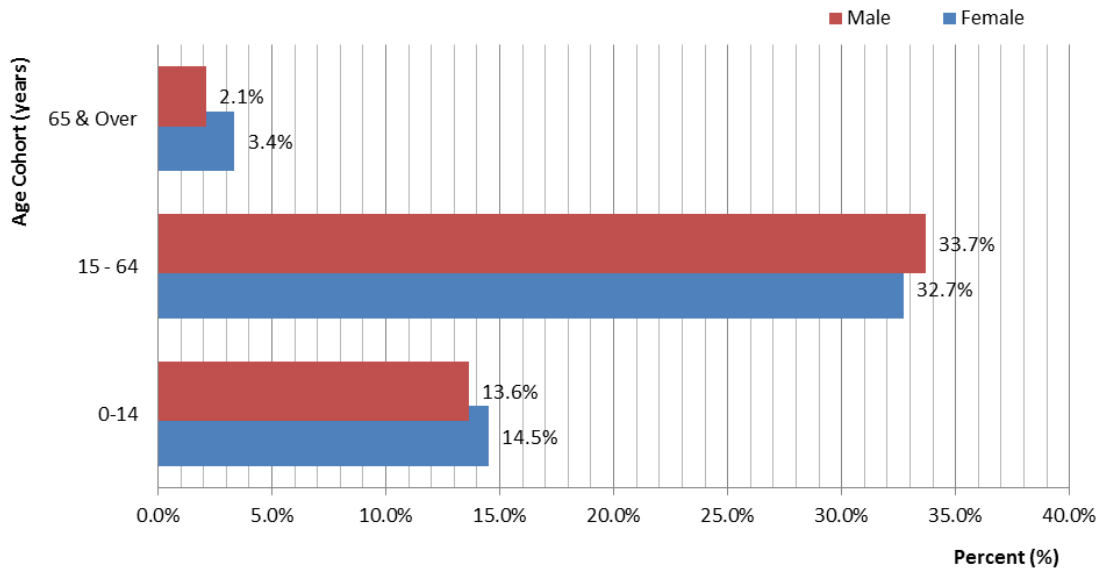
Source: STATIN Population Census 2011

Age Categories	Jamaica	St. Catherine	SIA
0-14	26.1%	26.1%	28.1%
15 - 64	65.9%	66.9%	66.4%
65 & Over	8.1%	7.0%	5.5%

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 the SIA population, approximately 7.4% comprised the young category and as mentioned previously, 5.5% make up the 65 years and older category.

As seen in Figure 5-117, Census 2011 data indicated that there were approximately 1.0% more males within the 15-64 years; however there were 1.3% and 0.9% more females in the 65 & over and 0-14 years cohorts respectively. Sex ratio for all age cohorts within the SIA was calculated to be 97.7 males per one hundred females. This is comparable to the 2007 SDC Profile of Old Harbour Bay that stated that there were more females (53.9%) than males (46.1%) in the population.

[12] http://statinja.gov.jm/Census/Census2011/Census%202011%20data%20from%20website.pdf

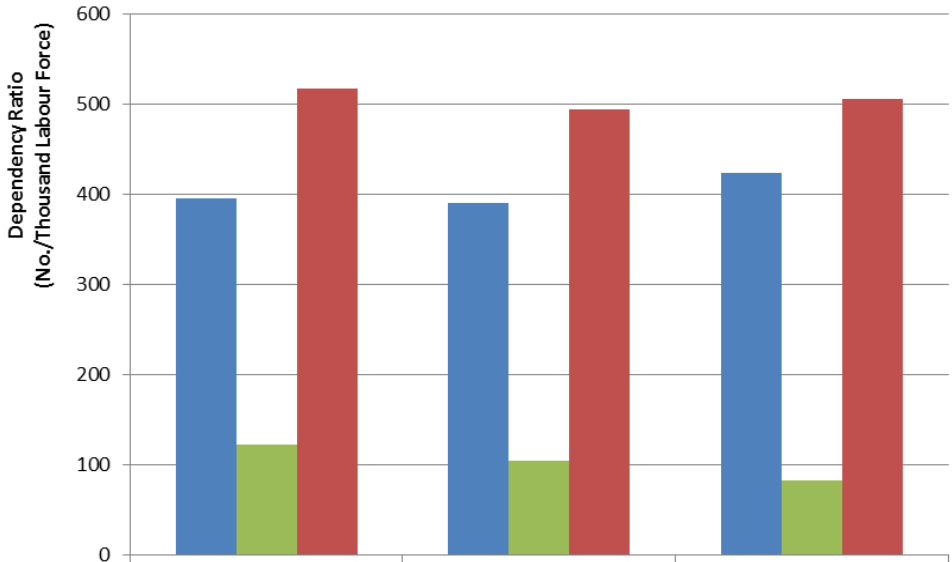


Source data: STATIN Population Census 2011

Figure 5-117 Male and female percentage population by age category for the SIA in 2011

Dependency Ratios

The child dependency ratio for the SIA in 2011 was 424.0 per 1000 persons of labour force age; old age dependency ratio stood at 82.4 per 1000 persons of labour force age; and societal dependency ratio of 506.4 per 1000 persons of labour force. This indicates that the youth (child dependency) are far more dependent on the labour force for support when compared with the elderly. Comparisons of the child dependency ratios at varying extents indicate that the child dependency ratio for the study area (SIA) was higher than the national and regional figures of 395.4 and 390.8 respectively (Figure 5-118).



	Jamaica	St. Catherine	SIA
Child Dependency	395.4	390.8	424.0
Old Age Dependency	122.4	104.0	82.4
Societal Dependency	517.8	494.8	506.4

Source: STATIN Population Census 2011

Figure 5-118 Comparison of dependency ratios for the year 2011

Population Density

The land area within the SIA was calculated to be approximately 7.6 km^2. With a population of 5,026 persons in 2011, the overall population density is estimated at 663.9 persons/km^2. This population density is considerably higher than the regional level (433.6 persons/km^2), as well as the national density of 245.5 persons/km^2 (Table 5-68). As seen in Figure 5-119, the population is not evenly distributed within the SIA; fewer persons live in the western and northern EDs within the SIA.

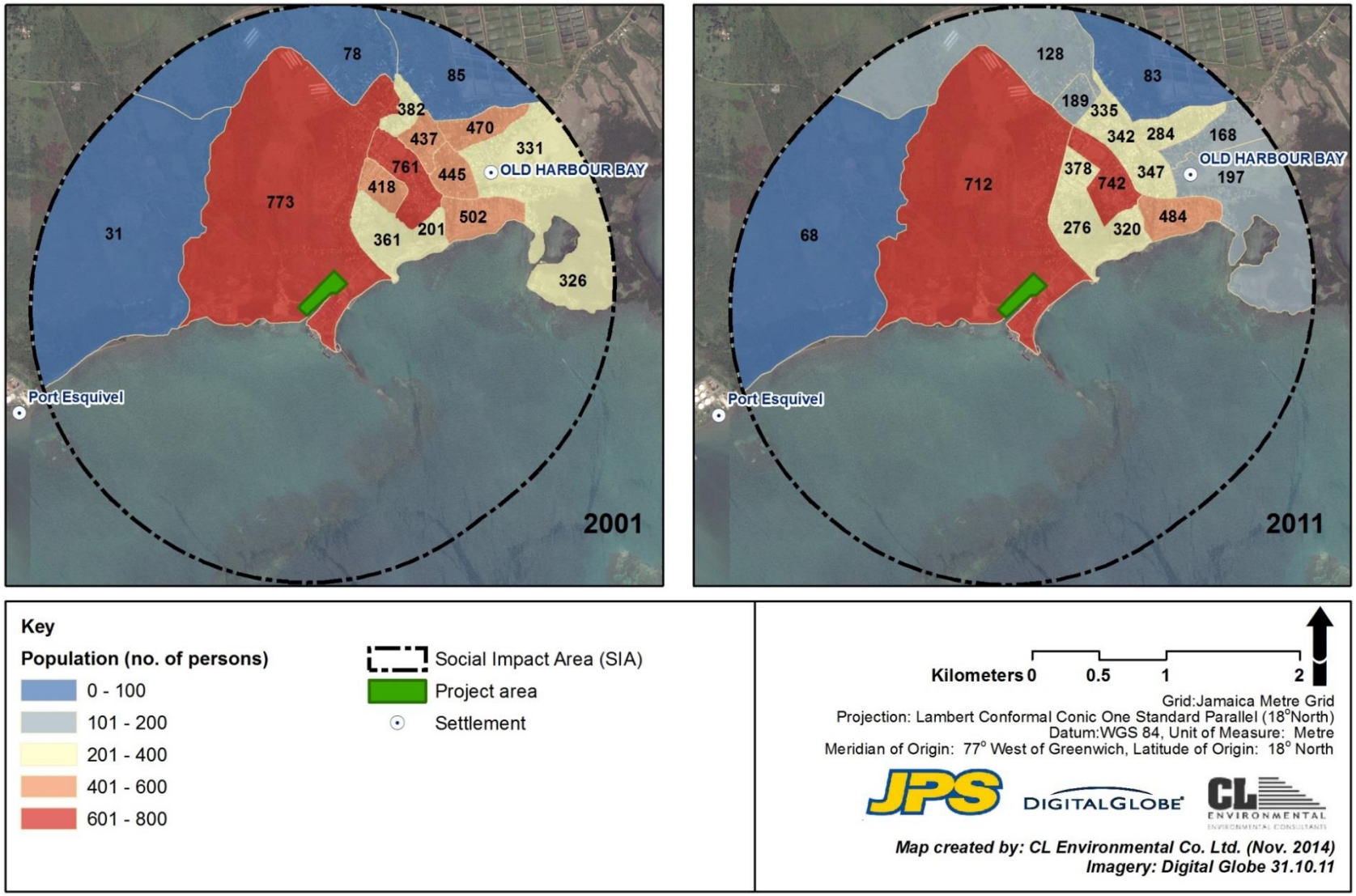
Table 5-68 Comparison of population densities for the year 2011

Source: STATIN Population Census 2011

Category	Jamaica	St. Catherine	SIA
Land Area (km^2)	10,991.0	1,190.6	7.6
Population	2,697,983	516,218	5,026
Population Density	245.5	433.6	663.9

Population Growth Areas

Figure 5-119 depicts the population within each enumeration district (ED) for the years 2001 and 2011. Total SIA population decreased from 5,601 persons to 5,026 persons within this ten year timeframe. An increase in population is observed for three EDS - two located to the west and north of the SIA, and another located 700 metres northeast of the project area. Population decreases are noticeable in all other EDs within the SIA.



Data source: STATIN Population Census 2011 and 2001

Figure 5-119 SIA 2001 and 2011 population data represented in enumeration districts

Migration Patterns

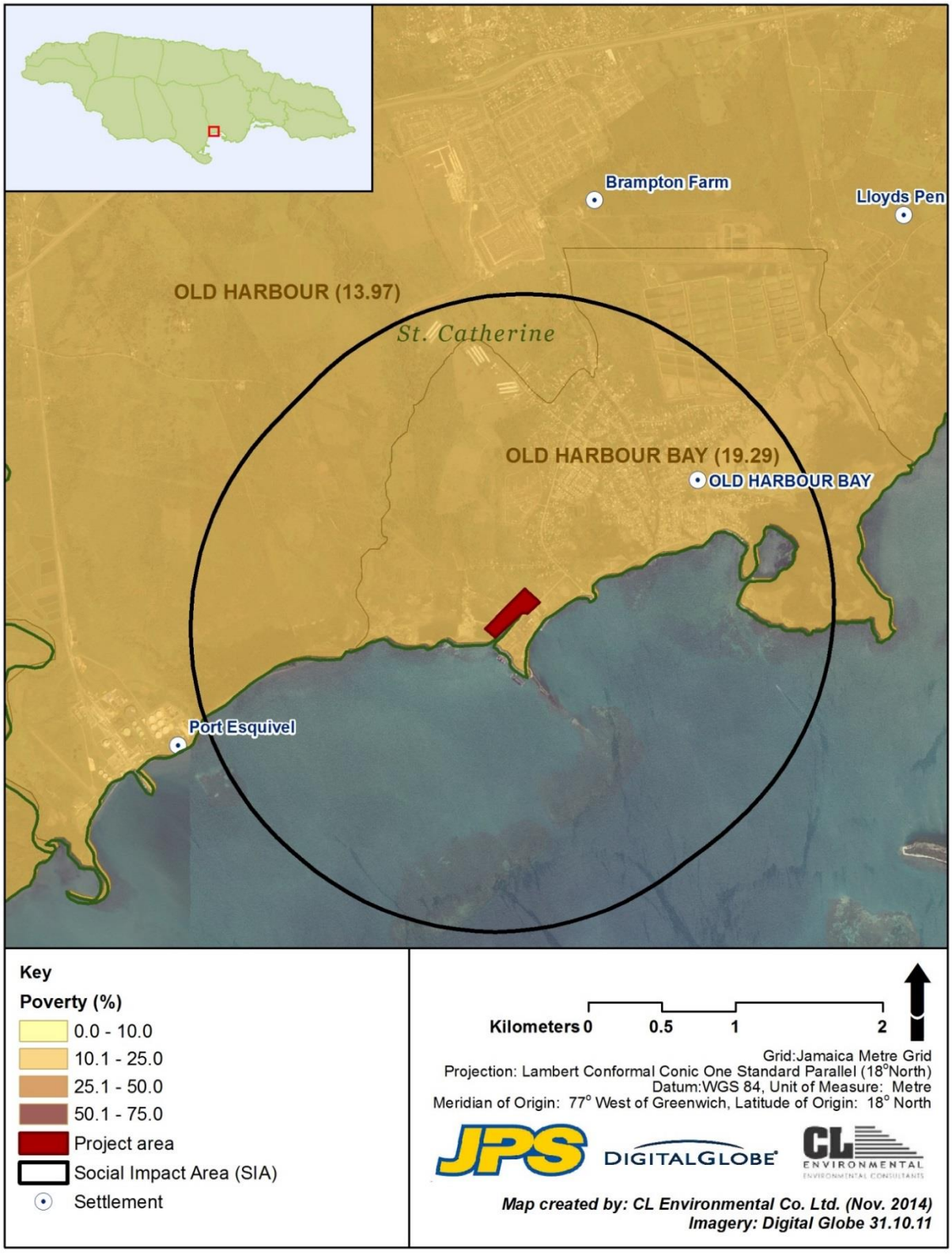
Migration is quite uncommon in the Community, as most residents (88.6%) have lived in the Community for 10 or more years (SDC 2007).

5.6.1.3 Poverty

The poverty GIS dataset developed by the Planning Institute of Jamaica (PIOJ) (with contributions from STATIN, Social Development Commission (SDC) and the University of Technology), primarily identifies areas of poverty by community. As described by PIOJ, for the 2002 poverty map:

> The indicators utilized were those that best predicted per capita consumption levels in households based on data from the Jamaica Survey of Living Conditions (JSLC) 2002. Relevant variables that were common to this survey and the Population Census 2001 were selected and tested for similarity. The satisfactory variables were then applied to the census data to obtain estimates of the consumption levels of the households that had consumption levels islandwide. Members of households that had consumption levels below the poverty line for the region in which their household was located were deemed to be in poverty. The proportion of persons in poverty in each community was used to rank the 829 communities.

As seen in Figure 5-120, the SIA population generally has less than 20% of persons living in poverty.



Data source: PIOJ (with contributions from STATIN, SDC and the University of Technology

Figure 5-120 Proportion of persons in poverty in each community

5.6.1.4 Education

The educational attainment of persons in 2011 for the national, regional and SIA extents are represented in Table 5-69. When educational attainment within the SIA is calculated as a percentage, it becomes evident that there is a propensity towards the attainment of a primary and secondary school education. Approximately half of the SIA population (50.7%) attained a secondary school education, followed by 33.6% attaining a primary education. Secondary educational attainment is higher than the Jamaica and St. Catherine figures (45.7% and 44.7% respectively). There are lower percentages of those attaining a university or other tertiary level in the SIA (6.2%) when compared to the national combined total of 9.9% for Jamaica and 12.7% for St. Catherine. Statistics for pre-primary and no education are comparable amongst all extents examined.

Table 5-69 Population 3 years old and over by highest level of educational attainment as a percentage, for the year 2011

Source: STATIN Population Census 2001

	Jamaica	St. Catherine	SIA
No Schooling	0.7%	0.6%	0.5%
Pre Primary	4.8%	4.9%	5.0%
Primary	34.4%	32.0%	33.6%
Secondary	45.7%	44.7%	50.7%
University	4.7%	5.9%	1.9%
Other Tertiary	5.2%	6.8%	4.3%
Other	0.5%	0.7%	0.4%
Not Stated	4.0%	4.4%	3.6%

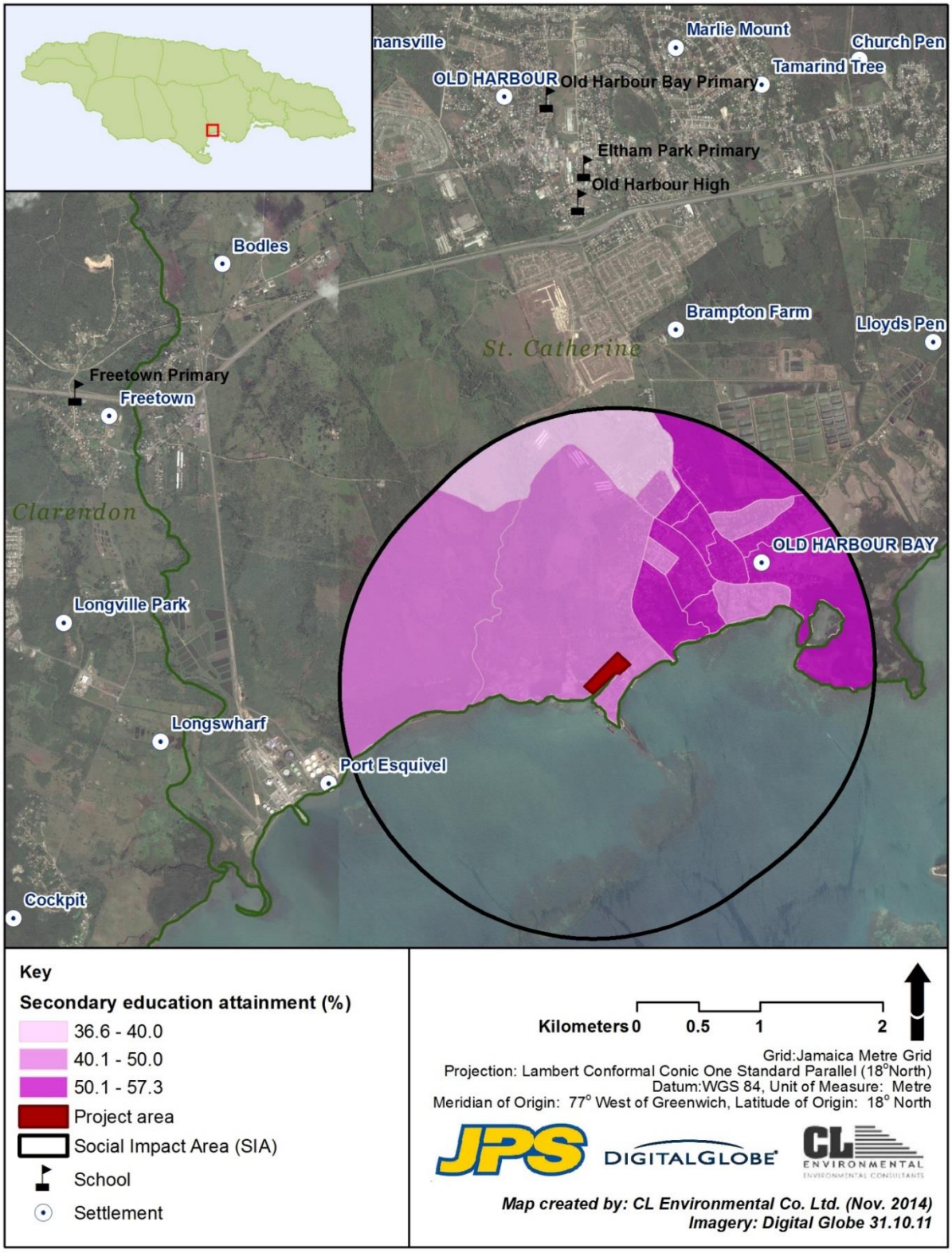
The relatively high proportion of the population in proximity to the project location attaining a secondary education, as well as tertiary education suggests that the labour pool is relatively educated, and as such, there should be no problem in obtaining non-technical workers from the community. This is shown in Figure 5-121, which also depicts the location of schools in proximity to the proposed location. No schools are found within the 2 km buffer SIA; the closest schools in proximity to the proposed location are situated north of the project area - approximately 3.7 km (Old Harbour High), 3.9 km (Eltham Park Primary) and 4.5 km north (Old Harbour High), as well as 4.9 km northwest (Freetown Primary).

In 2007, a large majority of the household heads had attained some level of education (93.5%). This was either, pre-primary, primary, secondary, all age, university, vocational, other tertiary or post-secondary. Similar to the 2011 Census data, the highest educational level attained by most household heads was secondary (51.2%). Only 3.3% of the household heads obtained university level education and 0.8% received vocational training (SDC 2007). Approximately 83% of the household members in the community of Old Harbour Bay had no academic qualification. When further broken down it can be seen that 83% of the male and 84% of the female population had no qualification (SDC 2007) (Table 5-70).

Table 5-70 Educational attainment as a percentage of household members in the community of Old Harbour Bay (2007)

Source: SDC 2007

QUALIFICATIONS	%MALE	%FEMALE
None	83.3	83.5
CXC Basic, JSC, JHSC, JSCE, SSC,JC or 3rd JLCL	3.3	1.7
CXC General, GCE 'O', AEB 1-2 Subjects	0.8	0.8
CXC General, GCE 'O' , AEB 3-4 Subjects	1.7	3.3
CXC Gen, GCE 'O', AEB 5+ Subjects	0.8	0.8
GCE 'A' Level/ Cape 1-3 Subjects, HSC	0.8	0.8
College Certificate/Diploma	1.7	0.8
Vocational (Certificate)	1.7	1.7
Associate Degree / Diploma / Other Certificates and Degrees MOE Recognized	0.0	0.8
Degree / Postgraduate Degree/Professional Qualification	0.8	0.8
Other	3.3	1.7
Not Stated	1.7	3.3
Total	100.0	100.0



Source: Education (STATIN Population Census 2011), Schools (MGI)

Figure 5-121 Percentage population attaining a secondary education within the SIA

5.6.1.5 Employment

Information presented below is primarily taken from the SDC 2007 Community Profile for the Old Harbour Bay Community.

Overview

The SDC 2007 Community Profile data revealed that 63% of the Old Harbour Bay Community population falls within the working age group (15 – 64). Approximately 56.3% of the labour force population in the community was employed at the time of the survey (2007), while 43.8% were unemployed. The data also revealed that on average two persons in each household were employed. Of the employed persons in the community the main categories of employment were full time (33%) and self-employed (50%). Of the remaining employed household members 8.9% were seasonally employed, 5.2% employed part time and 3% contractually employed. The highest percentage of employed persons throughout the cohorts fell between the ages of 35-39 years (21.5%), whereas, notable percentages were within the age range 40- 44 years (16.3%), 30-34 years (14.8%), 25-29 years (12.6%) and 45-49 years (12.6%). Approximately 61.6% of household heads were employed (SDC 2007).

For household heads who stated their monthly income, the most common income bracket reported was JMD $6,000-$24,999 monthly which accounted for 56.8% of employed residents. This was followed by the income brackets of JMD $25,000-$39,999 which accounted for 25.7% of employed residents, JMD $40,000 – 79,999 (9.5%), $3,201 – 5,999 (4.1%), $80,000 – 129,999 (2.7%) and $250,000 and over (1.4%). The main additional source of income for household heads was from remittance (17.6%) (Table 5-71). However a large amount of persons (35.2%) reported having no source of income (SDC 2007).

Table 5-71 Additional Financial Support received by Household Heads

SOURCES	%PERCENT
State Assistance	1.6
Remittances	17.6
Support from local network of family and friends	6.4
Salaries from other members your household	7.2
No additional sources	35.2

**Questionnaire allowed for multiple responses (SDC 2007)*

Unemployed Persons

Males accounted for 33.3% and females 66.7% of the unemployed persons in the community of Old Harbour Bay. Unemployment was highest among cohorts 20-24 years and 60+ years accounting for 22.9% respectively. Unemployed persons were among the cohorts 30-34 years (13.3%), 14-19 years (9.5%), 25-29 years (7.6%) and 35-39 years (7.6%) (SDC 2007) (Table 5-72). Among the unemployed persons sixty years and older females accounted for 15.2% and males 7.6%, while the cohort 20-24 years was equally distributed between males and females. Overall youth unemployment accounted for 32.4% of the total unemployed population (SDC 2007).

Table 5-72 Unemployment Status of Household Members by Gender

Source: SDC 2007

AGE COHORTS	%MALE	%FEMALE	%TOTAL
14 – 19	5.7	3.8	9.5
20 – 24	11.4	11.4	22.9
25 – 29	3.8	3.8	7.6
30 – 34	1.0	12.4	13.3
35 – 39	0.0	7.6	7.6
40 – 44	1.0	3.8	4.8
45 – 49	1.0	3.8	4.8
50 – 54	1.0	4.8	5.7
55 – 59	1.0	0.0	1.0
60 +	7.6	15.2	22.9

A somewhat significant amount of unemployed persons had been unemployed for five years or more accounting for 7.2% of males and 18.4% of females. For household heads that were unemployed, the reasons given for their unemployment were:

- Other reason "not specified (15.2%)
- Trying to find work but do not have the necessary skills or qualifications (12%)
- No Reason (9.6%)
- Illness (5.6%)
- Awaiting a promised job (3.2%)
- Amount of pay (0.8%)
- Have to stay with sick parent/child/elderly relative (0.8%)

For unemployed family members the main reason for unemployment was lack of skills/qualification (19.2%), no reason (9.6%), illness (4.8%), attending school (2.4%), amount of pay and awaiting promised job (1.6% respectively) and have to stay with sick parent/children/elderly (0.8%). The percentages may not add up due to the fact that persons were allowed multiple responses.

Main Occupations by Gender

The most common occupation group among household members was service, shop and market sales, which accounted for 50%. This was followed by agriculture and fishery, craft and related trades work and elementary occupations with 18.6%, 12.7% and 10.2% respectively. Females dominated the area of service, shop and market sales, while agriculture and fishery craft and related trade work had male dominance (Table 5-73).

Table 5-73 Main Occupations by Gender

Source: SDC 2007

OCCUPATION GROUP *(Categorizations Taken from STATIN Labour Force Survey)*	%MALE	%FEMALE	%TOTAL
Professional	3.4	8.3	5.9
Service workers and shop and market sales workers	32.8	66.7	50.0
Skilled agricultural and fishery	34.5	3.3	18.6
Craft and related trades workers	24.1	1.7	12.7
Elementary occupations	5.2	15.0	10.2
Clerks	0.0	5.0	2.5

Existing Skills

The data representing the skill sets present among household members in the community of Old Harbour Bay shows that the dominant areas were construction and cabinet making (19.2%), agriculture/farming (15.4%), beauty care and service (9.6%) and hospitality (9.6%). Most males had the aptitude in construction and cabinet making (33.3%) and agriculture/farming (27.8%), while most of the females were skilled in hospitality (20%), beauty care and service (18%) and commercial and sales (12%) (SDC 2007) (Table 5-74).

Table 5-74 Skill Distribution by Gender

Source: SDC 2007

SKILLS	%MALE	%FEMALE	%TOTAL
Beauty care and service	1.9	18.0	9.6
Hospitality	0.0	20.0	9.6
Construction and cabinet making	33.3	4.0	19.2
Machine and appliance	9.3	0.0	4.8
Commercial and sales	0.0	12.0	5.8
Professional and technical	11.1	6.0	8.7
Agricultural/farming	27.8	2.0	15.4
Secretarial/office clerk	0.0	4.0	1.9
Art and craft	1.9	0.0	1.0
Apparel and sewn products	3.7	8.0	5.8
Other	9.3	20.0	14.4
Not specified	1.9	6.0	3.8
Total	**100.0**	**100.0**	**100.0**

Beneficiaries Social Safety Net Programmes

Approximately 9.5% of the households within the Community had members benefitting from Social Safety Net Programmes. Of the 9.5% households with beneficiaries approximately 4.8% were on the Programme of Advancement through Health and Education (PATH programme), 0.8% for the National Health Fund (NHF) and 0.8% other (SDC 2007).

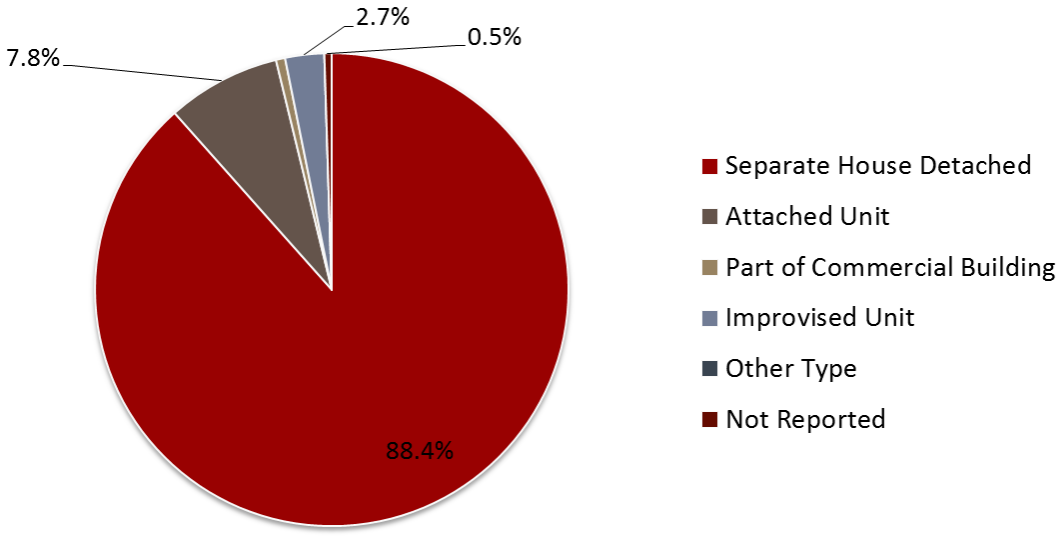
5.6.1.6 Housing

Housing Unit Type

For the purposes of this study the definition of housing unit, dwelling and household are those used in the population census conducted by the Statistical Institute of Jamaica (STATIN). The definition states that:

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

There were 1,447 housing units within the SIA in 2011. Approximately 88.4% of the housing units in the SIA were of the separate detached type, 7.8% were attached, 0.6% were a part of a commercial building, 2.7% were improvised units and 0.5% not reported (Figure 5-122).



Source: STATIN Population Census 2011

Figure 5-122 Percentage of housing units by type within the SIA

Household Headship

The percentage of male household heads to female household heads in the community of Old Harbour Bay was equally distributed at 50% respectively. This finding slightly contrasts with national presentation in the Jamaica Survey of Living Conditions (JSLC) 2007, where slightly more males (53.4%) than females (46.6%) were heading households in Jamaica (SDC 2007).

Informal Settlements

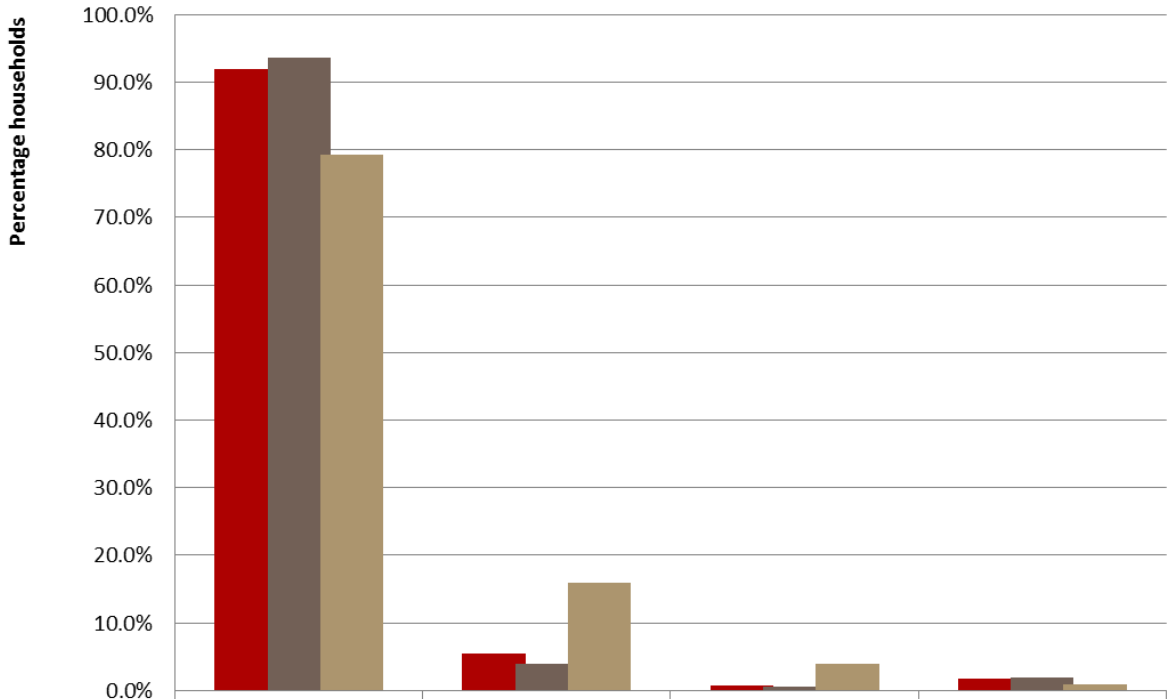
Terminal is part of the wider Old Harbour Bay community, which was originally known as Burkesfield. The name Terminal came into existence due to the construction of the Marine Terminal by the United States Marine Corps. The topography is generally flat and is characterized by ponds and swamps. This informal settlement has a street pattern that is made up of unpaved roads and footpaths. This informal residential area has 41 houses and assets such as three (3) shops and three (3) livestock farms (CLE 2007). The building typology and particularly housing in the area were predominantly poor structures built with temporary materials This is evident in the fact that 42% were very poor while only 7% were deemed very good, 24% were poor, 17% were good and 10% were fair. Another finding was that of the forty one (41) houses identified, thirty eight (38) were occupied while three (3) were unoccupied. Five (5) houses were abandoned and/or derelict and three houses were under construction.

The materials of housing construction ranged from a few well-built block and steel structures to a plethora of poorly built wooden houses. Only 24% of houses were made of block and steel while 66% were made of wood. 10% were constructed of mixed materials, most of which were a combination of block and steel, and wood. According to statistics, the population of the original study boundary was 144 persons, while the average household size was 3.97 persons per household. This statistics is slightly higher than the average household size for Jamaica and that of rural areas within Jamaica which stands at 3.4 and 3.6 persons per household (PIOJ, 2002) respectively.

5.6.1.7 Infrastructure

Lighting

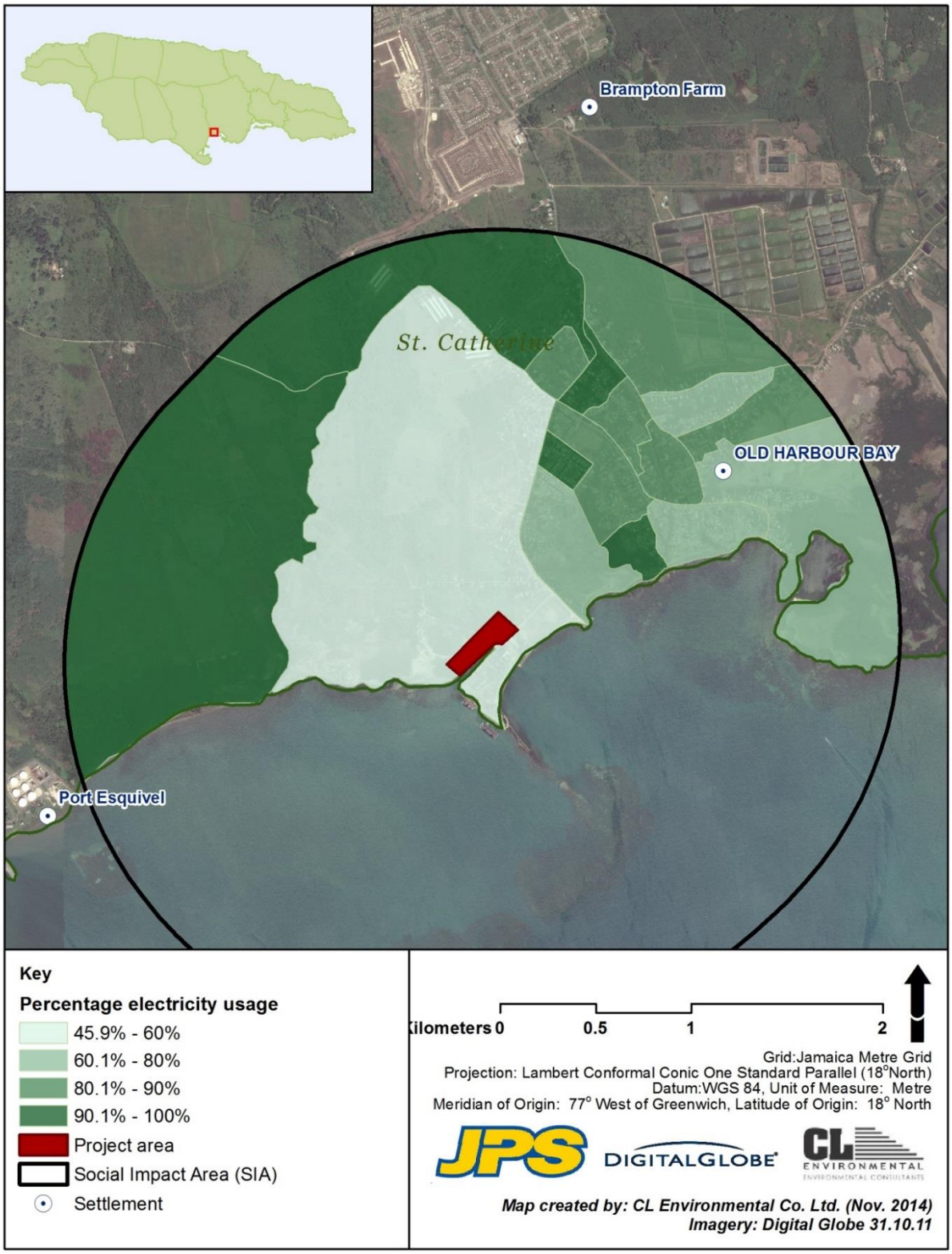
The percentage of households using electricity as their main means of lighting in the SIA (79.2%) was lowest amongst all extents (Figure 5-123). Data for the parish and national extents showed that less than 6% of households utilise kerosene; however within the SIA, 15.9% of households utilise this source of lighting. Other means of lighting was highest in the SIA (4.0%). Figure 5-123 details the percentage of households using a particular category of lighting and Figure 5-124 depicts the percentage households in the SIA using electricity.



	Electricity	Kerosene	Other	Not Reported
Jamaica	91.9%	5.5%	0.8%	1.8%
St. Catherine	93.6%	4.0%	0.6%	1.9%
SIA	79.2%	15.9%	4.0%	0.9%

Source: STATIN Population Census 2011

Figure 5-123 Percentage households by source of lighting



Source: STATIN Population Census 2011

Figure 5-124 Percentage dwelling with electricity within the SIA for the year 2011

Domestic Water Supply

The National Water Commission (NWC) is the public agency responsible for providing Jamaica's domestic water supply. Eighty nine percent (89.0%) of the households within the SIA received their domestic water supply from a public source, this is higher than the national and parish levels (75.5% and 82.2% respectively). About 5.7% of the households in the SIA received water from private sources, 3.9% from other sources, 0.3% from trucked water and 1.1% not reported.

Table 5-75 Percentage of households by water supply for the year 2011

Source: STATIN Population Census 2011

	Category	Jamaica	St. Catherine	SIA
Public Source	Piped in Dwelling	49.7%	63.5%	42.6%
	Piped in Yard	16.5%	16.1%	41.3%
	Stand Pipe	7.1%	1.8%	0.6%
	Catchment	2.2%	0.9%	4.6%
Private Source	Into Dwelling	6.4%	4.4%	3.5%
	Catchment	9.8%	3.6%	2.2%
	Spring/ River	3.0%	3.1%	0.0%
	Trucked Water/Water Truck	2.1%	3.7%	0.3%
	Other	1.8%	1.6%	3.9%
	Not Reported	1.3%	1.2%	1.1%

Water demand for the SIA in 2014 is estimated to be 1,105,165.9 litres/day (~291,954.0 gals/day) and is expected to decrease to 843,069.4 litres/day (~222,715.4 gals/day) over the next twenty five years based on population growth rates calculated previously.

Wastewater Generation and Disposal

It is estimated that approximately 884,132.7 litres/day (~233,563.2 gals/day) of wastewater is generated within the study area (for 2014) and is expected to decrease to 674,455.6 litres/day (~178,172.3 gals/day) over the next twenty five years based on calculated growth rates. Census 2011 data for wastewater disposal methods was not available. According to the SDC 2007 Community Profile of Old Harbour Bay, a significant number of households in the Community used pit latrine (48%), water closet linked to sewer (36%), water closet not linked to sewer (13.6%) and 6.4% soakaways (percentage won't add up as multiple responses were allowed). 15.7% of the households shared toilet facilities. On average these facilities were shared with approximately four other families.

Solid Waste Generation and Disposal

The National Solid Waste Management Authority (NSWMA) is responsible for domestic solid waste collection within the study area and specifically, MPM Waste Management Ltd. covers the parish of St. Catherine. In residential areas, garbage is collected once per week. This service is provided free (partial covered by property taxes) for the households within the area. The waste is transported to the Riverton Waste Disposal Site (landfill) located in southeast St. Catherine, approximately 29 km

northeast of the proposed development area. Riverton Waste Disposal Site is approximately 1.19 m^2 (119 hectares). It receives approximately 60% of the islands waste. Solid waste collection for commercial and industrial facilities is done by arrangements by these entities with private contractors. It is estimated that at the time of this study (2014), approximately 7,188.39 kg (~7.2 tonnes) of solid waste was being generated in the SIA.

5.6.1.8 Communication and Social Services

Telecommunication

The parish of St. Catherine and the study area are served with landlines provided by LIME Jamaica Limited (formerly Cable and Wireless). Wireless communication is provided by Digicel Jamaica Limited and LIME; a network to support internet connectivity is also provided by LIME and Flow.

Post Offices

Post offices are not found within the demarcated SIA; that found in Old Harbour is the closest to the proposed development area (approximately 4.2 km north of the project area).

Market/Shopping

There are two markets in proximity of the proposed site, namely the Old Harbour market and the Old Harbour Bay market.

5.6.1.9 Health and Emergency Services

Health Centres

One health centres exist within the SIA, namely the Old Harbour Bay Health Centre situated approximately 1.25 km northeast of the project area. This health centre, along with others situated in the parish of St. Catherine and depicted in Figure 5-125, (e.g. Old Harbour and Church Pen) fall under the responsibility of the Southeast Regional Health Authority (SERHA). The centre is a Type II Health Centre; it is serviced by a visiting Doctor and Nurse Practitioner and serves a population of about 12,000 persons. 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 are the services provided. [13] The main types of problems are asthma, diabetes and arthritis. It has a seating capacity of 150 persons; however, the facility experiences overcrowding when at times more than 400 patients are present. The public health facilities are without an ambulance; however, in case of emergencies, help is sought from the Jamaica Public Service, JAMALCO, WINDALCO or from the Spanish Town Hospital.

Hospitals

There are currently no public or private hospitals within the SIA; May Pen Hospital and Lionel Town Hospital are the closest to the site. Both are located approximately 18 km from the project area

[13] http://www.wrha.gov.jm/content/wrha_profile.html

(northwest and southwest respectively) and belong to the Southern Regional Health Authority (SRHA). The Lionel Town Hospital is a 'Type C' hospital. These are the basic district hospitals which interface with the Primary Health Care system at parish level. Inpatient and outpatient services are provided in general medicine, surgery, child and maternity care.[14] The Lionel Town Hospital is a 45 bed facility staffed by approximately 96 clinical, administrative and support staff. It provides services in the disciplines of Minor Surgery and General Medicine along with a monthly clinic in the area of Mental Health. May Pen Hospital is considered a 'Type C' hospital, however is being transitioned to a 'Type B' hospital. The following clinics and services have been put in place: medical, nutrition, ante-natal, gynaecological, blood centre, ECG, central sterilization, opening of an additional ward and 24 hour service in A&E, O.T., laboratory, radiography and Patient Admission System. The final expansion strategies for the hospital to be officially declared a Type "B" are the recruitment of a Paediatric Consultant and the opening of the sixth ward. [15]

Spanish Town Hospital belongs to the SERHA and is located approximately 20 km northeast of the project area. It is the largest 'Type B' Hospital in the island and services include medicine, surgery, urology, radiology, paediatrics, pathology, orthopaedics, laboratory and obstetrics and gynaecology. Demands on these services increased owing to growing communities in St. Catherine such as Portmore, Eltham and Ensom City which access the hospital, as well as increased numbers of motor vehicle accident victims from nearby highways. In response to these demands, improvements to the hospital were made. For example in 2008, the Katie Hoo Haemodialysis Centre was officially opened and is equipped with seven (7) machines, six (6) stations as well as other dialysis equipment. One year following this, the King of Spain Wing opened; this is a 34 bed facility which also hosts the Physiotherapy Department. The Spanish Town Hospital currently has a total bed capacity of 600, staff complement of 320 and annual patient load of 160,000[16].

Ambulance

The public health facilities are without an ambulance; however, in case of emergencies, help is sought from the Jamaica Public Service, JAMALCO, WINDALCO or from the Spanish Town Hospital.

Fire Stations

The Old Harbour Fire Station is the closest fire station to the proposed development area and is situated outside the 2 km SIA, approximately 4.4 km north of the project area (Figure 5-125). This station falls under Area III. This station has one fire engine with a water capacity of 1,818 – 2,273 litres (400-500 imperial gallons). If additional help is needed, backup would be called from the Spanish Town Fire Station, some 20 km away or May Pen Fire Station some 17 km away. Fire stations islandwide are served by a fleet of 91 operational firefighting and rescue vehicles and 58 utility

[14] http://www.serha.gov.jm/HospitalClassification.aspx

[15] http://www.srha.gov.jm/(S(cjpesv45wp1hxh45tmztaw55)A(LWGTf5TRzQEkAAAAYmExZGEyNTMtOTQ1MS00Y2E5LWExN2MtOTg5MDc0MzMzNzZiZBmNPbLEvZ8oIv4EJ8HqK7ztlLQ1))/Facilities/MPH.aspx

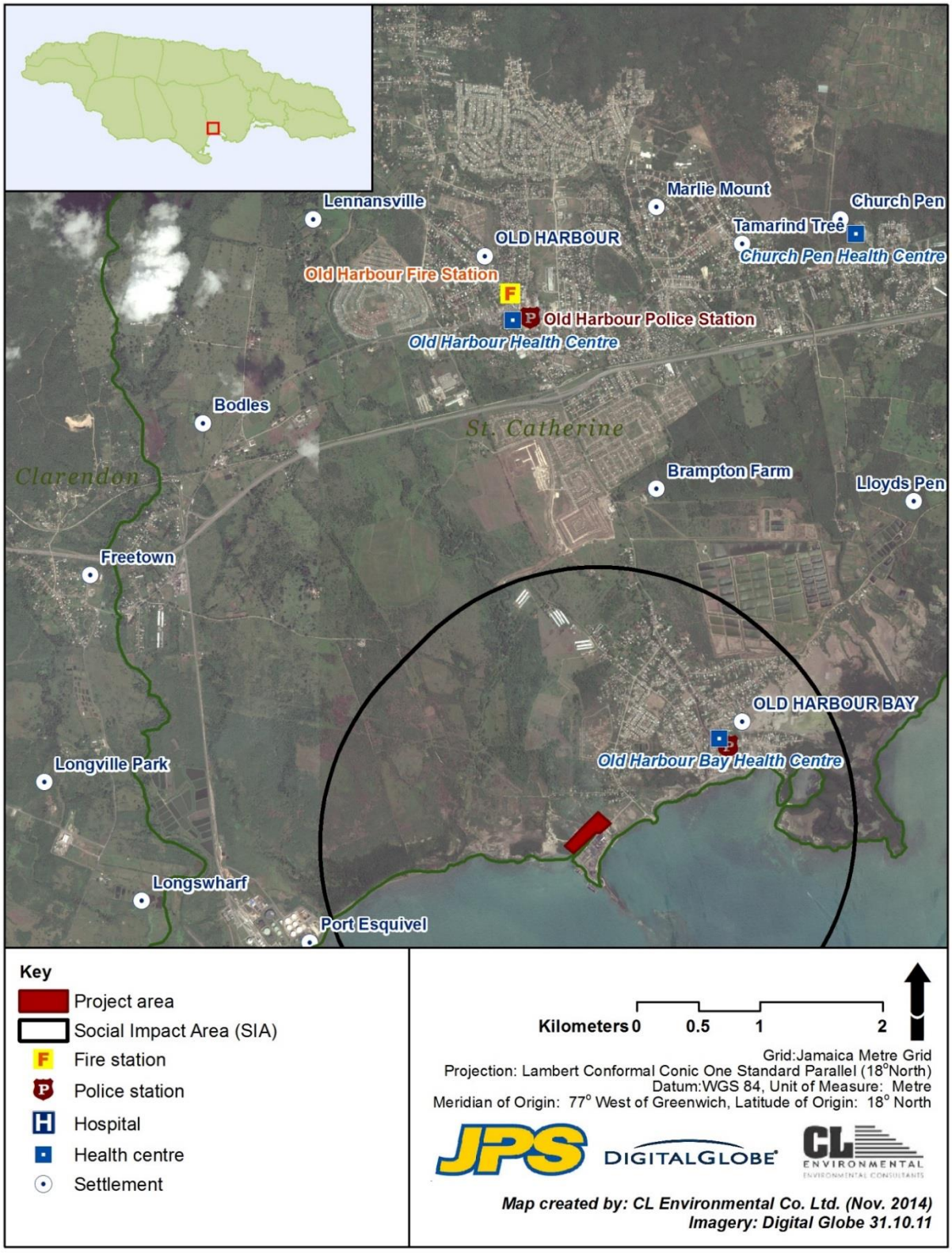
[16] http://www.serha.gov.jm/SpanishTown.aspx

vehicles. There are also 3 fire boats, one each assigned to the harbours in Kingston, Montego Bay and Ocho Rios. The Fire Prevention and Public Relations Division and the Emergency Medical Service (EMS) provide fire prevention services and emergency medical rescue/ paramedic services. [17] The fire department is equipped to fight an LNG fire (pers. comm.).

Police Stations

One police station exists within the SIA surrounding the proposed development area, namely Old Harbour Bay Police Station, 1.2 km northeast of the project area. It is part of the Saint Catherine North division (Police Area Five). It is this station that would respond to any events at the proposed site. In the Old Harbour Bay area the main crimes are related domestic disputes. The police station is adequately staffed and is in possession of a police vehicle.

[17] http://www.jfb.gov.jm/structure.html



Data source: Mona GeoInformatics Institute

Figure 5-125 Health and emergency services located in and around the SIA

5.6.1.10 Transportation

Airfields, Aerodromes and Airports

Air transport facilities do not exist within the SIA; the closest facility is an airfield, namely Port Esquivel Airfield situated 3 km southwest from the development area. The Norman Manley International Airport (NMIA) is the closest airport, approximately 35 km east of the development area. The NMIA is the primary airport for business travel to and from Jamaica and for the movement of air cargo. There are 13 scheduled airlines serving many international destinations and average daily aircraft movement is 67. In 2013, total passenger movements were approximately 1.37M and freight (cargo/mail) was 11,503 metric tonnes.

Road Network

The existing road network within and surrounding the SIA is depicted in Figure 5-126. Roads within the social impact area are in various states of repairs. Access to the site is the Old Harbour to Old Harbour Bay main road which may be entered from the Old Harbour square (beside the police station) or from Highway 2000 exit ramp. From Old Harbour, one would travel approximately 2.5km along the road to the turn off at the outskirts of the town of Old Harbour Bay. This section of the road is in need of repairs. There are sections along the asphaltic concrete surface where the surface becomes undulating (CLE, 2007). Some interior roads are unpaved such as Terminal Lane as well as there are paths which are in poor condition. A Parish Council roadway runs through the site.

The public transportation system within the community was considered to be reliable as there are a number of licensed taxis, unlicensed taxis available for commute throughout the community.

A large majority of the Old Harbour Bay Community utilized licensed taxis as their main type of transportation, accounting for 93.6% of residents. Other means were unlicensed taxis (“robot”), bicycles and private motor cars (SDC 2007).

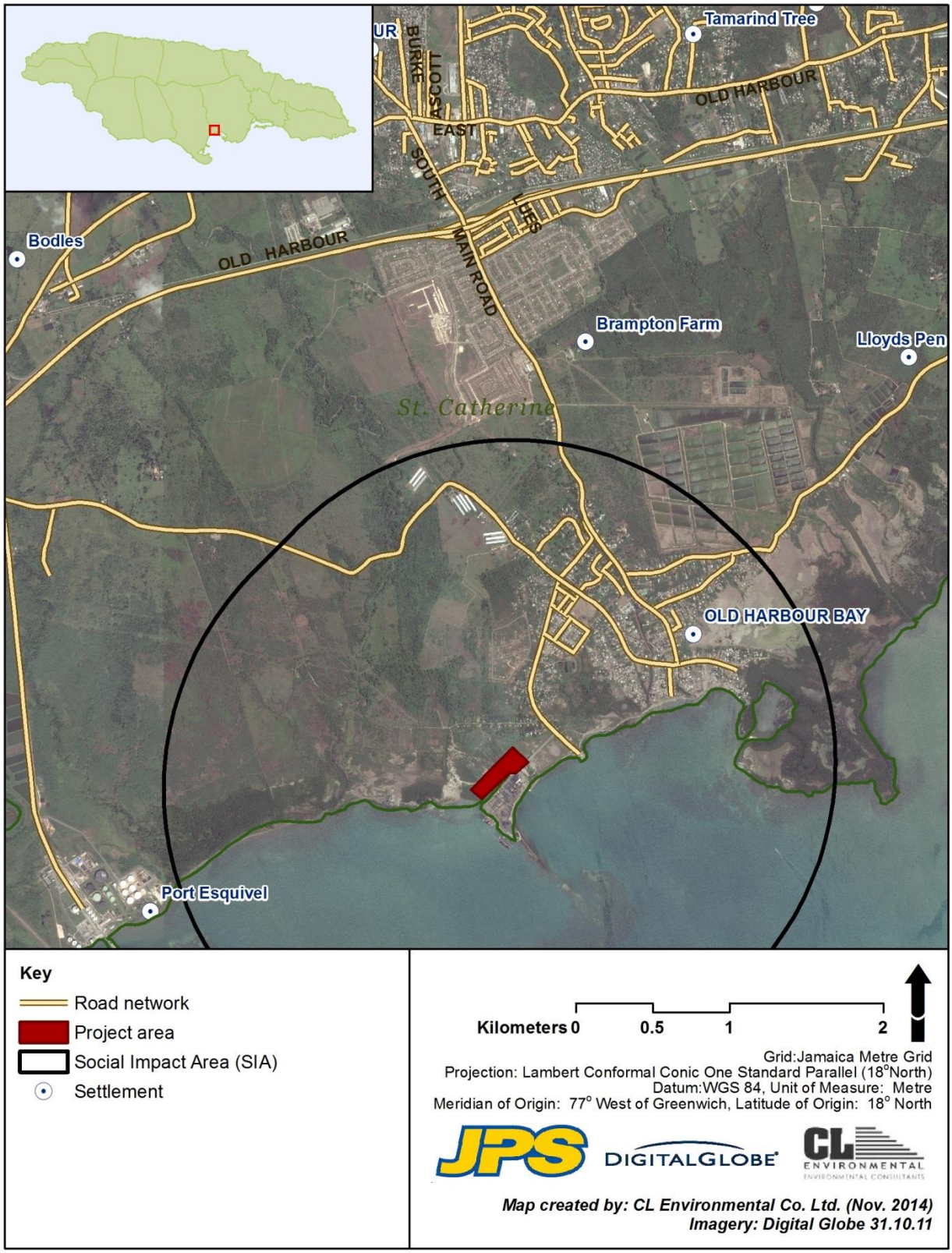


Figure 5-126 Road network and infrastructure located in the SIA

5.6.2 Land Use and Zoning

5.6.2.1 Land Use

Past

Historically, the area contains historic and archaeological sites dating back to Jamaica's first known inhabitants (The Taíno) and later those who came the Spanish, the Africans and the British. The area has seen various land uses over the past centuries. Cattle rearing were the main activity in the area during pre and post emancipation periods. It should be noted that all the plantations, pens and estates in the area had plantation houses and enslaved villages. In the more recent past, aquaculture was done on some areas of the property. Pre historical cultural material in the form of pottery sherds, both Spanish and English bricks and concrete troughs associated with cattle rearing are found to the immediate east and west of the proposed site. *(Source: Jamaica National Heritage Trust Archaeological Impact Assessment for the JPS 360MW Plant).*

Existing Land Use

The proposed site is adjacent to JPS' existing Old Harbour facility, which currently has 220 MW of generation and houses major transmission and distribution operation along with a privately owned diesel power plant (Doctor Bird I & II). The proposed project site is bounded on the east by the existing Old Harbour Power Plant, to the northeast by the existing switch yard, to the west by Thorn Savanna and to the south by the ocean. The proposed site of the new power plant is on the storage area for the existing Old Harbour 220 MW plant and LNG storage and vaporization facility. An air quality monitoring station and well water transfer pipes exist on the property, and the Parish Council roadway runs through the site.

Existing land use in the study area is agricultural, commercial, industrial, residential, educational and recreational (Figure 5-127). Other uses include a cemetery (Old Harbour Bay Cemetery), telecommunication modules and cellular towers, an airstrip and informal solid waste disposal. Agricultural facilities dominate the land use of the study area. Sugar cane farming, fishing and aquaculture (pond fish) are the major agricultural activities; however, subsistence farming also occurs in the area. There is also the Bodles Research Facility which conducts agricultural research activities. The Old Harbour Bay community is one of many residential fishing villages found along the coast in Jamaica, and is considered the largest fishing village on the island.

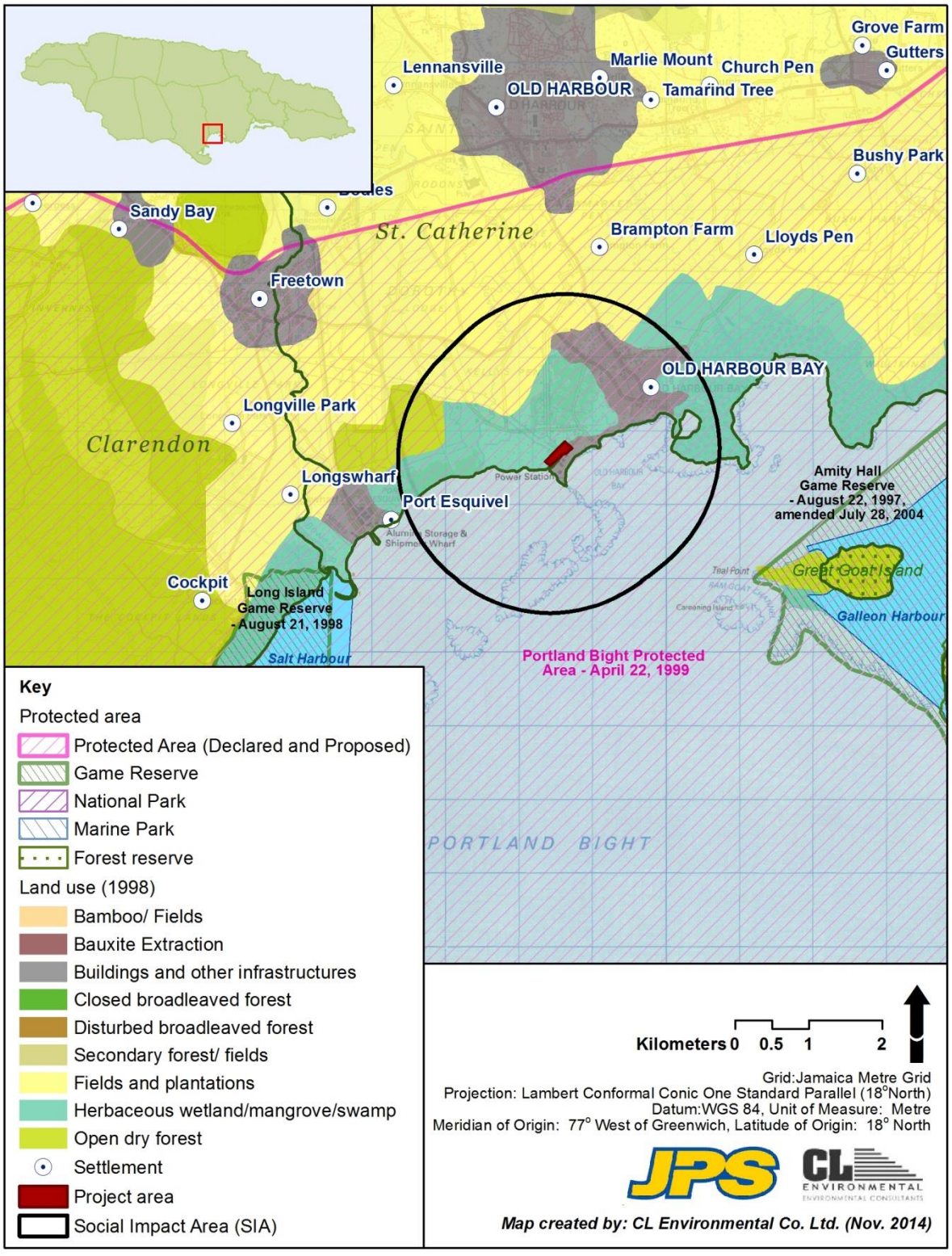
Commercially, the study area has restaurants, bars, a market and a fishing village (Old Harbour Bay), factories such as the Caribbean Boilers Hatchery, car wash, charcoal burning and scrap metal recovery operations. Industrial facilities include the Jamaica Energy Partners "Doctor Bird" power barges, Jamaica Public Service Company Ltd. Old Harbour Bay electric power station, Windalco's Port Esquivel Alumina Storage and Port and Jamaica Broilers Ethanol Dehydration Plant (Figure 5-128). Major residential areas within the area include sections of Old Harbour, New Harbour Village Phase I and II, Free Town and Longville Park Estates (Longville Park Phase III was recently built), Belmont Park Community and Old Harbour Bay. Other areas include Kellys Pen and an informal community. Recreational facilities are located at Old Harbour Bay where there is a community centre, which has a

football field and a hard court for netball and basketball. There are also areas within the community where individuals set up for their recreational activities. For transportation purposes, there is the Highway 2000 east-west link which runs through the SIA.

Future Land Use

Proposed land use on the site was previously described in section 4.0. Future developments in the wider area are shown in Figure 5-128 and include:

- Cement and Quarry Operations and 39MW Coal-fired Power plant (Cement Jamaica Limited)
- Salt Harbour Special Fishery Conservation Area



Data source: Land use (Forestry Department, 1998) and protected areas (NEPA and MGI)

Figure 5-127 Land use and protected areas within the SIA

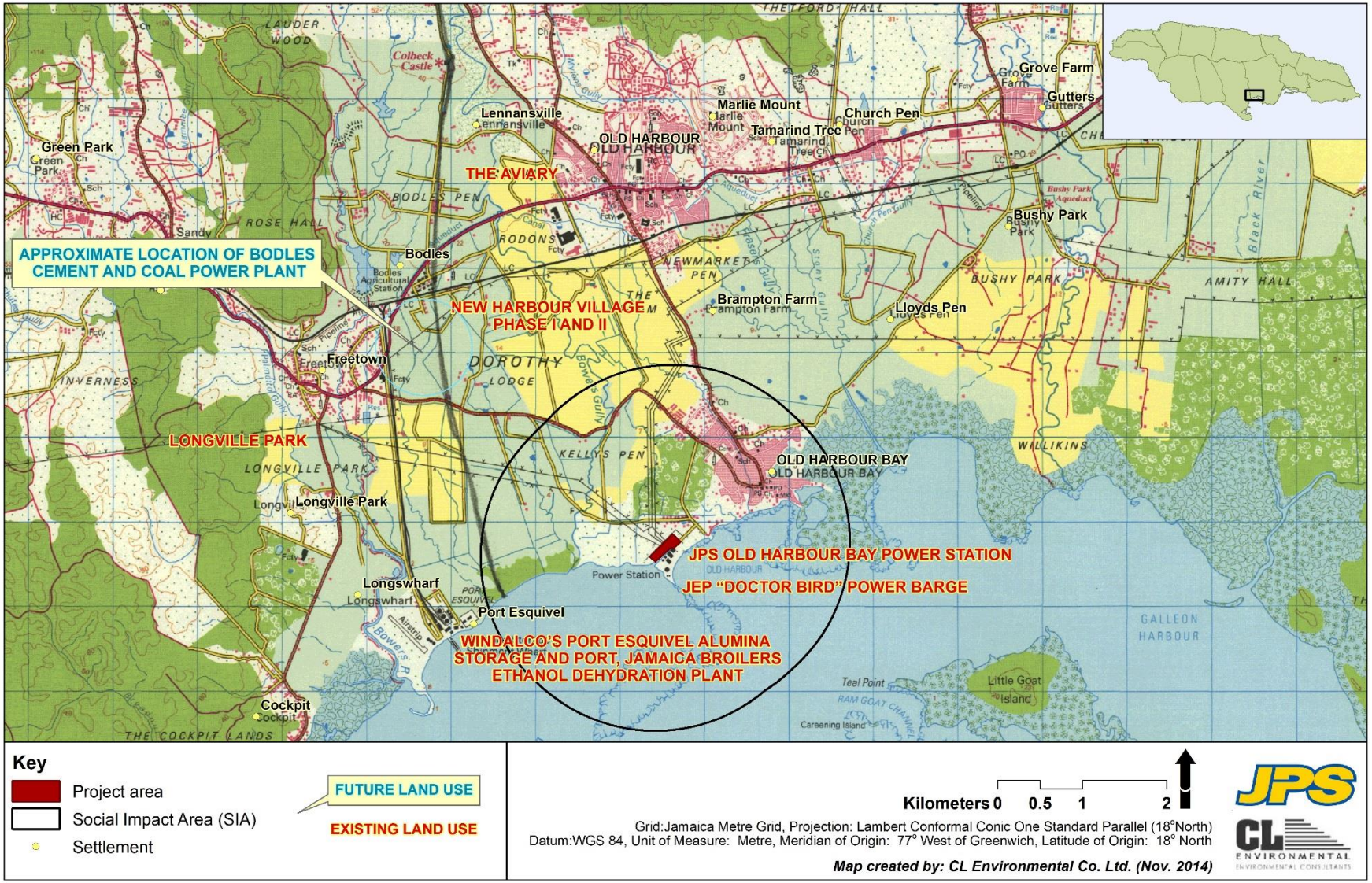


Figure 5-128 Existing and future land use

5.6.2.2 Protected Areas

Protected areas examined here include all areas of land or water protected by various laws in Jamaica, as well as international agreements that fall within or in proximity to the project area. These may include, but are not limited to, fish sanctuaries or Special Fisheries Conservation Areas (SFCA), protected areas, national parks, forest reserves, marine parks, game reserves and national heritage and monuments. Figure 5-127 gives an overview of the location of these protected areas in relation to the project area and SIA. The proposed development falls directly within the Portland Bight Protected Area (declared April 22, 1999 under Natural Resources Conservation Authority (NRCA) Act) and the Portland Bight Wetlands and Cays Ramsar Site. About 1.2 km outside the SIA exist two game reserves to the southwest and southeast, namely Long Island Game Reserve (declared August 21, 1998 under Wild Life Protection Act (WLPA)) and Amity Hall Game Reserve (declared August 22, 1997, amended July 28, 2004) respectively. In addition, the Galleon Harbour SFCA and the Salt Harbour SFCA are also located to the southwest and southeast of the project area. The proposed Project area is bounded by Special Fishery Conservation Areas (SFCA). SFCAs are no-fishing zones reserved for the reproduction of fish populations; thus, any fishing activities would be limited to areas offshore and outside the Bay. Also protected by law is the Great Goat Island forest reserve, 4km southeast of the project area (Figure 5-127).

Portland Bight Protected Area

The proposed project falls within the Portland Bight Protected area, co-managed by the Caribbean Coastal Area Management Foundation (CCAM) and the National Environment and Planning Agency (NEPA). The PBPA is the largest protected area in Jamaica enclosing 1,876 km^2 of coastal land and sea between Portland Ridge and Hellshire Hills, and including nearby cays such as Little Goat Island. More than half of the land area of the PBPA exists in its natural state, and includes dry limestone forests (210.3 km^2) and wetlands (82.0 km^2). The remainder of land is used for the cultivation of sugar cane or human settlement (Caribbean Coastal Area Management (C-CAM) Foundation, 2007). Regionally important examples of dry forest and nationally important areas of coral reef, mangrove wetland and seagrass occur within this area, which also provides habitat for at least 20 globally threatened species.[18] A management plan was prepared by the Caribbean Coastal Area Management Foundation (C-CAM) supported by a team of the major stakeholders.

Portland Bight Wetlands and Cays Ramsar Site

Jamaica has three designated Ramsar sites, one of which is the Portland Bight Wetlands and Cays, declared on February 2, 2006. The Portland Bight Wetlands and Cays run through the southern regions of St. Catherine and Clarendon in areas such as Old Harbour Bay (location of project area and SIA), Lionel Town and Hayes. The site is described to be of significant value for the country, as there are a range of endemic and rare plants, extensive fish life and several small coral cays existing within the site.

[18] http://www.ccam.org.jm

5.6.2.3 Zoning

As seen in Figure 5-129, the SIA falls within the St Catherine Coastal Development Order boundary. Another important zonation map to be considered is that arising from the development of Highway 2000 - 'Portmore to Clarendon Park Highway 2000 Corridor Development Plan 2004 – 2025'. This plan was developed by the Government of Jamaica to guide development along the H2K corridor and may be seen Figure 5-130. The proposed project area however falls within an area zoned for "heavy industry".

5.6.3 Aesthetics and Landscaping

The area of the proposed development is an industrialized area with the existing JPS Old Harbour Bay power plant, Port Esquivel, Best Dressed Chicken Feed Mill, Jamaica Energy Partners Dr Bird I and II Barges and Jamaica Broilers Ethanol Dehydration Plant in close proximity. The proposed development along with proposed landscaping will improve the visual impact of the site.

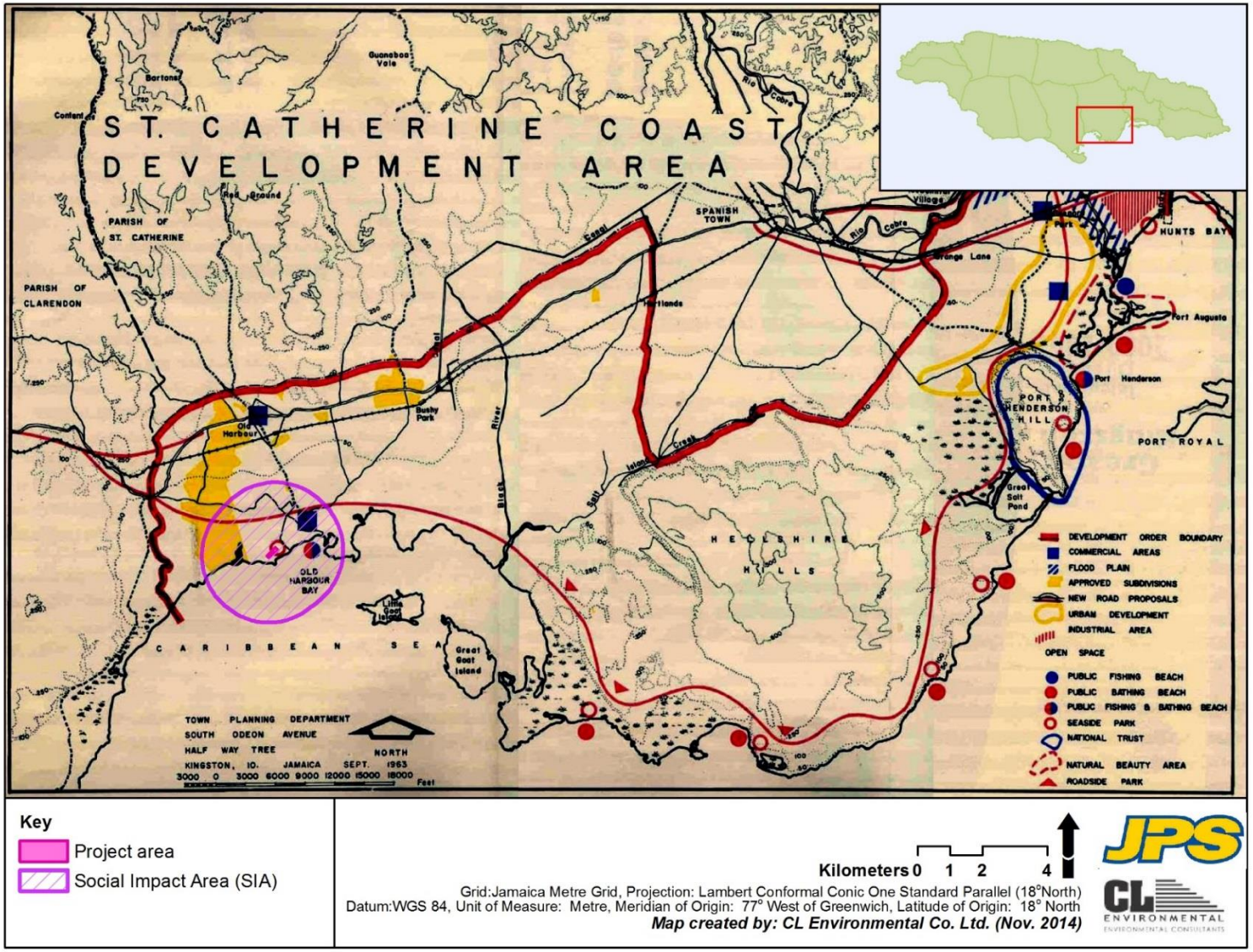


Figure 5-129 St Catherine Coastal Development Order map

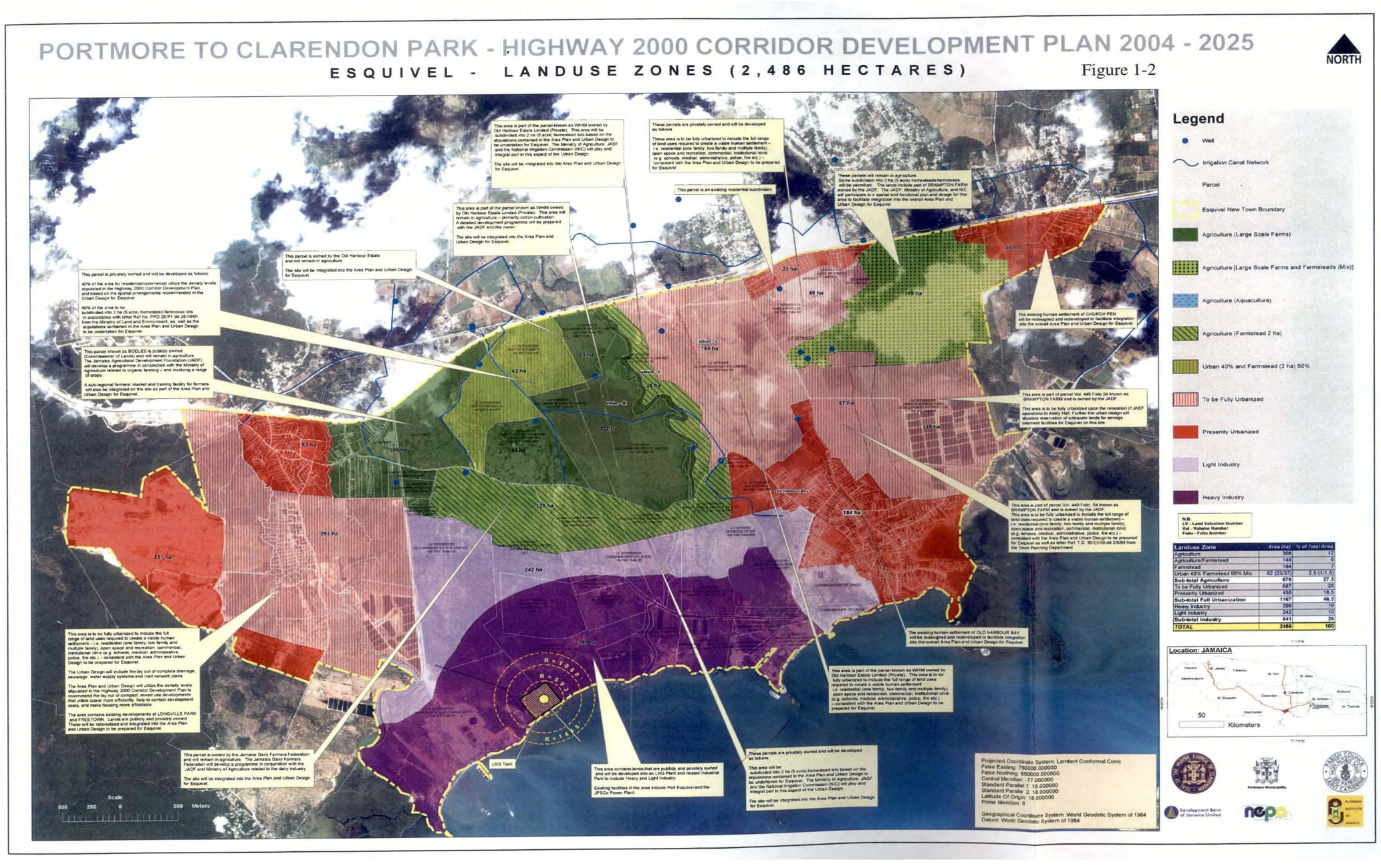


Figure 5-130 - Map showing Land Use of Highway 2000 Corridor Development (Portmore to Clarendon Park)

6.0 PUBLIC PARTICIPATION AND CONSULTATION

This section outlines the stakeholder consultation programme for this EIA process and summarizes the key stakeholder issues arising to date.

6.1 STAKEHOLDER CONSULTATION PROGRAMME

Stakeholder consultation during the course of this EIA includes the following mechanisms.

1. Perception Surveys:
    a. Conducted within 11 communities two (2) kilometres of the proposed development area (Blackwood Gardens, Settlement, Kelly Pen, Cross Roads, Dagger Bay, Station Lane, Bay Bottom, Burkesfield Meadows, Main Street Old Harbour Bay, Buddho and Terminal/ Terminal Road). The questionnaire (Appendix 8) administered addressed the following major issues:
        - General acceptability of the proposed project by community-based stakeholders.
        - Fears and expectations about the specific project, including any anticipated social conflict and crime.
        - Perceptions and attitudes of the community.
        - General health, safety and environmental concerns related to the project
    b. Aimed at fisher folk at the Old Harbour Bay Fishing Beach in an attempt to gather the opinions of fishers within a two (2) kilometre radius of the proposed development area.

2. Other Stakeholders:
    a. Water Resources Authority (WRA),
    b. St Catherine Parish Council
    c. National Works Agency (NWA)
    d. National Road Operating and Constructing Company (NROCC)
    e. Jamaica National Heritage Trust (JNHT)

3. Public Presentation:
    a. A public presentation outlining the project, environmental impacts, and proposed mitigations main findings of the EIA will be held at a community-based meeting. The meeting will be held in conformance with the NEPA Guidelines for Conducting Public Presentations. The key points are:

i. The Public Meeting shall not be held less than 21 days after the EIA is made available for public review; and
ii. The public has one (1) month after the public meeting to submit written responses/comments.

b. The continued availability of all EIA documentation for public review until a decision is made in respect of the development application. This includes:
i. The approved Terms of Reference (appended in the EIA),
ii. The EIA inclusive of all supporting technical appendices; and
iii. The verbatim minutes of the Public Meeting (including the register of attendance).

6.2 PERCEPTION SURVEY

6.2.1 Community

6.2.1.1 Introduction

On October 16 and 17, 2014 Eighty One (81) community questionnaires were administered (Appendix 8) within a two kilometre radius of the area proposed for the construction of the Jamaica Public Service Company's 190 Megawatt Combined Cycle Power Plant. The majority of the respondents (61.7%) were male and 38.3% were female. Of the Eighty One (81) respondents age cohort distribution was as follows; 4.9% were under 20 years of age, 19.8% were 20-29 years , 18.5% were aged 30-39 years, 18.5 % were aged 40-49 years, 27.2% were aged 50-59 years and 11.1% were older than sixty-five years of age.

Eleven communities were visited. These communities were Blackwood Gardens, Settlement, Kelly Pen, Cross Roads, Dagger Bay, Station Lane, Bay Bottom, Burkesfield Meadows, Main Street Old Harbour Bay, Buddho and Terminal/ Terminal Road.

6.2.1.2 Results and Findings

Of the residents interviewed 17.3% indicated that they were fishers and 7.4% indicated they were fish vendors. Approximately seventeen percent (17.3%) of respondents also indicated that someone in their household was a fisher, 18.5% indicated that someone in their household was a fish vendor, with 70.4% of respondents interviewed were head of their household.

Approximately ninety-eight percent (97.5%) of all respondents were aware that the Jamaica Public Service Company (JPS) operates the power plant in Old Harbour Bay. Ninety-Three percent (92.6%) of respondents were aware that JPS uses fuel oil in the production of electricity. As it related to awareness of the Office of Utilities Regulation's (OUR) revocation of the license issued to Energy World International (EWI); fifty-three percent (53.1%) of respondents indicated awareness while 44.4% were not aware of the OUR's revoking the EWI's license. Regarding respondents' awareness of plans by the Jamaica Public Service Company to construct a 180-200 MW (Megawatt) combined cycle power plant on property at the existing Old Harbour facility; 37% of respondents were aware of this proposal while

63% were unaware. While it cannot be statistically represented, it was realised that some respondents indicating awareness of the project were still thinking of the previously proposed 360 MW project and not this current 180- 200 MW project.

In general, interviewees' response while indicating some awareness of the projects details were not conclusive to confirm that their details were factual. Regarding project concerns, 30.9% of interviewees indicated that they had concerns about the project, 60.5% indicated they had no concerns and 8.6% were uncertain.

As it related to how the project may affect individuals' lives, interviewees indicated no effect as well as positive and negative impacts; some respondents indicated that they were not sure. Where positive impact was mentioned (30.9%), interviewees were anticipating job creation, employment opportunities and the expectation that electricity bills would be reduced upon the introduction of a natural gas plant. Where negative impact was mentioned (16%), some of the interviewees concerns' were related to possible health implications such as respiratory distress, elevated noise levels, pollution, vibrations, and soot emissions which damage food crops. A Health Impact Study was conducted for the previously proposed SJPC 360 MW power plant which highlighted some of these perceived issues, which upon investigation indicated that most persons within the area were not being affected. In fact, the perceived health impacts that are being postulated were not proven as similar populations in a different are of Jamaica had similar incidents when compared with those living in proximity to the power plants.

Approximately ninety six percent (96.3%) of interviewees, when asked if they depended on the proposed site for business, farming or residence indicated they did not. The remaining 3.7% indicated that they depended on the land. However when interviewed, it was realised that respondents may have been referring to JPS owned lands outside the existing perimeter fence of the power plant.

Regarding interviewees knowing of anyone who depended on the lands of the proposed site for business farming or residence 4.9% indicated that they knew someone, while 95.1% indicated they did not know of anyone. Again it was realised that respondents may have been referring to lands owned by JPS which falls outside the existing perimeter fence of the plant.

Approximately thirty one percent (30.9%) of respondents indicated that they had problems with domestic water supply. Problems stated were low water pressure, no water and mention of suspended particulates, primarily in the water some communities receive from JPS. While conducting the interviews, it was realised that the Old Harbour Bay residents receive water from the National Water Commission and the Jamaica Public Service Company. It was confirmed that residents of Terminal and Burkesfield Meadows, receive water from the JPS water line.

Approximately forty three percent (43.2%) of respondents indicated that their community was affected by flooding. Affected communities were Main Street Old Harbour Bay, Station Lane, Bay Bottom, Blackwood Gardens, Buddho, Dagger Bay and Terminal. Of the respondents (56.8%) indicating that

their communities were not affected by flooding, identified the communities of Cross Roads, Burkesfield Meadows, Kelly Pen and Settlement

Regarding whether the proposed site was affected by flooding, 6.2% of respondents indicated that the proposed site was affected while the others (93.8%) indicated that it was not. Approximately ninety nine percent (98.8%) of respondents indicated that the site was not affected by frequent fires.

When questioned, 43.2% of those interviewed indicated that they were affected by storm surge or sea level rise. When asked if the proposed site was affected by storm surge or sea level rise, 6.2% of respondents stated that the site was affected, while the balance (93.8%) indicated that the proposed site was not affected by storm surge or sea level rise.

As it related to respondents awareness of recreational facilities in or nearby their community, 76.5% stated that they were aware. On the issue of historic sites and/or cultural areas in or nearby their community 27.2% stated that they knew of such an area or site. Regarding the presence of nature reserves, 50.6% respondents indicated that they knew of a reserve in or nearby their community. Those aware of a recreational facility mentioned mainly the Blackwood Gardens Community Centre. Goat Island was named as both a historic site and nature reserve. The Anglican Church at the Old Harbour Bay Square was also named as a historic site.

In general, respondents were aware of the Jamaica Public Service Company and a proposal to construct a new power plant. However respondents not aware of the details associated with the plant and in some instances thought the project was that proposed in years past, and had concerns related to experiences they have had in the past.

Percentages presented for community respondents are for the total number of respondents.

Please see Appendix 9 for detailed results of the perception survey by community.

6.2.2 Fisherfolk

6.2.2.1 Introduction

On October 16 and 17, 2012, twenty (20) questionnaires specifically aimed at fisher folk were administered at the Old Harbour Bay Fishing Beach, in an attempt to gather the opinions of fishers within a two kilometre radius of the area proposed for the construction the Jamaica Public Service Company's 190 Megawatt Combined Cycle Power Plant. Forty percent (40%) of the respondents were female and 60% were male.

During this exercise respondents were somewhat reluctant to provide answers and either declined giving a response or gave vague non-specific answers. Although interviewed at the Old Harbour Bay Fishing beach, respondents were from the communities of Old Harbour Bay, Settlement, Buddho, Blackwood Gardens, Dagger Bay, Bay Bottom, Station Lane, Burkesfield Meadows and Main Street Old Harbour Bay specifically the Panton Town and Nurain/Noreign Avenue areas.

6.2.2.2 Results and Findings

Of the Twenty (20) respondents age cohort distribution was as follows; 0.0% were under 20 years of age, 5.0% were 20-29 years , 5.0% were age 30-39 years, 40.0 % were age 40-49 years, 35.0% were age 50-59 years and 10.0% were older than sixty-five years of age while 5% of respondents did not state their age.

More than half of respondents (55.0%) indicated they were fishers (fishermen/women) while 45.0% of indicated they were fish vendors. Forty percent (40.0%) of respondents indicated that in addition to them another person in the household was a fisher. Approximately a third (30.0%) of respondents indicated that in addition to them another person in the household was a fish vendor.

None of the interviewees indicated they were fishing or selling fish for up to five years; 10.0% six to eleven years; 10.0% twelve to seventeen years; 5.0% eighteen to twenty-four years; 5.0% twenty five to thirty years and 40.0% for over thirty years. Approximately a third (30%) on those interviewed did not state how long they had fished or sold fish. Respondents indicating they were fish vendors indicated that they sold fish at the Old Harbour Bay Fishing Beach.

Of the respondents indicating that they fished, 14.3% did not specify what was used. Approximately seven percent (7.1%) indicated that they used lines, 14.3% indicated they uses the spear; 28.6% used only the net, 14.3% used only the fish pot, 14.3% used both the net and fish pot. 7.1% indicated they used mesh wire for fishing.

Approximately twenty nine percent (28.6%) of fishers indicated that they fished only in the Old Harbour Bay area, 7.1% of fishers fished in both the Old Harbour Bay area and Rocky Point; 7.1% fished in both the Old Harbour Bay area and Pedro Cay, 14.3% fished only in Pedro Cay. Approximately twenty nine percent (28.6%) indicated that they fished far out to sea but did not specify an exact location, 7.1% indicated they fished in the Pedro and Morant Cays and 7.1% of respondents did not specify where they fished.

Approximately seventy nine percent (78.6%) of the respondents used canoes with engines for fishing, no fisher used canoes without an engine for fishing. Of the respondents having canoes with an engine, 78.6% used one engine and 7.1% used 2 engines. Approximately seventy nine percent (78.6%) used 40 horsepower (hp) engines, 7.1% used 50hp engines; 14.3% did not respond. Approximately fourteen percent (14.3%) of interviewees did not indicate what type of vessel they used for fishing, while 7.1% indicated that a large boat was used, but fishing was not by net.

On the issue of how many persons worked on fishing canoes/vessels, two persons worked on 21.4% of vessels, three persons worked on 57.1% of vessels and forty-four to forty-seven persons worked on 7.1% of vessels and 14.3% of interviewees did not offer a response.

Regarding the frequency of fishing and selling of fish, fishers indicated that they fished mainly twice or three times per week. Fishers indicating that they fished once per week also indicated that they remained at sea for an extended period before returning to Old Harbour Bay. The type of fish caught

as reported by fishers included, doctor fish, parrot, snapper, sprat, angel, grunt, jack, turbit and welshman. Some fishers stated that they caught “reef fish” which they explained encompassed the varying species of fish they catch.

Concerning the pound catch of fish, fishers indicated that they caught total weights ranging from three pounds to four hundred pounds. In the case of large vessels, the pound catch estimated was four thousand. The main reported weight varied from approximately three pounds per day to eighty pounds per day. Respondents indicating heavier pound catch, were those who spent multiple days at sea and returning to shore with between three and five hundred pounds of fish. Interviewees were not able to state the weight per species of fish they caught.

On the matter of average weekly income from fish sales, no respondent reported an income of less than $1,000.00 per week or an income of between $1,000.00 and $2,000.00 per week; 5.0% indicated an income of $2,000.00 to $4,000.00 per week. 20.0% indicated income ranging between $4,000.00 and $6,000.00. 10.0% of interviewees stated that an income of between $6,000.00 and $8,000.00 was generated, while 40.0% indicated that average weekly income was more than $8000.00 per week. 15.0% of respondents did not offer a response.

Relating to the changes in the pound catch/sale/yield over time, 70% of respondents who offered a response indicated a decrease. 5.0% indicated an increase and 5.0% indicated no change. 20% of interviewees did not offer a response.

Regarding changes in the size and types of fish caught or sold 35.0% of interviewees indicated that they did not observe a change while 30.0% indicated they observed a decrease. 10.0% of respondents stated that there was an increase in the size and types of fish caught or sold, 20.0% of respondents offered no response while 5.0% stated that they have observed "unusual fish". Migration of new fish species, climate change, an increase in the number of vendors and a decrease in the amount of fish, damage to the reef caused by the power station and the presence of dolphins were stated as contributing factors to the fluctuations in fish earning and fish catch.

Eighty five percent of all respondents were aware that the Jamaica Public Service Company (JPS) operates the power plant in Old Harbour Bay, 5.0% were not aware, while 10.0% did not offer a response.

Ninety percent of respondents were aware that JPS uses fuel oil in the production of electricity while 10.0% did not offer a response. As it related to awareness of the Office of Utilities Regulation's (OUR) revocation of the license issued to Energy World International (EWI), only 35.0% of respondents were aware. More than halve (55.0%) of respondents were not aware of the OUR’s revocation; 10.0% did not offer a response. Regarding respondents’ awareness of plans by the Jamaica Public Service Company to construct a 180-200 MW (Megawatt) combined cycle power plant on property at the existing Old Harbour facility; it was observed that 45.0% of respondents were aware of this proposal and 45.0% of respondents were not aware and 10.0% of interviewees did not offer a response.

On the issue of project concerns, 20.0% of all respondents expressed concern, 60.0% did not express concern and 10.0% of respondents were uncertain if they had any concerns and 10.0% offered no response. Interviewees expressing concern were concerned about the availability of possible work opportunities for the youth, noise emissions from the JPS Plant and pollution of the reef.

Fifteen percent of respondents anticipated a positive impact on their lives as a spin off from the project; 25.0% of respondents were unsure of any impact on their lives, 30.0% of respondents indicated that they did not expect the project to affect their lives in any way while 15.0% of respondents expected a negative impact. Fifteen percent of respondents offered no response. Interviewees anticipating a negative impact on their lives anticipated a reduction in the yield of fish. Interviewees also expected their health to be negatively affected and noise levels to increase. It was also highlighted that there is an "acid smell" in the air which blows from the plant over sea and affects the fishers, it was expected that this would get worse with the introduction of a new power plant.

A positive impact on individuals' lives was anticipated as cheaper electricity cost was expected as a spin-off of the project. It was also expected that more jobs would be created and the project was seen as a good development which is needed for the community.

Seventy five percent of respondents indicated that they did not depend on the proposed site for any type business/fishing/residence, 15.0% indicated that they depended on the proposed site and specified fishing and small farming, whilst 10.0% did not offer a response.

Seventy percent of respondents indicated that they did not know of anyone who depended on the proposed site for any type business/fishing/residence, 20.0% indicated that they knew of someone who depended on the proposed site and specified fishing and small farming, whilst 10.0% did not offer a response.

In general, it was realised that males tended towards fishing at sea and women sold fish. Some of those who fished, travelled distances in excess of 75 miles and sometimes stayed at sea for days before returning to shore. Fishing vessels were mainly single engine canoes with an engine size of 40 Hp.

While it could not have been statistically represented, it was learnt that from the perspective of the fish vendor, the season when fish sales are high is at times when fish is scarce and in high demand. Fishermen indicated that their pound catch is highest at "fall o' year". While the exact period for fall o' year could not be stipulated, it was gleaned that this period occurs between August and December when there is good weather if no hurricanes affect the area.

7.0 IDENTIFICATION AND ASSESSMENT OF POTENTIAL DIRECT AND INDIRECT IMPACTS AND RECOMMENDED MITIGATION

Impact matrices for the site preparation/construction and operational phases were created utilising the following criteria[19]:

- **Direction of Impact-** This describes the nature of the potential impact; positive, negative or no impact of a particular activity on a receptor.
- **Magnitude of Impact:** This is defined by the severity of each potential impact and indicates whether the impact is irreversible or, reversible and estimated potential rate of recovery. The magnitude of an impact cannot be considered high if a major adverse impact can be mitigated.
- **Extent of Impact:** The spatial extent or the zone of influence of the impact should always be determined. An impact can be site-specific or limited to the project area; a locally occurring impact within the locality of the proposed project; a regional impact that may extend beyond the local area and a national impact affecting resources on a national scale and sometimes trans-boundary impacts, which might be international.
- **Duration of Impact:** Environmental impacts have a temporal dimension and needs to be considered in an EIA. Impacts arising at different phases of the project cycle may need to be considered.
- **Significance of the Impact:** This refers to the value or amount of the impact. Once an impact has been predicted, its significance must be evaluated using an appropriate choice of criteria. The most important forms of criterion are:
    - Specific legal requirements e.g. national laws, standards, international agreements and conventions, relevant policies etc.
    - Public views and complaints
    - Threat to sensitive ecosystems and resources e.g. can lead to extinction of species and depletion of resources, which can result, into conflicts.
    - Geographical extent of the impact e.g. has trans- boundary implications.
    - Cost of mitigation
    - Duration (time period over which they will occur)
    - Likelihood or probability of occurrence (very likely, unlikely, etc.)
    - Reversibility of impact (natural recovery or aided by human intervention)
    - Number (and characteristics) of people likely to be affected and their locations
    - Cumulative impacts e.g. adding more impacts to existing ones.

[19] Taken from - Ogola, P. F. A. 2007. Environmental Impact Assessment General Procedures, presented at Short Course II on Surface Exploration for Geothermal Resources, organized by UNU-GTP and KenGen, at Lake Naivasha, Kenya, 2-17 November, 2007

- Uncertainty in prediction due to lack of accurate data or complex systems. Precautionary principle is advocated in this scenario.

In addition to the criteria listed previously for identifying potential impacts, those were supplemented by:

- The Consultants' experience,
- Documented impacts from similar projects,
- The data collected,
- Analysis of the processes in the proposed project,
- Information generated from models,
- Concerns raised from stakeholders in the social surveys; and
- Discussions held among the EIA Study team.

Table 7-1 shows the impact assessment criteria for the various potential impacts.

Table 7-1 Impact assessment criteria for potential environmental impacts

SCORE	0	1	2	3
CRITERIA	Negligible	Minor	Moderate	Significant
DURATION	None	Physical impacts lasting less than a few months before recovery occurs. Impact does not persist after the activity ends.	Physical impacts lasting from a few months to two years before signs of recovery. It is not inter-generational.	Physical impact is persistent after 2 years. Impacts on a biological population over a number of recruitment cycles or generations of the population.
MAGNITUDE	No measurable change in availability of resources or function of systems. No measurable effect on people.	Changes in form and/or ecosystem function and/or a resource. The system maintains the ability to support ecosystem/ resource functions with only minor changes in community value and no overall loss/gain. Only a small fraction of the local community is affected.	Changes in form and/or ecosystem function and/or a resource. The system's ability to support ecosystem/ resource functions and economic benefit is affected but not lost. Only a moderate fraction of the local community is affected.	Changes in form and/or ecosystem function and/or a resource. The system's ability to support ecosystem/resource functions and economic benefit is highly affected. A large fraction of the local community is affected.
EXTENT	None	Isolated effects within activity site.	Localized area close to borders or offsite dispersion pathways.	Widespread: offsite regional effects

Table 7-2 Impact matrix for site preparation and construction phase

	RECEPTOR	IMPACT	DIRECT/INDIRECT		DIRECTION			DURATION	MAGNITUDE	EXTENT	SIGNIFICANCE SCORE
			DIRECT	INDIRECT	POS	NONE	NEG				
Physical	Water Column	Increased turbidity and TSS from runoff	X				X	1	1	1	-1
	Hydrology and Run Off	N/A									
	Airshed	Reduced Air quality and Noise Pollution	X				X	1	1	1	-1
Biological	Fish	N/A									
	Marine invertebrates	N/A									
	Terrestrial Invertebrates	Displacement and loss of habitat	X				X	1	1	1	-1
	Reptiles (Marine Turtles, Crocodiles)	Displacement, loss of habitat and disruption of nesting	X				X	1	1	1	-1
	Avifauna	Displacement and loss of habitat	X				X	1	1	1	-1
	Reefs	Increased turbidity and other pollutants from runoff		X			X	1	1	2	-1.3
	Seagrass	Increased turbidity and other pollutants from runoff		X			X	1	1	2	-1.3
	Salina Vegetation	Species loss	X				X	1	1	1	-1
	Mangroves	Species loss	X				X	1	1	1	-1
Heritage	Heritage	Destruction of artefacts	X				X	1	1	1	-1
Human/ Social	Traffic	Increased traffic congestion	X				X	1	1	1	-1
	Existing natural and social environment	Increased solid waste generation	X				X	1	1	1	-1
		Increased wastewater generation	X				X	1	1	1	-1
		Increased accidental potential of labourers	X				X	1	1	1	-1
		Increased noise and dust exposure of labourers	X				X	1	1	1	-1
		Increased water usage	X				X	1	1	1	-1
	Labour Force/Local Economy	Increased employment	X		X			1	1	2	1.33

Table 7-3 Impact matrix for operational phase

ACTIVITY/HAZARD	RECEPTOR	IMPACT	DIRECT/INDIRECT		DIRECTION			DURATION	MAGNITUDE	EXTENT	SIGNIFICANCE SCORE
			DIRECT	INDIRECT	POS	NONE	NEG				
Fire	**Biological**										
	Fish/Marine Mammals	Species loss	X				X	1	3	1	1.67
	Meiofauna and Bottom dwellers	N/a	X				X	1	3	1	1.67
	Reptiles	Species loss	X				X	1	3	1	1.67
	Seagrass	Species loss	X				X	1	3	1	1.67
	Reef	Species loss	X				X	1	3	1	1.67
	Terrestrial Flora and Fauna	Species loss	X				X	1	3	1	1.67
	Physical										
	Water Quality	N/a									
	Air Shed	N/a									
	Socioeconomic										
	Local Population	Injury from thermal radiation and vapour dispersion (if ignited)	X				X	1	3	2	2
	Occupational										
	Plant Employees	Injury and/or death from thermal radiation and vapour dispersion (if ignited)	X				X	1	3	2	2
Water Usage and Wastewater Generation	Water Resources	Increased water usage	X				X	1	1	1	1
	Sewage and Wastewater	Increased wastewater generation	X				X	1	1	1	1
	Surface Water Quality	Increased temperature from cooling water discharge	X				X	1	1	1	1
		Increased chemical wastewater	X				X	1	1	1	1
	Ground Water Quality	N/A				X					
	Potable Water Quality	N/A				X					
Hazardous and Non-Hazardous Waste	**Biological**										
	Fish/Marine Mammals	Habitat destruction/loss	X				X	1	2	1	1.33
	Reptiles	Habitat destruction/loss	X				X	1	2	1	1.33
	Seagrass	Habitat destruction/loss	X				X	1	2	1	1.33
	Reef	Habitat destruction/loss	X				X	1	2	1	1.33
	Terrestrial Flora and Fauna	Habitat destruction/loss	X				X	1	2	1	1.33
	Physical										
	Surface Water Quality	Increased hydrocarbons in water in the event of oil/fuel spills	X				X	1	2	2	1.67
	Ground Water Quality	Increased hydrocarbons in water in the event of oil/fuel spills	X				X	1	2	2	1.67
	Potable Water Quality	Increased hydrocarbons in water in the event of oil/fuel spills	X				X	1	2	2	1.67
	Socioeconomic										
	Local Population	Aesthetically unappealing	X				X	1	1	1	1
	Occupational										
	Plant Employees	Aesthetically unappealing	X				X	1	1	1	1
Air Emissions	**Physical**										
	Air Shed	Reduced NOx, SO_2, CO and CO_2.	X		X			3	2	2	2.3
		Reduced greenhouse gas emissions	X		X			3	3	2	2.67
	Socioeconomic										

ACTIVITY/HAZARD	RECEPTOR	IMPACT	DIRECT/INDIRECT		DIRECTION			DURATION	MAGNITUDE	EXTENT	SIGNIFICANCE SCORE
			DIRECT	INDIRECT	POS	NONE	NEG				
	Local Population	Acute respiratory ailments	X				X	2	1	1	1.33
	Occupational										
	Plant Employees	Acute/chronic respiratory ailments	X				X	2	1	1	1.33
Noise and Vibration	**Biological**										
	Fish/Marine Mammals	Disturbance of sensitive species	X				X	1	1	1	1
	Meiofauna and bottom dwellers	Disturbance of sensitive species	X				X	1	1	1	1
	Reptiles	Disturbance of sensitive species	X				X	1	1	1	1
	Seagrass	N/a									
	Reef	N/a									
	Terrestrial Flora and Fauna	Disturbance of sensitive bird species	X				X	1	1	1	1
	Physical										
	Water Quality	N/a									
	Air Shed	Noise pollution	X				X	1	1	1	1
	Socioeconomic										
	Local Population	Disturbance from noise and vibration	X				X	1	1	1	1
	Occupational										
	Plant Employees	Acute/chronic hearing problems (PPE recommended), vibration nuisance	X				X	3	1	1	1.67
Natural Disasters	**Biological**										
	Fish/Marine Mammals	Habitat destruction/loss, species loss	X				X	2	3	1	2
	Meiofauna and bottom dwellers	Habitat destruction/loss, species loss	X				X	2	3	1	2
	Reptiles	Habitat destruction/loss, species loss	X				X	2	3	1	2
	Seagrass	Habitat destruction/loss, species loss	X				X	2	3	1	2
	Reef	Habitat destruction/loss, species loss	X				X	2	3	1	2
	Terrestrial Flora and Fauna	Habitat destruction/loss, species loss	X				X	2	3	1	2
	Physical										
	Surface Water Quality	Increased hydrocarbons from fuel oil spill and other pollutants	X				X	2	3	1	2
	Ground Water Quality	Increased hydrocarbons from fuel oil spill and other pollutants	X				X	2	3	1	2
	Potable Water Quality	N/A									
	Socioeconomic										
	Local Population	Serious injury or death	X				X	2	3	1	2
	Occupational										
	Ship Employees	Serious injury or death	X				X	2	3	1	2
Employment	**Socioeconomic**										
	Labour Force/Local Population	Increased jobs/employment	X		X			3	3	3	3
		Economic growth nationally	X		X			3	3	3	3
		Increased worker productivity	X		X			3	3	3	3
Electricity Costs	**Socioeconomic**										
	Local Population	Stable electricity supply and lower electricity costs	X		X			3	3	3	3
Traffic	**Socioeconomic**										
	Local/Community roads	No net increase in traffic	X			X					

7.1 SITE PREPARATION AND CONSTRUCTION

7.1.1 Physical

7.1.1.1 Land Impacts

Noise Pollution

HEAVY EQUIPMENT

Site clearance for the proposed development necessitates the use of heavy equipment to carry out the job. Equipment to be used include bulldozers, backhoes etc. They possess the potential to have a direct negative impact on the noise climate. Noise directly attributable to site clearance 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). Where the baseline levels are above the stated levels then it should not result in an increase of the baseline levels by more than 3dBA at the nearest residence.

Construction noise can result in short-term impacts of varying duration and magnitude. The construction noise levels are a function of the scale of the project, the phase of the construction, the condition of the equipment and its operating cycles, the number of pieces of construction equipment operating concurrently.

To gain a general insight into potential construction noise impacts that may result from the project, the typical noise levels associated with various types of construction equipment are identified in Table 7-4.

Table 7-4 Typical construction equipment noise levels

Type of Equipment	Typical Sound Level at 50 ft. (dBA Leq.)
Dump Truck	88
Portable Air Compressor	81
Concrete Mixer (Truck)	85
Jackhammer	88
Scraper	88
Bulldozer	87
Paver	89
Generator	76
Pile driver	101
Rock Drill	98
Pump	76
Pneumatic Tools	85
Backhoe	85

Adapted from - Route 101A Widening and Improvements, City of Nashua Hillsborough County, New Hampshire; McFarland-Johnson, Inc. May 30, 2007

The Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM) version 1.1 was used to predict noise levels from construction activities on the proposed power plant site at the

nearest residential receptor. This receptor is located at Terminal Lane and is situated approximately 231.2m from the site. A total of 12 pieces of equipment were used to analyse a worst case scenario (all equipment being used at the same time) and at the closest point to the receptor (231.2m) and no shielding of the equipment.

The results of the model indicate that the overall Leq will be 71.6 dBA which would exceed the NEPA standards for daytime (55 dBA) and night time (50 dBA). The model also predicted a Lmax of 77.6 dBA which the highest noise level expected during a measurement period or a noise event (Table 7-6).

ACCESS ROAD

During the site clearance and construction phases of the Proposed Project, an access road will be built to the site which will facilitate the movement of heavy vehicles and equipment. It is anticipated that during the site filling phase is when the highest daily volume of vehicular traffic will occur. It is anticipated that during this phase approximately 70 truck trips per day to carry fill material to the site. SoundPlan 7.3 model was used to determine the potential noise impact to the community for this activity (worst case scenario). A speed limit of 30 km/h for the trucks was used in the model.

The predicted noise along Old Harbour Main Road, Terminal Road and the Access Road are reported in Table 7-5. Sixteen locations (receivers) were assessed (two sensitive receptors – church & school) of which eight were found to be in exceedance of the NEPA daytime noise standard. The day time noise standard was used as the trucking will be done during day time hours.

Table 7-5 Predicted noise levels along Old Harbour Bay Main Road, Terminal Road and Access Road from approximately 70 truck trips per day

RECEIVER	PREDICTED NOISE (dBA)	NEPA DAY TIME NOISE STD (dBA)
House 1 OHB Main Road	53.2	55
House 2 OHB Main Road	62.9	55
House 2 Terminal Road	50.7	55
House 3 Terminal Road	63.0	55
House 5 Blackwood Gardens	58.7	55
House 6 Terminal Road	59.4	55
House 7 Terminal Road	61.7	55
House 8 Terminal Road	59.4	55
House 9 Burkesfield Meadow	46.1	55
House 10 Burkesfield Meadow	43.7	55
House 11 Terminal Road	60.8	55
House 12 Terminal Road	57.8	55
New Harbour Phase 1	51.5	55
New Harbour Village Phase 2	51.8	55
Blackwood Gardens Basic School	40.6	45
Mount Refuge Baptized Church	51.8	55

Table 7-6 RCNM worst case scenario noise level prediction of the construction noise on the proposed JPS 190MW power plant site

			Roadway Construction Noise Model (RCNM),Version 1.1												
Report date:	12/17/2014														
Case Description:	JPS1														
				---- Receptor #1 ----											
		Baselines (dBA)													
Description	Land Use	Daytime	Evening	Night											
Nearest Structure Terminal Lane	Residential	61.4	61.4	59.9											
				Equipment											
				Spec	**Actual**	**Receptor**	**Estimated**								
		Impact		**Lmax**	**Lmax**	**Distance**	**Shielding**								
Description		**Device**	**Usage(%)**	**(dBA)**	**(dBA)**	**(meters)**	**(dBA)**								
Dump Truck		No	40		76.5	231.2	0								
Concrete Mixer Truck		No	40		78.8	231.2	0								
Jackhammer		Yes	20		88.9	231.2	0								
Dozer		No	40		81.7	231.2	0								
Paver		No	50		77.2	231.2	0								
Generator		No	50		80.6	231.2	0								
Compressor (air)		No	40		77.7	231.2	0								
Impact Pile Driver		Yes	20		101.3	231.2	0								
Pumps		No	50		80.9	231.2	0								
Pneumatic Tools		No	50		85.2	231.2	0								
Backhoe		No	40		77.6	231.2	0								
Excavator		No	40		80.7	231.2	0								
				Results											
		Calculated (dBA)			**Noise Limits (dBA)**							**Noise Limit Exceedance (dBA)**			
				Day		**Evening**		**Night**		**Day**		**Evening**		**Night**	
Equipment		***Lmax**	**Leq**	**Lmax**	**Leq**	**Lmax**	**Leq**	**Lmax**	**Leq**	**Lmax**	**Leq**	**Lmax**	**Leq**	**Lmax**	**Leq**
Dump Truck		52.8	48.9	55	N/A	55	N/A	50	N/A	None	N/A	None	N/A	2.8	N/A
Concrete Mixer Truck		55.2	51.2	55	N/A	55	N/A	50	N/A	0.2	N/A	0.2	N/A	5.2	N/A
Jackhammer		65.3	58.3	55	N/A	55	N/A	50	N/A	10.3	N/A	10.3	N/A	15.3	N/A
Dozer		58	54.1	55	N/A	55	N/A	50	N/A	3	N/A	3	N/A	8	N/A
Paver		53.6	50.6	55	N/A	55	N/A	50	N/A	None	N/A	None	N/A	3.6	N/A
Generator		57	54	55	N/A	55	N/A	50	N/A	2	N/A	2	N/A	7	N/A
Compressor (air)		54	50.1	55	N/A	55	N/A	50	N/A	None	N/A	None	N/A	4	N/A
Impact Pile Driver		77.6	70.7	55	N/A	55	N/A	50	N/A	22.6	N/A	22.6	N/A	27.6	N/A
Pumps		57.3	54.3	55	N/A	55	N/A	50	N/A	2.3	N/A	2.3	N/A	7.3	N/A
Pneumatic Tools		61.6	58.5	55	N/A	55	N/A	50	N/A	6.6	N/A	6.6	N/A	11.6	N/A
Backhoe		53.9	50	55	N/A	55	N/A	50	N/A	None	N/A	None	N/A	3.9	N/A
Excavator		57.1	53.1	55	N/A	55	N/A	50	N/A	2.1	N/A	2.1	N/A	7.1	N/A
	Total	77.6	71.6	55	N/A	55	N/A	50	N/A	22.6	N/A	22.6	N/A	27.6	N/A
		*Calculated Lmax is the Loudest value.													

The NEPA day time noise limit (55 dBA) along the access road was depicted in Figure 7-1.

The proposed project has the potential to be a noise nuisance during the construction phase. However, with the proper mitigative steps the proposed project will have minimal if any impact on the surrounding community.

RECOMMENDED MITIGATION

vi. Use equipment that has low noise emissions as stated by the manufacturers.
vii. Use equipment that is properly fitted with noise reduction devices such as mufflers.
viii. Operate noise-generating equipment during regular working hours (e.g. 7 am – 7 pm) to reduce the potential of creating a noise nuisance during the night.
ix. Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is workers operating equipment generating noise of ≥ 80 dBA (decibels) continuously for 8 hours or more should use ear muffs. Workers experiencing prolonged noise levels 70 - 80 dBA should wear earplugs.
x. Management controls will be used to mitigate the potential noise impacts along the access route. These are;
    a. Trucks and other heavy duty vehicles will be required to travel at 30 km/h along the access route.
    b. Truck and heavy duty vehicles should travel along the access route only during day time hours 7 am – 5 pm.

The avifauna will be marginally affected by changes in the noise environment; the community dynamics and population have already been shaped by elevated noise levels in the project area and zone of influence. Therefore, no mitigation is required.

Vibration

Construction activities often generate vibration complaints. This may be as a result of interfering with persons normal routines/activities. This can become more acute if the community has no understanding of the extent and duration of the construction. This can lead to misunderstandings if the contractor is considered to be insensitive by the communities although he may believe he is in compliance with the required conditions/ordinances.

Construction activities can result in various degrees of ground vibration. This is dependent on the type of equipment used and the methodologies employed.

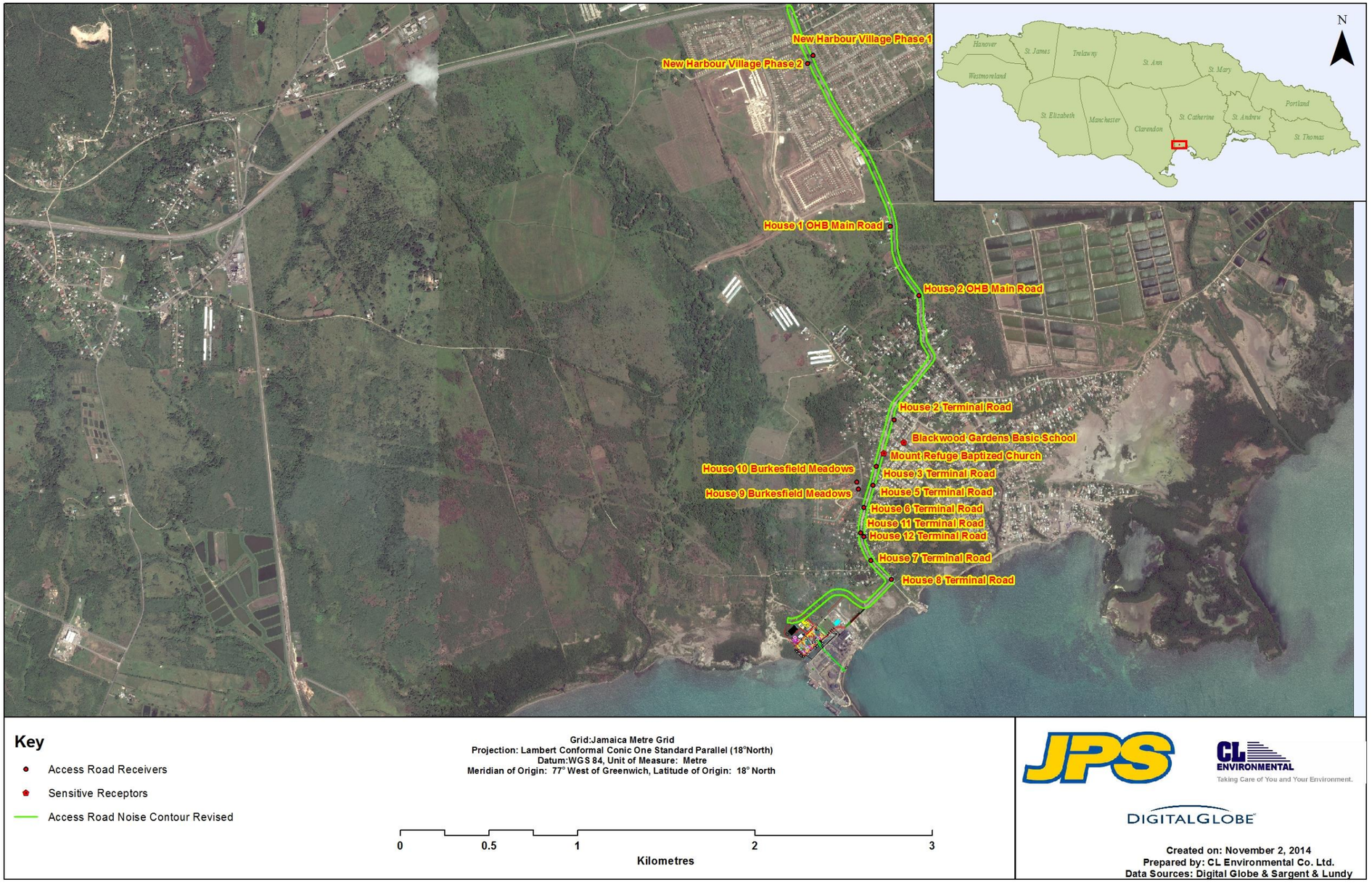


Figure 7-1 Map showing the 55 dBA noise contour along the access road noise and modelled noise receivers

Various governmental agencies have criteria regarding architectural and structural damage, as well as annoyance and acceptability of vibration. In general, most of the criteria specify that for a PPV less than approximately 3.048 mms-1 (0.12 inches per second), the potential for architectural damage due to vibration is unlikely. A PPV of approximately 3.048 mms-1 (0.12 inches per second) to 12.7 mms-1 (0.50 inches per second) there is potential for architectural damage due to vibration, and for a PPV greater than approximately mms-1 (0.50 inches per second) the potential for architectural damage due to vibration is very likely.

Human beings are known to be very sensitive to vibration, the threshold of perception being typically in the PPV range of 0.14 mms-1 to 0.3 mms-1 (British Standard BS 5228-2:2009). An indication of the effects of ground vibration on humans is detailed by the standard and detailed in Table 7-7.

Table 7-7 Guidance on the effects of vibration

VIBRATION LEVEL	EFFECT
0.14 mms^{-1}	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mms^{-1}	Vibration might be just perceptible in residential environments.
1.0 mms^{-1}	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mms^{-1}	Vibration is likely to be intolerable for any more than a brief exposure to this level.

The effects of construction vibration (both on humans and buildings) is summarized in Table 7-8.

Table 7-8 Effects of Construction Vibration

PEAK PARTICLE VELOCITY (mm/sec)	EFFECTS ON HUMANS	EFFECTS ON BUILDINGS
< 0.127	Imperceptible	No effect on buildings
0.127 – 0.381	Barely perceptible	No effect on buildings
0.508 – 1.27	Level at which continuous vibrations begin to annoy in buildings	No effect on buildings
2.54 – 12.7	Vibrations considered unacceptable for people exposed to continuous or long-term vibration	Minimal potential for damage to weak or sensitive structures
12.7 – 25.4	Vibrations considered bothersome by most people, however tolerable if short-term in length	Threshold at which there is a risk of architectural damage to buildings with plastered ceilings and walls. Some risk to ancient monuments and ruins.
25.4 – 50.8	Vibrations considered unpleasant by most people	U.S. Bureau of Mines data indicates that blasting vibration in this range will not harm most buildings. Most construction vibration limits are in this range.
>76.2	Vibration is unpleasant	Potential for architectural damage and possible minor structural damage

Vibrations from various types of construction equipment under a wide range of construction activities have been measured by the Federal Transit Administration (FTA) in the United States. The data in

Table 7-9 provides a reasonable estimate for a wide range of soil conditions. Additional data on other equipment are represented in Table 7-10, which were obtained from measurements on several projects including the Central Artery/Tunnel Project in Boston and from several published sources including the FTA Manual and Dowding's Textbook.

Table 7-9 Vibration source levels for construction equipment (from measured data)

Table 12-2. Vibration Source Levels for Construction Equipment (From measured data.[7,8,9,10])			
Equipment		**PPV at 25 ft (in/sec)**	**Approximate L_v† at 25 ft**
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58
† RMS velocity in decibels (VdB) re 1 micro-inch/second			

Source: FTA (2006)

To predict the vibration at a receptor from the operation of the equipment listed in Table 7-9, the following equation is used:

$$PPV_{equip} = PPV_{ref} \times (25/D)^{1.5}$$

where: PPV (equip) is the peak particle velocity in in/sec of the equipment adjusted for distance

PPV (ref) is the reference vibration level in in/sec at 25 feet from Table 12-2

D is the distance from the equipment to the receiver.

Table 7-10 Equipment Vibration Emission Levels

Equipment Description	Vibration Type Steady or transient	Ref PPV at 100 ft.
Auger Drill Rig	Steady	0.011125
Backhoe	Steady	0.011
Bar Bender	Steady	N/A
Boring Jack Power Unit	Steady	N/A
Chain Saw	Steady	N/A
Compactor	Steady	0.03
Compressor	Steady	N/A
Concrete Mixer	Steady	0.01
Concrete Pump	Steady	0.01
Concrete Saw	Steady	N/A
Crane	Steady	0.001
Dozer	Steady	0.011
Dump Truck	Steady	0.01
Excavator	Steady	0.011
Flat Bed Truck	Steady	0.01
Front End Loader	Steady	0.011
Generator	Steady	N/A
Gradall	Steady	0.011
Grader	Steady	0.011
Horizontal Boring Hydraulic Jack	Steady	0.003
Hydra Break Ram	Transient	0.05
Impact Pile Driver	Transient	0.2
Insitu Soil Sampling Rig	Steady	0.011125
Jackhammer	Steady	0.003
Mounted Hammer hoe ram	Transient	0.18975
Paver	Steady	0.01
Pickup Truck	Steady	0.01
Pneumatic Tools	Steady	N/A
Scraper	Steady	0.000375
Slurry Trenching Machine	Steady	0.002125
Soil Mix Drill Rig	Steady	0.011125
Tractor	Steady	0.01
Tunnel Boring Machine (rock)	Steady	0.0058
Tunnel Boring Machine (soil)	Steady	0.003
Vibratory Pile Driver	Steady	0.14
Vibratory Roller (large)	Steady	0.059
Vibratory Roller (small)	Steady	0.022
Welder	Steady	N/A
Concrete Batch Plant	Steady	N/A
Pumps	Steady	N/A
Blasting	Transient	0.75
Clam Shovel	Transient	0.02525
Rock Drill	Steady	0.011125
3-ton truck at 35 mph	Steady	0.0002

To predict the vibration at a receptor from the operation of the equipment listed in Table 7-10, the following equation is used:

$$PPV_{equipment} = PPV_{ref} (100/D_{rec})^{n}$$

Where:

PPV_{ref} = reference PPV at 100 ft.
D_{rec} = distance from equipment to the receiver in ft.
n = 1.1 (the value related to the attenuation rate through ground)

The closest residential receptor to the JPS 190MW is approximately 760.56 feet (231.82 m).

The vibration impact was predicted on the closest receptors with the use of ten (10) pieces of construction equipment (Table 7-11).

Table 7-11 Predicted vibration levels at the closest residential receptor to the JPS 190MW Power Plant in PPV in/sec and PPV mm/sec in brackets

EQUIPMENT	RECEPTOR VIBRATION
Pile Driver (Impact)	0.009 (0.23)
Vibratory Roller	0.0013 (0.03)
Large Bulldozer	0.00053 (0.013)
Loaded Truck	0.00045 (0.0114)
Jack Hammer	0.00021 (0.0053)
Back Hoe	0.0012 (0.030)
Dump Truck	0.0011 (0.0279)
Frontend Loader	0.0012 (0.030)
Grader	0.0012 (0.030)
Paver	0.0011 (0.0279)

Comparing these level with the British Standard from a human standpoint, most equipment used would result in no vibration being perceived except with pile driving which might just be perceptible.

From a building standpoint, the vibration levels predicted will have no effect residential buildings within proximity of the JPS 190MW Power Plant project.

RECOMMENDED MITIGATION

d. Sequence of operations:
    iii. Phase demolition, earth-moving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately.
    iv. Avoid night time activities. People are more aware of vibration in their homes during the night time hours.
e. Alternative construction methods:

iv. Avoid impact pile-driving where possible in vibration-sensitive areas. Drilled piles or the use of a sonic or vibratory pile driver causes lower vibration levels where the geological conditions permit their use.
v. Select demolition methods not involving impact, where possible.
vi. Avoid vibratory rollers near sensitive areas.

f. Have regular meetings or devise a communication strategy to inform the residents of construction activities.

Solid Waste Generation

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

i. From the construction campsite.
ii. From construction activities such as site clearance and excavation (vegetative debris).
iii. Construction materials packaging (cardboard, plastics, fencing material, wooden pallets, containers etc.)
iv. Earth materials from grading, roadway construction etc.

RECOMMENDED MITIGATION

i. Skips and bins should be strategically placed within the campsite and construction site.
ii. The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour.
iii. The skips and bins at both the construction campsite should be emptied regularly to prevent overfilling.
iv. Disposal of the contents of the skips and bins should be done at an approved disposal site.

Storage of Raw Material and Equipment

Any raw materials used in construction will be stored onsite. There will be a potential for them to become air or waterborne. Stored fuels and the repair of construction equipment has the potential to leak hydraulic fuels, oils etc.

RECOMMENDED MITIGATION

vii. A central area should be designated for the storage of raw materials. This area should be lined in order to prevent the leakage of chemicals into the sediment.
viii. Raw materials that generate dust should be covered or wetted frequently to prevent them from becoming air or waterborne.
ix. Fine grained materials (sand, marl, etc.) will be stockpiled away from drainage channels and low berms will be placed around the piles which themselves will be covered with tarpaulin to prevent them from being eroded and washed away.
x. Raw material should be placed on hardstands surrounded by berms.
xi. Equipment should be stored on impermeable hard stands surrounded by berms to contain any accidental surface runoff.

xii. Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers should be surrounded by bunds to contain the volume being stored in case of accidental spillage.

Transportation of Raw Material and Equipment

The transportation and use of heavy equipment and trucks is required during construction. Trucks will transport raw materials and heavy equipment. This has the potential to directly impact traffic flow along local roads.

RECOMMENDED MITIGATION

vii. Paths of the planned roadways should be used, rather than creating temporary pathways just for equipment access.
viii. Adequate and appropriate road signs should be erected to warn road users of the construction activities. For example reduced speed near the construction site.
ix. Raw materials such as marl and sand should be adequately covered within the trucks to prevent any escaping into the air and along the roadway.
x. The trucks should be parked on the proposed site until they are off loaded.
xi. Heavy equipment should be transported early morning (12 am – 5 am) with proper pilotage.
xii. The use of flagmen should be employed to regulate traffic flow.

7.1.1.2 Water Impacts

Wastewater Generation and Disposal

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

RECOMMENDED MITIGATION

ii. Provide portable sanitary conveniences for the construction workers for control of sewage waste. A ratio of approximately 25 workers per chemical toilet should be used.
iii. Showers should be provided for the workers.

7.1.1.3 Air Impacts

Site preparation has the potential to have a two-folded direct negative impact on air quality of the surrounding residential area. The first impact is air pollution generated from the construction equipment and transportation. The second is from fugitive dust from the proposed construction areas and raw materials stored on site. Fugitive dust has the potential to affect the health of construction workers, the resident population and the surrounding vegetation.

RECOMMENDED MITIGATION

v. Areas should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased.

vi. Minimize cleared areas to those that are needed to be used.
vii. Cover or wet construction materials such as marl to prevent a dust nuisance.
viii. Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators.

7.1.2 Biological

7.1.2.1 Habitat Fragmentation

Habitat fragmentation is the process whereby a large, continuous area of habitat is both reduced in area and divided into two or more fragments by roads, fields, towns and many other human constructs (Primack, 2006). These fragments are often isolated from each other by a highly modified or degraded landscape and their edges experience an altered set of microclimate conditions called "edge effect". Edge effect refers to the variation in the observed microenvironment at the fragment edge. Differences in microclimate factors such as light, temperature, wind and humidity may each significantly impact species composition and vigour within the fragment.

Fragmentation normally occurs during circumstances of severe habitat loss where, for example, large areas of natural vegetation may be cleared for agricultural, residential or industrial developments such as this. The development may reduce the passive movement of spores and seeds across a landscape as well as restrict the movement of animal species that often act as pollen and seed vectors. Fragmentation may also lead to increased vulnerability of the fragment to invasion by exotic and native pest species as well as diseases.

The effects of habitat fragmentation, however, are expected to be minimal negative since the study site and surrounding areas were already degraded and the species composition limited by current land use practices (e.g. logging, burning and livestock grazing). Although planned access roads and fencing may limit the movement of animal vectors, the grasses and some of the common herbs present are wind propagated.

The marine environment also appears to be heavily degraded and may also experience some habitat fragmentation as a result of the lying of various pipelines. However the impacts of these activities is expected to be minimal.

RECOMMENDED MITIGATION

iii. Limit rights-of-passage to areas already showing noticeable signs of habitat degradation. For example areas with open fields and pastureland.
iv. Develop thorough procedures for the proper disposal of solid waste as well as hazardous and flammable materials. Restrict their disposal into surrounding locales.

7.1.2.2 Flora

The vegetation present within the study area exhibited high levels of anthropogenic influence, which was evidenced by the secondary community observed. The study has shown that the planned development of a power plant would not result in the inadvertent removal of endemic, endangered, threatened or rare species; however, the National Flower *Guiacum officinale* occurs on the site. Effects on the flora, especially during the construction phase, may vary.

RECOMMENDED MITIGATION

i. None required

Accidental or Intentional Removal of Important Plant Species or Communities

Over 52 plant species were encountered. This moderate species richness is possibly due to the mixture of vegetation types present and the then prevailing drought. Although none were endemic, endangered, threatened or rare, the diversity of the area is important. Therefore, minimising the negative impact on the flora during the construction phase of the development is also important.

- Mangroves are very important land stabilisers in a wetland community and help to provide conditions necessary for other plant species to become established. They are also important because they may be used as a habitat for faunal species.
- The Guango/Bastard Cedar stand in the greater SJPC lands provided a microhabitat for several plant and fungal species not common to the surrounding vegetation. Based on their basal diameter it may be estimated that several of the trees were quite old (a tree-core analysis would be necessary to determine their actual age). The herb, *Rivina humilis* (Bloodberry) frequently occurred here and is known to have tremendous potential for medicinal remedies.

RECOMMENDED MITIGATION

vii. The removal of vegetation should be strictly limited to the development site.
viii. Altering the orientation or placement of the development's footprint should be considered in more densely vegetated or otherwise sensitive communities mentioned above are not or minimally disturbed.
ix. A proper plan should be developed concerning transportation routes and storage for equipment and material.
x. The proposed post construction or operation road network should be kept simple as well as be used throughout the preparation and construction phases of the project.
xi. Proper planning regarding access points to the construction site should be established.
xii. A buffer area should be established and maintained between the project area and the surrounding vegetation.

Increased Soil/Substrate Erosion and Flooding

The potential for land erosion and flooding 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 drainage.

Areas where bare ground is exposed tend to erode faster than areas inhabited by plants as they help percolate rainwater into the substrate below. There was evidence on site that some soil compaction and erosion was occurring due primarily to the degraded nature of the community. As such any further vegetation removal would intensify these impacts.

RECOMMENDED MITIGATION

iv. If possible, trees with trunks of DBH 20 cm and greater should be left intact.
v. Remove trees only as would be necessary. A tree removal protocol should be developed for site preparation prior to project initiation.
vi. Prepare vegetation restoration plan to be implemented once construction is complete.

Storage and Transportation of Raw Materials

Plant growth and health can be significantly affected by dust, grime and toxic emissions. Leaching from storage areas can disturb the pH balance in the soil and result in plant loss.

RECOMMENDED MITIGATION

iii. A central area should be designated for the storage of raw materials. This area should be lined in order to prevent the leakage of paints and chemicals into the sediment.
iv. In terms of transporting equipment, the paths of the planned roadways should be used, rather than creating temporary pathways just for equipment access.

Impact on Biodiversity/Ecosystem Functions

In terms of the impact on vegetation, the least affected area would be the primary development lands. Here the community was the least rich in species; canopy cover was sparse; and the vegetation indicative of an open, secondary successional, xerophytic community. Occasional flora constituents, such as columnar cacti, (*Harrisia gracilis* and *Stenocereus hystrix*) and ornamental shrubs (namely *Nerium oleanrder*) may be pollenated by bats.

The SJPC lands which surround the project area (and should have the least direct impact) had the highest diversity but was dominated by *Samanea saman* (Guango) and *Guazuma ulmifolia* (Bastard Cedar) trees. In 2012 the Guango/Bastard Cedar stand was a closed community with limited light permeating through to the forest floor in some sections. As a result, the shrub component of this stand was quite poor; however, the ground and epiphytic constituents were well represented. In rainy periods, herbs, such as *Achyranthes indica* (Devil's Horse-whip) and *Ravina humilis*, were very common as these species were adapted to the low-light conditions.

Fruit trees of the Anacardiaceae family, namely *Mangifera indica* (Mango) and *Anacardium occidentale* (Cashew) and Caricaceae (*Carica papaya*) have been known to be frequented by fruit bat species. However, these trees were limited to domestic cultivation away from the primary development lands and should not be severely impacted by the development.

RECOMMENDED MITIGATION

See mitigations stated for the unintentional removal of important species above.

7.1.2.3 Fauna

Overall, the proposed development will have an impact on the fauna on the property with special emphasis on the birds, as a result of the modification or removal of some of their habitat such as the mudflats, mangrove forest and the old fish ponds. However during the survey no animals with special conservation status were encountered on the property. Specific potential impacts are listed below.

- The study was not conducted at the time when the migrant warblers are present. The migrant warblers are known to utilize mangrove forests and acacia woodlands which are present in the project area. However, none of the migrant warblers have any special conservation status in Jamaica. The removal of vegetation will result in the loss of habitat for the migrant warblers.
- During the clearing of the property, there is an increased probability of human and crocodile interaction which increases the risk of people hunting the crocodiles or poaching the eggs because they are in high demand.
- The clearing of the property will remove seasonal flooding of the artificial fish ponds, mangroves, woodland and mudflats which will have an impact on the avifauna and the terrestrial and amphibious invertebrates.

RECOMMENDED MITIGATION

- Planting of trees on the property will increase avifauna and terrestrial invertebrates' number.
- The re-vegetation of the site will not have a significant impact on the crocodile population. However the vegetation can help hide the juvenile crocodiles from predators.
- A winter bird survey should be a part of the monitoring plan for the project.
- The removal of the vegetation will change the bird species composition in the area. In order to reduce the negative impact of the development, trees can be planted which could attract a number of birds.

7.1.2.4 Benthic Communities

Fish

Runoff and or siltation as a result land based activities may result in reduced water quality resulting in the temporary displacement of some fish species in the area of influence. The excess sedimentation can also result in the clogging of fish gills.

RECOMMENDED MITIGATION

See Mitigation - Sediment Barriers and Silt Screens

Reptiles- Sea Turtles and Crocodiles and Mammals- Dolphins

Land based activities may disrupt nesting activities for turtles and crocodiles and temporarily displace these animals.

RECOMMENDED MITIGATION

Sensitisation and education of all construction personnel about all marine fauna (reptiles and mammals) and birds must be undertaken prior to any major works. This should include, but not limited to; proper procedures in the event of an accident/entanglement/interaction; protocol if a nest is discovered. The use of a spotter may also be necessary in-order to prevent incidents.

Where possible, all work activities should be conducted outside of crocodile and turtle nesting seasons.

Reefs

Nearby and surrounding reef systems may be exposed to high levels of sediment as a result of the construction activities. The sedimentation of these sensitive ecosystems may result in the smothering of sessile organisms, in particular coral colonies and sponges.

RECOMMENDED MITIGATION

- Sediment barriers/silt and retention ponds are recommended See Recommended
- Special care should be taken in the placement of these screens around these systems.
- Contractors should be responsible for ensuring that only the approved areas identified are used thus minimising the possible damage to any nearby reefs. .

Seagrass

Run-off and excess sedimentation may impact nearby seagrass beds.

RECOMMENDED MITIGATION

- Construct berms around the construction site
- Sediment barriers/silt screens are recommended.

Further to this special care should be taken in the placement of these screens around these systems, in particular where seagrass beds occur near to shoreline areas. Small sections of seagrass were found within the footprint near the shoreline. These areas should be avoided where possible.

7.1.3 Heritage

If significant artefacts are present in any of these proposed project areas, site clearance has the potential to negatively affect the archaeological heritage of the area.

RECOMMENDED MITIGATION

i. During site clearance, JNHT should be present in order to undertake further archaeological evaluations and ascertain the magnitude of Taíno sites, if any.
ii. Ensure the preservation of the historic and cultural sites.
iii. Monitoring should be conducted during clearing and excavation stages in areas where historic artefacts were discovered.

iv. The recording of impacted structures should be undertaken prior to destruction.

7.1.4 Human/Social

7.1.4.1 Employment

There is the potential for increased employment during the pre-clearance and construction phases. It is anticipated that approximately 70 persons will be employed directly during the site clearance and an average of 200 persons to a maximum of 400 -450 persons at the peak during construction. Approximately 70% of the work force will be obtained from local labour. In addition it is anticipated that approximately 1,140 and 1,520 – 1,710 indirect and induced jobs are expected to be created during the site clearance and construction phases respectively; thus further benefitting the community. This represents a significant level of employment within the study area and has the potential to be a significant positive impact.

RECOMMENDED MITIGATION

No mitigation required.

7.1.4.2 Traffic Management (Commuters and Pedestrians)

The construction process may necessitate the re-routing of some vehicular and pedestrian traffic and introducing traffic delays thereby increasing in travel time. Any re-routing of vehicular traffic has the potential to lead to increase fares. Increased accident potential from additional trucks traversing the main roads is also a possibility.

Negative impacts on traffic are expected during the construction stages, and these include:

- Disruptions in traffic.
- Reduced level of service due to increased large/construction vehicle on the roads.

Wear and tear on roads from loaded trucks transporting material and/or construction debris is also a cause for concern.

RECOMMENDED MITIGATION

During the site preparation and construction phases, the following should be enforced:

vi. Trucks should operate ideally during off peak hours.
vii. Loading of trucks as per NWA axel load guidelines.
viii. Traffic diversion routes must be identified and constructed as necessary.
ix. Adequate caution signage as per NWA guidelines and the use of flagmen where necessary.
x. Trucks must be properly covered and loaded so as to not let loose material fall during transport.

7.1.4.3 Housing

It is not expected that the structure of housing will be adversely impacted and as such relocation of residents is not a foreseen measure.

RECOMMENDED MITIGATION

None required.

7.1.4.4 Aesthetics

Solid waste generation during the construction period can have a potential negative impact on visual aesthetics if improperly collected and stored on site. There is also the potential for vermin infestation if discarded food and food containers are present.

RECOMMENDED MITIGATION

iii. Skips and bins should be strategically placed within the campsite and construction site.
iv. The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour.

7.2 OPERATION

7.2.1 Physical

7.2.1.1 Land Impacts

Hydrology and Runoff

As mentioned previously in section 5.1.6 Hydrology and Runoff, runoff was estimated for both existing (predevelopment) and post development scenarios. The post development scenario for the site considered climate change impacts.

The flows from this area will increase from 15 to 22 percent for the 10 to 100 year event due to the increased impermeable areas after the construction of the power plant.

Table 7-12 Comparison of predevelopment and post development future flows from the JPS site

Storm	Predevelopment runoff (m^3/s)	Future Flows (m^3/s)	Increases
Ivan	4.3		
Gustav	0.8		
10yr	2.2	2.69	22%
50yr	3.1	3.56	15%
100yr	3.4	3.92	15%

RECOMMENDED MITIGATION

iii. In order to minimize quantity of waste water, rain water from clean areas such as roads, paved areas free from contamination and buildings, etc. will be collected through open ditches (and/or) road side gutters. Collected rainwater will be routed to the holding area before being re-routed to the sea. This will allow for sediments to fall out before discharge to the sea. The recommended volume for the holding area should contain the first flush or ½ inch of rainfall before it discharges to the sea.

iv. Oily water on the site will generally originate from two area, plant floor and car park area. Floor water will originate from a number of activities; these will include wash down operations, maintenance operations, and spills during loading. Oily water in car park area may be as a result of spills from delivery trucks or any other vehicles undergoing mechanical problem or maintenance. Floor water will be directed to floor drains which will terminate at oil water separators. Similarly car park runoff will be directed to storm drains which will terminate in oil water separators as well. Class 1 separators are recommended for both circumstances given the bay is an environmentally sensitive area.

Noise

The predicted noise from the proposed power plant was determined by using SoundPlan version 7.3. The noise spectrum for both the Steam Turbine Generators and the Gas Turbine Generators and other major equipment provided by the manufacturer was used to calibrate the model. Once the model was calibrated then structures such as the auxiliary buildings, tank farm, ground and other buildings within the area were added.

The noise impact from the proposed plant at the fence line (industrial), institutional (schools) and residential location were assessed and reported in Table 7-13 and depicted in Figure 7-2 and Figure 7-3.

COMPARISON WITH NEPA GUIDELINES

Stations 3 and 5 will be non-compliant with the NEPA day time standard when winds from the south were taken into consideration and Stations 2, 3 and 5 non-compliant with the NEPA night – time standard with or without considerations of wind. It is should be noted that only Station 5 was offsite the JPS compound.

COMPARISON WITH WORLD BANK GUIDELINES

Stations 2, 3 and 5 will be non-compliant with the World Bank day time guidelines, this with or without influences of the south wind, except for Station 5, where exceedance occurred only with the wind. Stations 2, 3, 5 and 6 non-compliant with the night-time guidelines with or without wind considerations.

Table 7-13 Comparison of anticipated noise readings with NEPA and World Bank guidelines

STATION			DAY TIME (7 am. – 10 pm.) (dBA)					NIGHT TIME (10 pm. – 7 am.) (dBA)				
No.	LOCATION	CATEGORY	BASELINE	PREDICTED NOISE FROM 190MW PLANT (GP)	PREDICTED NOISE FROM 190MW PLANT (CONCAWE)	NEPA STD.	WORLD BANK GUIDELINE	BASELINE	PREDICTED NOISE FROM 190MW PLANT (GP)	PREDICTED NOISE FROM 190MW PLANT (CONCAWE)	NEPA STD.	WORLD BANK GUIDELINE
1	North-Western Property Boundary	Industrial	66.9	64.9	68.1	75	70	59.6	64.9	68.1	70	70
2	South-Western Property Boundary	Industrial	62.4	**71.9**	**74.7**	75	70	56.5	**71.9**	**74.7**	70	70
3	South-Eastern Property Boundary	Industrial	64.0	**74.9**	**77.5**	75	70	58.0	**74.9**	**77.5**	70	70
4	North-Eastern Property Boundary	Industrial	62.9	64.7	67.1	75	70	59.8	64.7	67.1	70	70
5	Informal Settlement	Residential	61.4[20]	54.1	**57.0**	55	55	59.9	**54.1**	**57.0**	50	45
6	Blackwood Gardens	Residential	52.2[21]	46.5	48.6	55	55	46.9	**46.5**	**48.6**	50	45
7	Old Harbour Bay Police Station	Residential	56.2[22]	37.4	38.9	55	55	52.7	37.4	38.9	50	45
8	New Harbour Village Phase II	Residential	43.1	35.7	36.6	55	55	41.9	35.7	36.6	50	45
9	Longville Park Housing Scheme	Residential	51.7[23]	27.4	21.6	55	55	49.9	27.4	21.6	50	45
10	New Harbour Village Phase I	Residential	60.6[24]	31.1	31.0	55	55	56.3	31.1	31.0	50	45
11	JPS Guard House	Industrial	61.4[25]	56.8	60.0	75	70	54.9	56.8	60.0	70	70

NB: Numbers in red indicate non-compliance with both NEPA and World Bank guidelines and blue indicate non-compliance with World Bank guideline.

[20] Average of noise data from 2007 – 2012 (Campbell 2014), Jamaica Energy Partners Annual Noise Assessment (2013 and 2014) and current measurements
[21] Average of noise datd from Jamaica Public Service Noise Assessments (2010, 2011 and 2013), South Jamaica Public Company EIA (2012) and current measurements
[22] Average of noise data from 2007 – 2012 (Campbell 2014), Jamaica Energy Partners Annual Noise Assessment (2013 and 2014), South Jamaica Public Company EIA (2012) and current measurements
[23] One of noise measurements conducted for the South Jamaica Public Company EIA (2012)
[24] Average of noise data from 2007 – 2012 (Campbell 2014), Jamaica Energy Partners Annual Noise Assessment (2013 and 2014) and South Jamaica Public Company EIA (2012)
[25] One of noise measurements conducted for the South Jamaica Public Company EIA (2012)

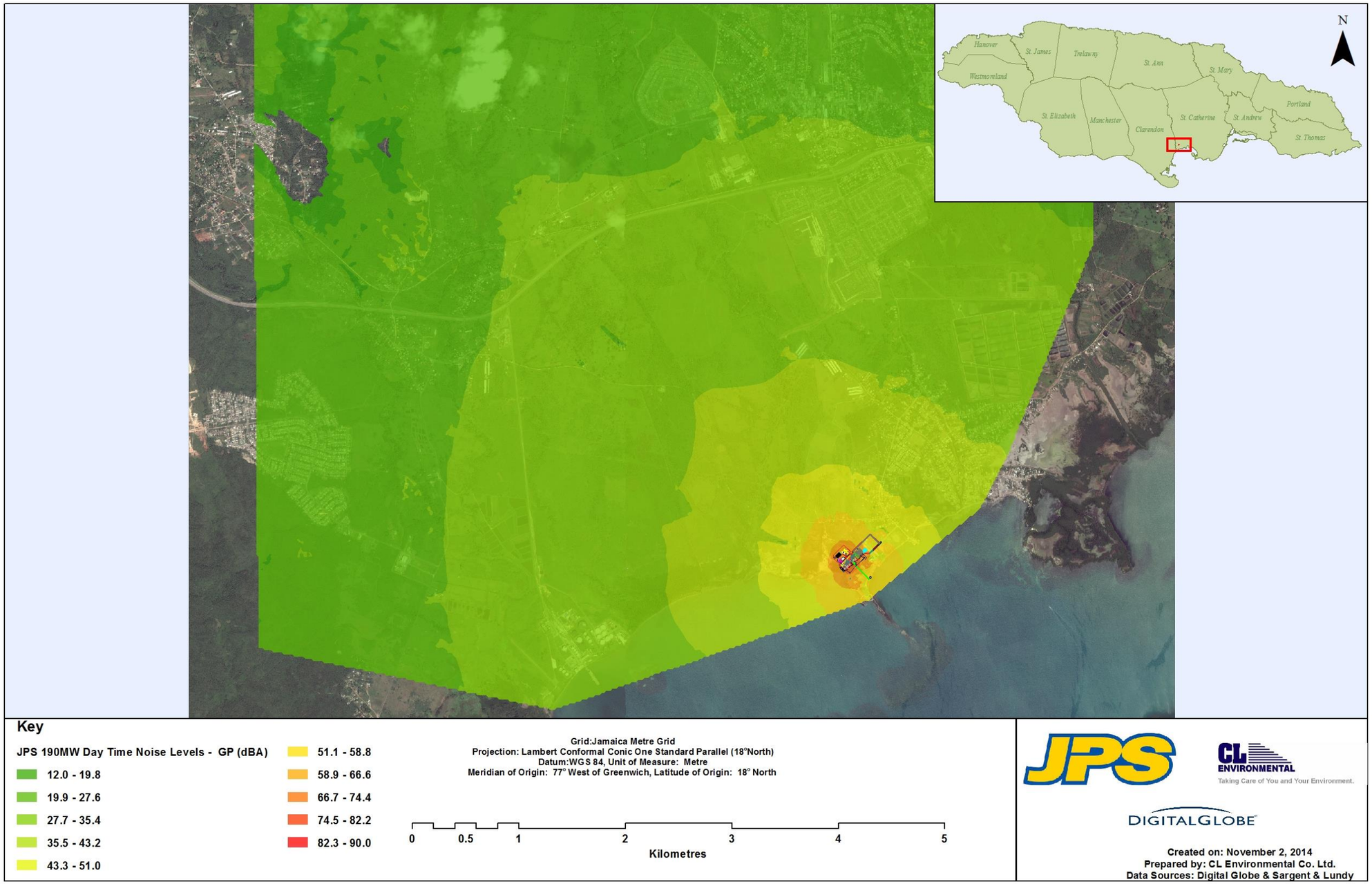


Figure 7-2 Predicted day time noise level of the proposed 190 MW LNG power plant (General Prediction model)

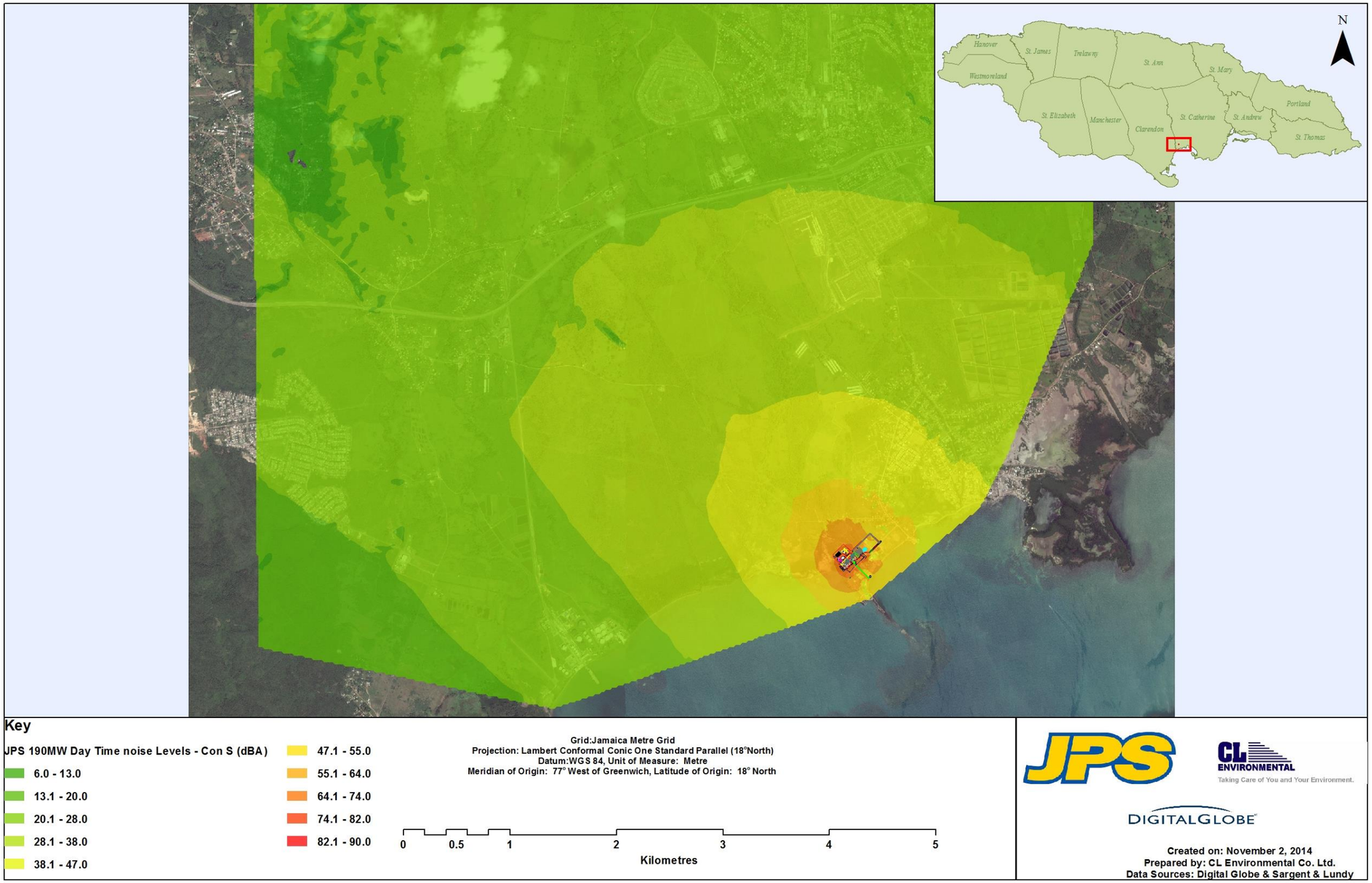


Figure 7-3 Predicted night time noise level of the proposed 190 MW LNG power plant (Concawe model - winds from the south)

Although the locations at which noise levels were taken during the conduct of the EIA were compliant with the NEPA and World Bank guidelines, there were areas in proximity to the proposed Plant where the noise generated by the Plant would be non-compliant. This assessment was done using the night time noise limit of 50 dBA, since once the night time noise limits are met then automatically the day time night standard would be met. This coupled with the fact that persons will be more sensitive to night time noise.

Based on this, a 50 dBA noise limit was predicted using the noise model. This identified the following two areas to be non-compliant with the 50 dBA limit. These are: Sections of Terminal Lane and Sections of Terminal Road and are illustrated in Figure 7-4.

COMMUNITY NOISE EQUIVALENT LEVEL (CNEL)

CNEL is equivalent to the European Standard of Day Evening Night Levels (L_{den}). It is a 24-hour equivalent continuous level in dBA where 5 dBA is added to evening noise levels from 7:00 p.m. to 10:00 p.m. and 10 dBA is added to night-time noise levels from 10:00 p.m. to 7:00 a.m. It can give an indication of the likelihood of community complaints about a noise source. At a guideline CNEL level of 65 dBA it is expected that will be sporadic complaints from the community.

The calculated 65 dBA CNEL limit lines were calculated for the JPS 190MW operating alone using the General Prediction and Concawe (wind from the south) models and are illustrated in Figure 7-5. The results indicate that there should be no complaints from the community as it relates to the operation of the JPS 190MW power plant alone.

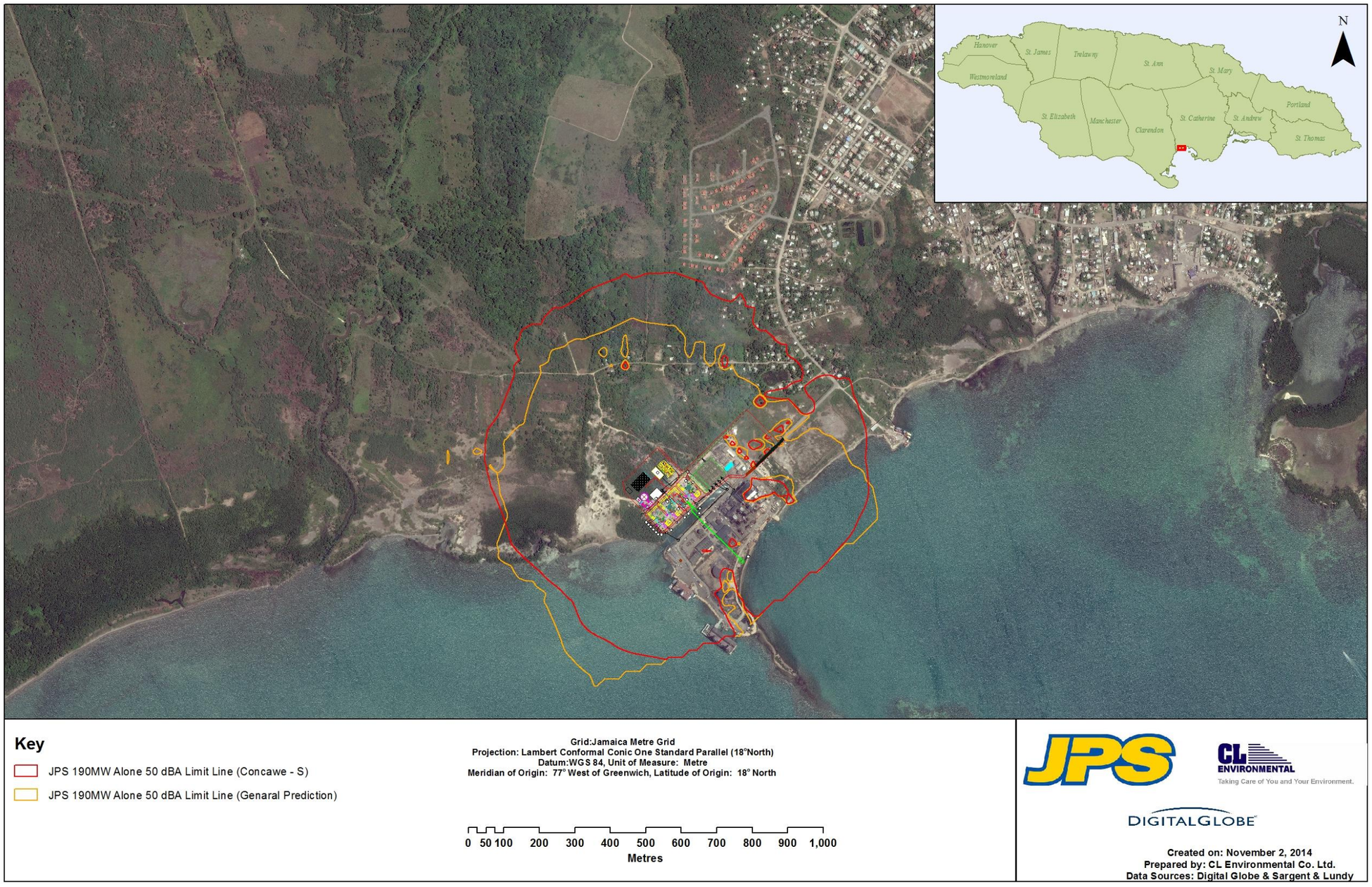


Figure 7-4 The NEPA 50 dBA (night time) limit lines using the General Prediction and Concawe (winds from the south) models

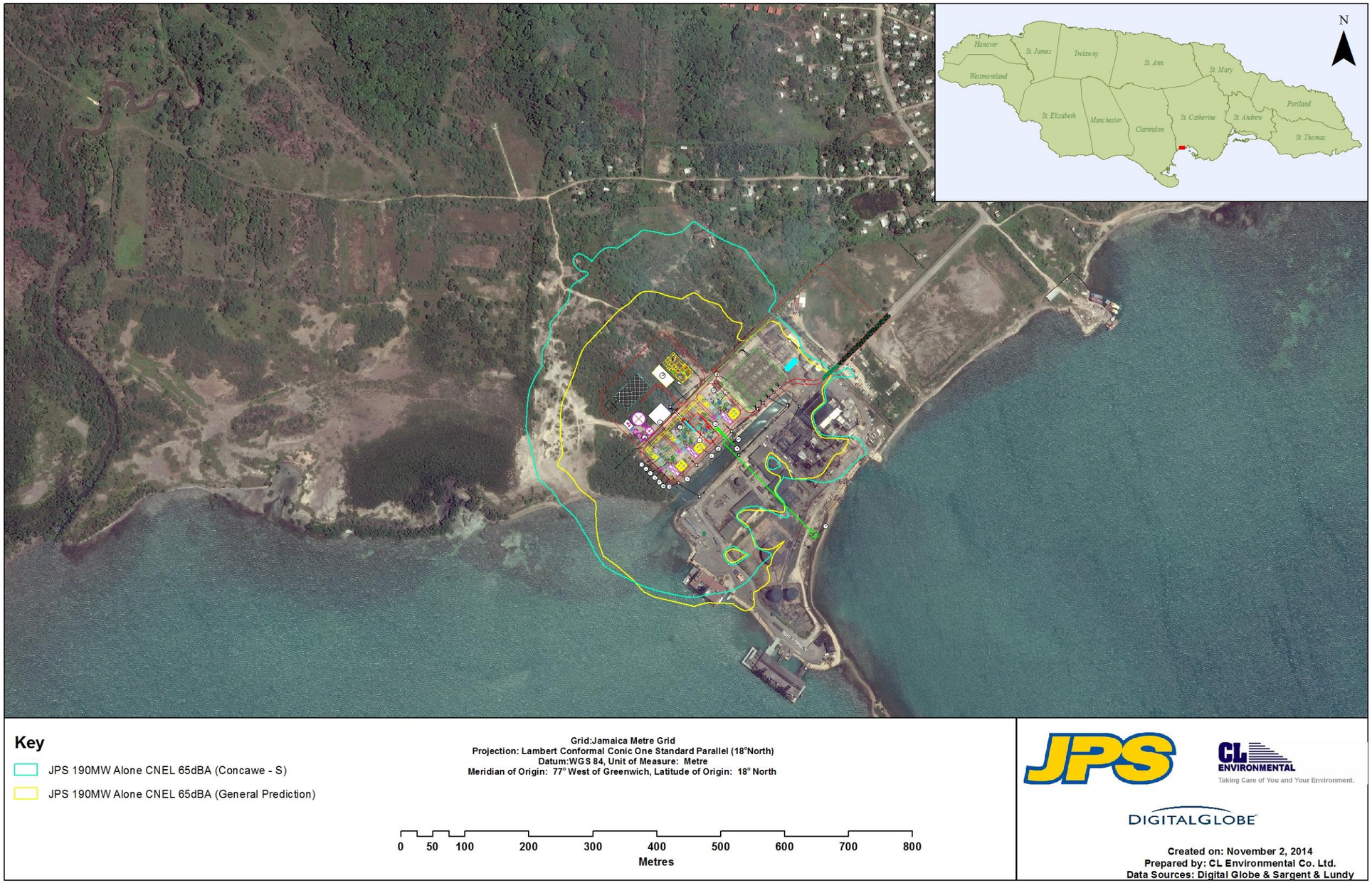


Figure 7-5 Community Noise Equivalent Levels (CNEL) 65 dBA limit lines for General Prediction and Concawe (winds from the south) models

SENSITIVE RECEPTORS

Sensitive receptors (schools, churches and clinics) within 6 km were mapped. Note that this list is not intended to be exhaustive. The noise attributed to the operation of the JPS 190MW power plant alone and in combination with Jamaica Energy Partners Doctor Birds I and II at the various receptors was predicted using both the General Prediction Model and the Concawe Model with wind blowing from the south (worst case scenario).

Schools

A total of twelve schools were investigated (Table 7-14). When the General Prediction model was used to predict the noise levels when the JPS 190MW power plant was operating alone, the stations generally exhibited the inverse law, which is the decrease in noise with increasing distance. The noise levels ranged from a low of 25.7 dBA (Old Harbour Primary) to a high of 39.2 dBA (Blackwood Gardens Basic School). When modelled with the Concawe model with the wind blowing from the south (worst case scenario) the noise levels at the schools ranged from a low of 21.2 dBA (Longville Park Early Childhood Centre) to a high of 41.1 dBA (Blackwood Gardens Basic School). The noise levels however did not exhibit the inverse law.

The predicted noise levels from the JPS 190MW plant operating alone noise levels at the schools were all compliant with both the NEPA daytime standard and the World Bank guideline when both the General Prediction and concawe models were used.

Table 7-14 Schools listed in order of increasing distance (m) from the proposed JPS 190MW power plant with the predicted noise from JPS 190MW power plant operating alone

SCHOOLS	DISTANCE FROM DOCTOR BIRD POWER FACILITY (m)	LAeq (16)		NEPA STD	WORLD BANK GUIDELINE
		JPS 190 MW	CONCAWE S – JPS 190 MW		
Blackwood Gardens Basic School	1143.7	39.2	41.1	45	55
Children First Basic	1235.0	39.1	40.4	45	55
Old Harbour Bay Primary	1330.1	37.7	38.4	45	55
Baptist Early Childhood Centre	1353.3	38.1	39.2	45	55
St. Wade Basic School	1415.0	37.4	38.9	45	55
Old Harbour High School	3795.6	28.6	27.5	45	55
Portmore Community College (Old Harbour)	4149.2	27.7	26.4	45	55
Freetown Primary	4409.1	26.9	26.2	45	55
Monsignor Colin Bryan Preparatory	4597.5	27.1	25.9	45	55
Longville Park Early Childhood Centre	4609.3	26.5	21.2	45	55
Old Harbour Early Childhood Institution	5009.3	26.0	24.3	45	55
Old Harbour Primary	5091.8	25.7	23.8	45	55

Churches

Predicted noise levels at eighteen churches were scrutinized (Table 7-15). The noise levels at the churches did not exhibit the inverse law regardless if the General Prediction model or the Concawe model were used to predict the noise levels. When the General Prediction model was used the noise levels ranged from 26.0 dBA (Old Harbour Baptist) to 40.3 dBA (Mount Refuge Fire Baptize Holiness). When the Concawe model was used the noise levels ranged from 21.3 dBA (Longville Park Church) to 42.1 dBA (Mount Refuge Fire Baptize Holiness).

With the exception of the predicted noise at Mount Refuge Fire Baptize Holiness when JPS 190MW and JEP Doctor Birds I and II are operational (Concawe), all other predicted noise levels were compliant with both the NEPA daytime standard and the World Bank guideline when both the General Prediction and concawe models were used (Table 7-15).

Table 7-15 List of churches in order of increasing distances (m) from the proposed JPS 190 power plant with the predicted noise from JPS 190MW power plant operating alone

CHURCHES	DISTANCE FROM DOCTOR BIRD POWER FACILITY (m)	LAeq (16)		NEPA STD	WORLD BANK GUIDELINE
		GP JPS 190 MW	CONCAWE S – JPS 190 MW		
Mount Refuge Fire Baptize Holiness	1038.5	40.3	42.1	55	55
Unnamed Church	1353.0	38.1	39.7	55	55
St Phillips Anglican	1370.9	38.1	39.3	55	55
Refuge Temple Old Harbour Bay	1454.2	37.1	38.4	55	55
Old Harbour Bay Baptist	1499.4	36.8	37.4	55	55
Old Harbour Bay SDA	1564.9	35.9	37.0	55	55
Faith Bible Baptist Church	1792.3	35.4	36.2	55	55
Old Harbour Evangelistic Centre	3471.4	28.8	28.5	55	55
Church of Our Lord Apostolic Faith	3868.2	28.5	27.4	55	55
Jehovah Witness	3948.2	28.3	27.2	55	55
Hebron Gospel Hall	4120.0	27.9	26.6	55	55
Old Harbour SDA	4185.9	27.8	26.3	55	55
Holy Ghost Ministries Inc.	4312.6	37.4	26.0	55	55
Church of the Holy Trinity	4347.4	27.4	25.9	55	55
St. Michael & St. George Anglican	4421.3	26.9	26.2	55	55
Longville Park Church	4611.7	26.3	21.3	55	55
St Dorothy's Anglican Church	4992.7	26.7	24.3	55	55
Old Harbour Baptist	5061.7	26.0	24.2	55	55

Clinics

The noise levels at two clinics were examined (Table 7-16) when the JPS 190MW power plant was operating alone. The results indicated that noise at both clinics complied with the inverse law when either General Prediction or Concawe models were used. The noise levels when the General Prediction

model was used varied from 27.0 dBA (Old Harbour Health Centre) and 35.1 dBA (Bay View Medical Centre) and when Concawe model was used 25.5 dBA (Old Harbour Health Centre) and 37.0 dBA (Bay View Medical Centre).

All predicted noise levels were compliant with both the NEPA daytime standard and the World Bank guideline whether the General Prediction and Concawe models were used (Table 7-16).

Table 7-16 Noise levels at clinics in order of increasing distance (m) from the proposed JPS 190 MW power plant with the predicted noise from JPS 190MW power plant operating alone

CLINICS	DISTANCE FROM DOCTOR BIRD POWER FACILITY (m)	LAeq (16)		NEPA STD	WORLD BANK GUIDELINE
		GP JPS 190 MW	CONCAWE S – JPS 190 MW		
Bay View Medical Centre	1669.2	35.1	37.0	55	55
Old Harbour Health Centre	4479.2	27.0	25.5	55	55

RECOMMENDED MITIGATION

No mitigation is required.

Vibration

The operation of the power plant has the potential to create vibration that may cause a nuisance to both employees and residents alike.

RECOMMENDED MITIGATION

v. Ensure that the equipment are placed on the manufacturer's recommended dampening system.
vi. Monitor the following:
    a. Speed (RPM) and Power (MW)
    b. Bearing vibration: seismic, shaft rider, or shaft x-and-y proximity probes (as applicable)
    c. Journal bearing and thrust bearing metal temperature
vii. Install the continuous monitoring system for GE steam turbines - The Turbine Supervisory Instrumentation (TSI) System. This monitoring includes the typical radial displacement vibration and axial position measurements used for GE steam turbines.
viii. Vibration-monitoring capability and evaluation is one of the most important portions of the TSI system for trending and predicting changes in turbine health and thermodynamic performance. Overall, vibration monitoring provides the means to track the following types of problems:
    a. Bearing problems
        i. A change in vibration level or erratic vibration reading can be indicative of a wiped bearing and scored journal, as can an increase in bearing metal or oil drain temperature.
    b. Rotating parts-related problems

i. Any circumferential variation in weight in the rotating parts will result in an unbalance, which will be reflected in the vibration level at the bearings. This includes problems such as: loss of bucket covers, or loss of part or all of a bucket. Step changes in vibration level may be indicative of this condition in many cases.

c. Bowed rotors
   i. Rubbing of steam path components due to insufficient clearance, created by mis-assembly or mis-operation can create a bow due to uneven heating or cooling of the rotor surfaces. This shift in centre of rotation further compounds the rub and increases distortion.
   ii. Packing, spill strips and bucket covers are the most frequently damaged parts in a bowed rotor event, but permanently bowed rotors may also occur if the localized heating or cooling is sufficient to change material properties of the rotor body.
   iii. A bow in the rotor (of even a few mils) may cause a shift in the axis of rotation sufficient to produce a change in vibration level at the bearings. In the low-pressure element of the unit, which contains longer buckets, severe mechanical damage can be caused by water induction and this may be reflected by a change in the vibration level at the bearings. Where applicable, water detection thermocouples can be used to better identify if there is a water induction problem and to help identify the source of the water.

Traffic

There is little potential for an increase in overall traffic as it is expected that there will be the closure of the JPSCo Old Harbour plant, with the opening of the 190 MW plant. Therefore, it is expected that the traffic that now goes to this plant will be diverted to the 190 MW LNG plant thus no net increase.

RECOMMENDED MITIGATION

No mitigation is required.

7.2.1.2 Water Impacts

Pollution of Water Resources

HAZARDOUS AND NON-HAZARDOUS WASTE

Non-hazardous and hazardous wastes include general solid waste, waste oils, oil contaminated rags, hydraulic fluids, used batteries, empty paint cans, waste chemicals and used chemical containers, oily sludge from oil water separators and scrap metals among others. These have the possibility of polluting nearby surface water bodies as a result of improper disposal practices.

RECOMMENDED MITIGATION

Waste materials should be segregated into non-hazardous and hazardous wastes and considered for re-use /recycling prior to disposal. A waste management plan should be developed that contains a

waste tracking mechanism from the originating location to the final waste reception location. Storage, handling and disposal of hazardous and non-hazardous waste should be conducted in a way consistent with good EHS practice for waste management

NATURAL DISASTERS

With any natural disaster comes the possibility of fuel/oil spill as a result of storage tank or pipeline damage. This may affect nearby surface water bodies and/or groundwater.

RECOMMENDED MITIGATION

Each storage tank should be surrounded by a bund which is designed to contain at least 110% of the storage tank capacity.

The tanks should also be designed for the seismic rating of the region and the tank profile should take into account the wind loads (both typical and maximum) for the region and must be able to withstand a Category 5 hurricane. Equipment and structures must also be designed to withstand the harshest recorded environment for the region.

Oily Water Management

Oily water on the site will generally originate from two areas, plant floor and the car park area. Floor water will originate from a number of activities; these will include wash down operations, maintenance operations, and spills during loading. Oily water in the car park area may be as a result of spills from delivery trucks or any other vehicles undergoing mechanical problem or maintenance.

RECOMMENDED MITIGATION

ii. Direct rainfall into the areas or floor washing water will be led to an oil separator by gravity and connected to the industrial waste piping network. The Oil removal system receives oil-contaminated water from all over the plant. Oil removed from the Oil/water separator will be stored within the separator for periodic removal and off-site disposal.

Sewage and Wastewater Management

Water for plant and sanitary processes will be obtained from a well source. The wastewater produced from the power plant operations will include wastes from the following sources:

- RO plant reject water (brine)
- Demineralization waste water
- Filter backwash water
- Cooling tower

RECOMMENDED MITIGATION

All wastewater from the plant will be collected in a concrete tank and pre-treated to a satisfactory level and routed through a holding area to make it fully compliant with NEPA effluent quality standards before being re-routed back to the flume. The effluent quality will also be monitored by a continuous

monitoring system. Sewage effluent from various buildings will be piped to the central sewage treatment plant. Waste water meeting the designated standards (Table 7-17) will be discharged into the holding pond. Those not meeting the standards will be treated to reflect the following:

Table 7-17 NEPA wastewater standard targets

Parameter	Treated waste water quality
pH	6.5~8.5
Oil & Grease (mg/l)	<10
BOD5 (mg/l)	<30
COD (mg/l)	<100
TSS (mg/l)	Max. 150, Monthly Avg.: <50

Chemically contaminated waste will be isolated by spill wall, dike, pit, trench, etc. Waste, if not biodegradable, will be treated separately and removed for disposal.

Commonly used chemicals on the plant are:

1. Phosphates
2. Oxygen scavenger
3. Amine
4. Sulphuric acid

Cooling Water Management

The cooling water from the plant will be discharged from the plant at a rate of 282,812 GPM and at a higher temperature than that of the seawater. The background or ambient temperature of seawater was measured at 30.71 degrees Celsius on average whereas the discharge from the plant will be at 35.5 degrees Celsius.

The region of water body which undergoes changes in temperature due to heated water discharge is termed as the thermal plume. This begins at the hot water outlet and extends in horizontal and vertical directions. The behaviour of thermal plume is influenced by many parameters such as the flow rate and temperature difference at the outlet and its characteristics, flow dynamics of receiving water body, relative locations of intake and outfall, withdrawal velocity, type of structure and the meteorological conditions. The thermal plume can be broadly divided into two zones: namely near field and far field. Near field is the zone adjacent to the discharge point.

In order to predict the behaviour of the plume in terms of its movement and temperature, scaled and calibrated numerical models are generally employed. The nearfield and far field modelling are generally separated to because of scaling differences. Nearfield models simulate the behaviour of the Gully in the vicinity of the discharge point.

Hydrodynamic Modelling (Thermal Dispersion)

DESIGN APPROACH AND STANDARDS

The performance of the outfall is characterized by its ability to meet NEPA guidelines for trade effluent discharge. The guideline for thermal discharge states that temperature increases of up to 2^{o}C above ambient is allowed at the point of discharge. The World Bank guidelines dictate that within the mixing zone a temperature rise of 3^{o}C is allowable, and where the mixing zone distance is not specified a distance or 100m. The start of the discharge should be considered as the point where the river meets the sea, the standards should therefore be met at or before 100m away from that point.

It is envisaged the cooling water will be discharged to the northeast corner of flume which will in turn discharge to the Bay. This will negate the need for nearfield modelling as the flume is a small channel that guides the flow to the Bay. As the heated water travels from the discharge point (in the flume), it is anticipated that some negligible amounts of heat will be lost by evaporation and radiation. On entering the Bay the heated water will spread out over the surface of the sea under the influence of buoyancy, momentum and shear stresses between the two layers. The water will be vertically stratified with the hot water forming a plume on the surface of the cooler sea water. This plume will be convected up and down the coast by the currents whilst being gradually dispersed by vertical and horizontal mixing. The temperature concentration will thus reduce and the edge of the plume will become indistinct. The degree of mixing occurring will be a function of the variability of the velocity, which in turn will depend upon tidal and wind conditions as well as local bathymetry (Ackers, 1980).

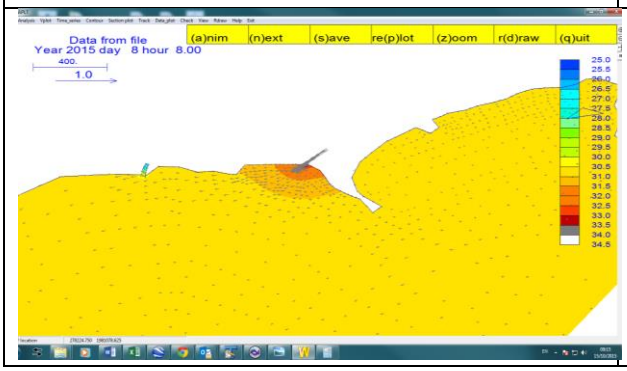
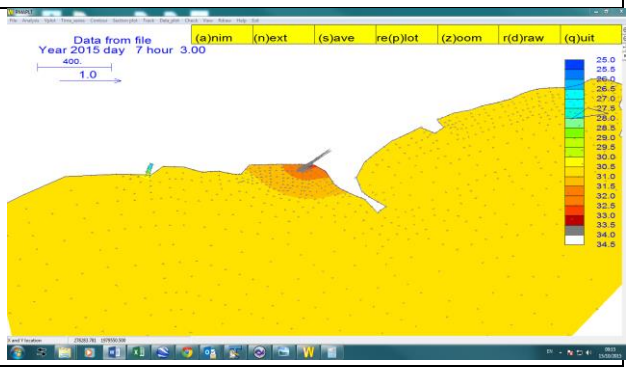
The modelling approach was to use the calibrated finite element hydrodynamic model to simulate the dispersion and mixing of the plume; applying the flows to the surface layer as a point source within northeast corner of the thermal flume.

FAR-FIELD THERMAL DISPERSION MODELLING RESULTS OF PROPOSED DISCHARGE CONDITIONS

Slow Wind Conditions

During average wind conditions the temperature of the cooling water will fall to between 32.5 °C and 31.5 °C, a maximum of 1.8 degrees above the ambient temperature of 30.7°C well within the mixing zone (or 100m radius). The cooling process will take longer as the movement of currents driven by wind are slower and facilitates less mixing. This will cause a noticeable area of slightly elevated temperature, which will have further temperature decreases down to background temperatures at or before the 100m from the discharge point. See Table 7-18.

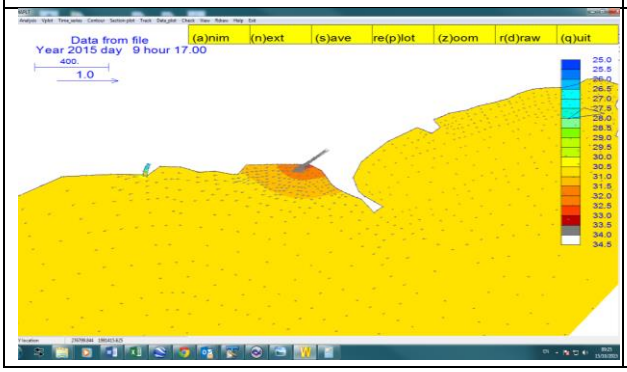
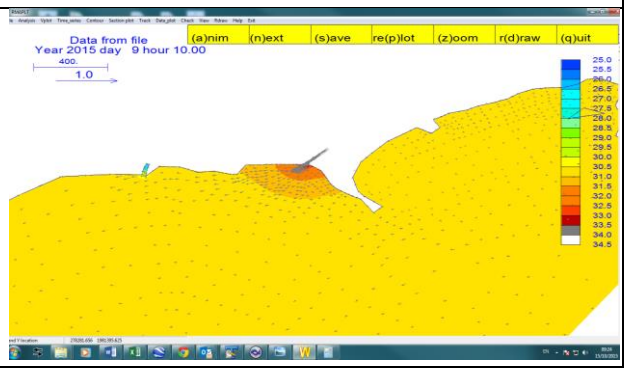
Table 7-18 Falling Tide and Rising Tide – Slow Wind Conditions

Falling Tide	Rising Tide
	

Average Conditions

During average wind conditions the temperature of the cooling water will fall to between 32.5 °C and 31.5 °C, a maximum of 1.8 degrees above the ambient temperature of 30.7°C well within the mixing zone (or 100m radius). The cooling process will take a shorter time than for slow wind conditions as the movement of currents driven by wind are faster and facilitates more mixing and a relatively smaller plume, which will have further temperature decreases down to background temperatures just outside of the 100m limit. See Table 7-19.

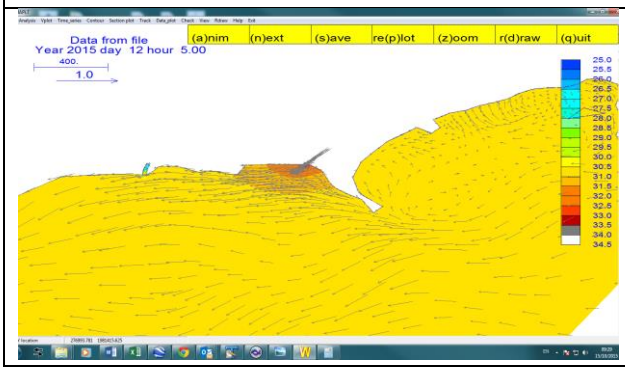
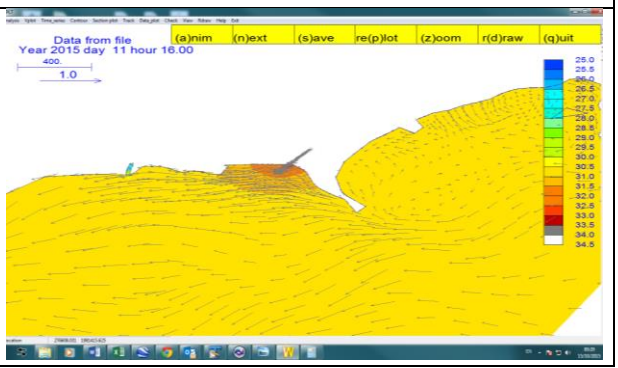
Table 7-19 Falling Tide and Rising Tide - Average Wind Conditions

Falling Tide	Rising Tide
	

Fast Wind Conditions

During fast wind conditions the temperature of the cooling water will fall to between 32.5 °C and 31.5 °C, a maximum of 1.8 degrees above the ambient temperature of 30.7°C well within the mixing zone (or 100m radius). The cooling process will be shorter than for average conditions as the movement of currents driven by wind are very fast and facilitates good mixing. This will cause a fairly small area of slightly elevated temperature within the mixing zone, which will have further temperature decreases down to background temperatures just outside of 100m limit. See Table 7-20.

Table 7-20 Falling Tide and Rising Tide - Fast Wind Conditions

Falling Tide	Rising Tide
	

RECOMMENDED MITIGATION

None Required. Having a small area of elevated temperature is unavoidable. It is within the limits set by the Regulatory agencies and thus will not require any mitigation at this time.

7.2.1.3 Air Impacts

Air Dispersion Modelling

An air dispersion modelling analysis was undertaken to determine the impact of the air pollutants from the proposed facility on the ambient air quality (Appendix 10). A determination was 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 (SO2), total suspended particulates (TSP), particulate matter less than ten microns (PM10) or nitrogen dioxide (NO2) is greater than an annual average of 21 µg/m3 or a 24-hour average concentration of 80 µg/m3; or
b) The increment in the predicted average concentration of CO is greater than 500 µg/m3 as a 8-hour average or 2000 µg/m3 as a 1-hour average

Additionally, the cumulative air quality impact of all active operating sources within the project area (including the proposed power plant) will be determined.

PROCESS DESCRIPTION AND AIR POLLUTANT SOURCES

Unit Operations of Proposed Facility

The Old Harbour 190 MW Gas-Fired Combined Cycle Power Plant will consist of three (3) blocks. Each block consists of 3x3x1 configuration, (three combustion turbine generators, three heat recovery steam generators (HRSGs) and one steam turbine generator) and is a multi-shaft design for gas turbine and steam turbine generators. The combustion turbines will be dual fuel capable, with LNG as the primary fuel. The exhaust gas from the gas turbine is led to the associated HRSG for generating the

steam which in turn will be fed to a common steam turbine generator. The HRSGs will be dual pressure, non-reheat type, with duct burners, in order to obtain optimum exhaust gas energy utilization based on thermo-economic considerations.

The plant is designed for both base load and cycling duty (two shift operation) in order to be able to comply with all instructions from the system load dispatcher. The plant will operate with a 98% average annual equivalent availability factor (EAF) for the life time of the plant. This reliability is based on the inherent reliability of the Original Equipment Manufacturer (OEM) turbine packages, the unique features of the OEM gas turbines that allow for optimum maintenance schedules, a robust balance of plant (BOP) design, all coupled with competent operations and maintenance staff that will be provided. In addition, the company intends to enter into a long term service agreement (LTSA) with the OEM for scheduled maintenance on the gas turbines. This will ensure that maintenance is done in accordance with OEM requirements, with genuine OEM parts and service, and in an expeditious manner.

A metering system is used in order to measure net energy output from the plant, and to monitor and co-ordinate operation of the facility. The location of the metering system will be in a 138 kV substation control building, and potential transformers for the metering system will be located on the 138 kV side of each generator transformer feeders in the 138 kV switchyard to measure net electrical energy outputs. In order to meet the NOx emission requirement, a diluent injection system will be used at each gas turbine generator. Additionally, continuous emissions monitoring (CEM) ports will be provided for the measurement of air emission levels in the exhaust stack of each HRSG.

Potential Air Emissions

The air pollutants of concern to be discharged into the ambient air from the proposed power plant will be TSP, NOx, SO_2, CO and various priority air pollutants. These priority air pollutants include acetaldehyde, acrolein, benzene, formaldehyde and xylenes.

MODELLING APPROACH

The assessment methodology for the air dispersion modelling 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 modelling programs. AERMOD is a regulatory steady-state plume modelling 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 modelling air quality impacts of pollution sources, making it a popular choice among the modelling community for a variety of applications. Some of the modelling capabilities of AERMOD include the following:

- The model may be used to analyse 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 pre-processing 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 modelling the effects of settling and removal (through dry and wet deposition) of large particulates and for modelling 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.

MODEL INPUTS

Source Emissions

A critical step for conducting air dispersion modelling 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 7-21 shows the source information data determined for the proposed power plant, while Table 7-22 displays the emission rates for criteria and priority air pollutants that were calculated based on the use of a fuel heat consumption rate of 1.383×10^9 kJ/h and USEPA emission factors for Stationary Gas Turbines.

Source information data for the main operating air pollution sources in the air shed – namely the Best Dressed Feed Mill, JPS existing power plant and JEP power plant are shown in Table 7-23, while

those for the alumina handling activities at Port Esquivel are displayed in Table 7-24. Table 7-25 and Table 7-26 highlight the available emission rates for the main operating air pollution sources in the air shed. These data were obtained from the Air Dispersion Modelling Report for the Best Dressed Feed Mill, dated August 2014.

Table 7-21 Source information data for the proposed power plant

Source ID	Type	Description	X Coord, m	Y Coord, m	Elevation, m	Height, m	Diameter, m	Exit Velocity, m/s	Exit Temperature, K
MS1	POINT	Main Stack 1	276701	1980416	3.0	45	3.9	11.6	370.5
MS2	POINT	Main Stack 2	276647	1980363	2.4	45	3.9	11.6	370.5
MS3	POINT	Main Stack 3	276618	1980335	2.1	45	3.9	11.6	370.5

Note that the Bypass stacks were not modelled because the HSRG stacks have lower exit gas velocities and temperatures that would result in lower exhaust plume heights and higher ambient impacts

Table 7-22 Air pollutant emission rates for the proposed power plant using Natural Gas

Source ID	PM, g/s	SO_2, g/s	NOx, g/s	CO, g/s	Acetaldehyde, g/s	Acrolein, g/s	Benzene, g/s	Formaldehyde, g/s	Xylenes, g/s
MS1	1.09	0.562	21.5	4.96	6.61E-03	1.06E-03	1.98E-03	0.117	1.06E-02
MS2	1.09	0.562	21.5	4.96	6.61E-03	1.06E-03	1.98E-03	0.117	1.06E-02
MS3	1.09	0.562	21.5	4.96	6.61E-03	1.06E-03	1.98E-03	0.117	1.06E-02

Table 7-23 Source information data for JEP, JPS and BDFM

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
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

Source: Air Dispersion Modelling Report for Best Dressed Feed Mill, St. Catherine, Jamaica, 2014

Table 7-24 Source information data for Alumina handling at Port Esquivel

Source ID	Type	Description	X Coord, m	Y Coord, m	Elevation, m	Release Height, m	Length X, m	Length Y, m	Initial Lateral Dimension, m	Initial Vertical Dimension, m
HDRSTRUL	AREA	Unloading of Hydrate to storage	274006.38	1979786	3	4.572	65.98	60.99		
HDRSTRLD	AREA	Loading of Hydrate to storage	274006.38	1979786	3	4.572	65.98	60.99		
HDRSTR2	AREA	Hydrate Storage	274035.18	1979775	3	15.24	34.25	35.54		
RLCRUNL	VOLUME	Unloading of alumina from railcars	274001.69	1979713	3	31.5	20.66		4.80465	3.4186
TRNSF1	VOLUME	Transfer station	274070.86	1979608	3	31.5	2.5		0.5814	7.3256
TSL05	VOLUME	Storage Silo #5	274010.77	1979573	3	52	33.8		7.86047	7.3256
TSL01	VOLUME	Silo #1	274092.14	1979580	3	52	17.53		4.07674	7.3256
TSL02	VOLUME	Silo #2	274105.92	1979559	3	52	17.53		4.07674	7.3256
TSL03	VOLUME	Silo #3	274119.06	1979538	2.41	52	17.53		4.07674	7.3256
TSL04	VOLUME	Silo #4	274135.96	1979514	2	52	17.53		4.07674	7.3256
SHPLDR	VOLUME	Ship Loader	274240.82	1979345	0	11.1	24.41		5.67674	4.6512
TRHSE	VOLUME	Transfer House	274178.84	1979465	2	47.7	20.66		4.80465	4.186

Source: Air Dispersion Modelling Report for Best Dressed Feed Mill, St. Catherine, Jamaica, 2014

Table 7-25 Criteria emission rates for other nearby existing facilities

Source ID	Description	PM (g/s)	SO_2 (g/s)	NOx (g/s)	CO (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
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	BDFM Diesel Engine	0.014	0.07	0.448	0.119
FEEDB1	BDFM Boiler 1	0.0413	2.13	0.408	0.00331
FEEDB2	BDFM Boiler 2	0.00853	0.199	0.14	0.0103
GRAIN	BDFM Grain Receiving	0.416	0	0	0
MILL	BDFM Mills	2.3	0	0	0
HDRSTRUL	Unloading of Hydrate to storage	0.00377			
HDRSTRLD	Loading of Hydrate to storage	0.00377			
HDRSTR2	Hydrate Storage	0.1244			
RLCRUNL	Unloading of alumina from railcars	0.186			
TRNSF1	Transfer station	0.03067			
TSL05	Storage Silo #5	0.03067			
TSL01	Silo #1	0.03067			
TSL02	Silo #2	0.03067			
TSL03	Silo #3	0.03067			
TSL04	Silo #4	0.03067			
SHPLDR	Ship Loader	0.186			
TRHSE	Transfer House	0.186			

Source: Air Dispersion Modelling Report for Best Dressed Feed Mill, St. Catherine, Jamaica, 2014

Table 7-26 Available priority air pollutant emission rates for nearby sources

Pollutants, g/s	FEEDE	FEEDB1	FEEDB2
Acetaldehyde	1.3E-05		
Acrolein	4.07E-06		
Benzene	4.01E-06	5.25E-07	9.44E-07
Formaldehyde	6.1E-04	8.1E-05	2.12E-04
Xylenes	9.98E-05		

Comparison of Proposed Emission Rates with Emission Standards

Table 7-27 highlights the emission standards to be applied to the proposed power plant and these standards are based on the NRCA (Air Quality) Regulations, 2006. The table also shows the emission rates derived for the facility based on the conversion of the USEPA emission factors (with units of lb/MMBtu) to ng/J. It should be noted that the derived emission rates in Table 7-27 revealed one

exceedence – NOx. The NOx emission rate is design technology based (diluent injection) and will require certain design changes in order to ensure the achievement of compliance with the standard.

Table 7-27 Emission rate comparison with emission standards

Facility	Pollutant	Emission Standard, ng/J	Emission Factor, lb/MMBtu	Emission Rate, ng/J
New Fuel Combustion - Gas Fired 29-73 MW	NOx	40	6.6×10^{-3}	55.9
	CO	125	1.3×10^{-1}	12.9
	PM	13	3.0×10^{-2}	2.84

Building Downwash Effects

Buildings located close to point sources (see Figure 7-6) 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 modelling.

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 short-term modelling, 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

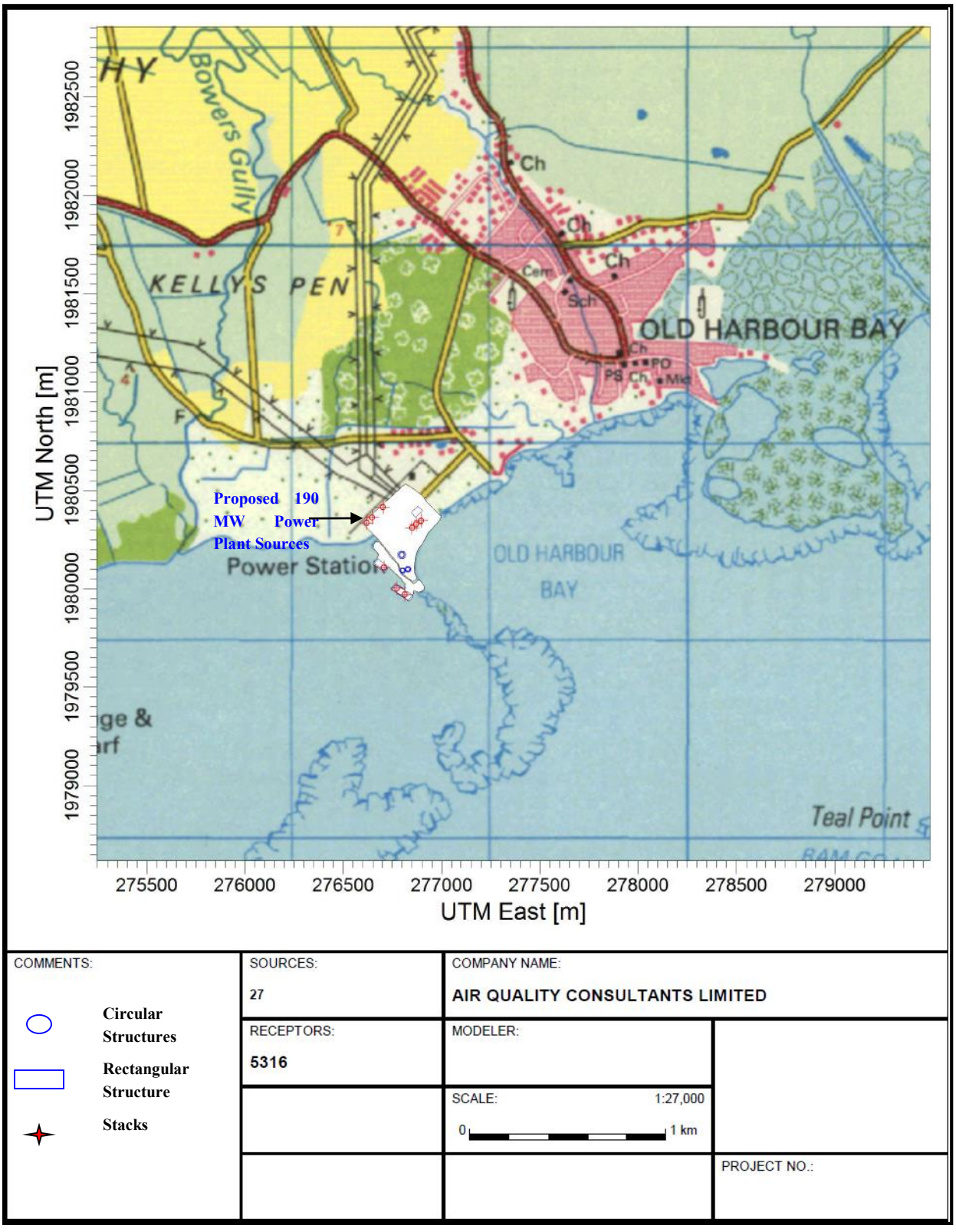


Figure 7-6 Proposed point sources and main buildings

There are a number of buildings nearby the point sources that were identified in the modelling 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 7-28 shows the calculated GEP stack heights for the proposed power plant facility. It was observed that the recommended stack heights were equal or above the calculated GEP stack heights and hence, the unmodified algorithms for building downwash were used by the model to generate the building heights and projected building widths that were calculated using part two of the BPIP program. Hence, it is expected that point source emissions would not result in excessive pollutant concentrations in the immediate vicinity of the source, but rather significantly beyond the facility's fenceline.

Table 7-28 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
MS1	45.00	0.00	64.00	65.00
MS2	45.00	0.00	64.00	65.00
MS3	45.00	0.00	64.00	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.

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, as well as upper air data. These data were obtained as a MM5 modelled data set for years 2009 through 2013 with the centre point for the modelling site being main stack #2 with UTM coordinates 276647 in the east and 1980363 in the north.

Both data files were then used to generate the meteorological input files 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 surface parameters within a 3 km radius around the centre of the modelling domain that were applied to the AERMET processor are listed in Table 7-29.

Table 7-29 Surface Parameters for AERMET Processor

Sector (angle from north)	Land Use	Albedo	Bowen Ratio	Surface Roughness
0 – 90^{o}	Cultivated land	0.28	0.75	0.0725
90 – 225^{o}	Water	0.14	0.45	0.0001
225 – 360^{o}	Cultivated land	0.28	0.75	0.0725

The 2009-2013 meteorological pre-processed data was used to determine its corresponding Wind Rose plot (see Figure 7-7). The Wind rose show that the most predominant wind direction blows from the east-southeast, with the secondary wind direction being from the east. This means that the emissions plume will be dispersed mainly in the west-north-westerly direction, and secondarily in the western direction from the proposed plant site.

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 Main Stack #2, with coordinates 276,647 m UTME and 1,980,363 m UTMN. Figure 7-8 shows the model domain that was utilized in the project, including the receptor grid and the plant boundaries. The model domain is overlain on a Jamaica Metric Grid 1:50,000 topographic map.

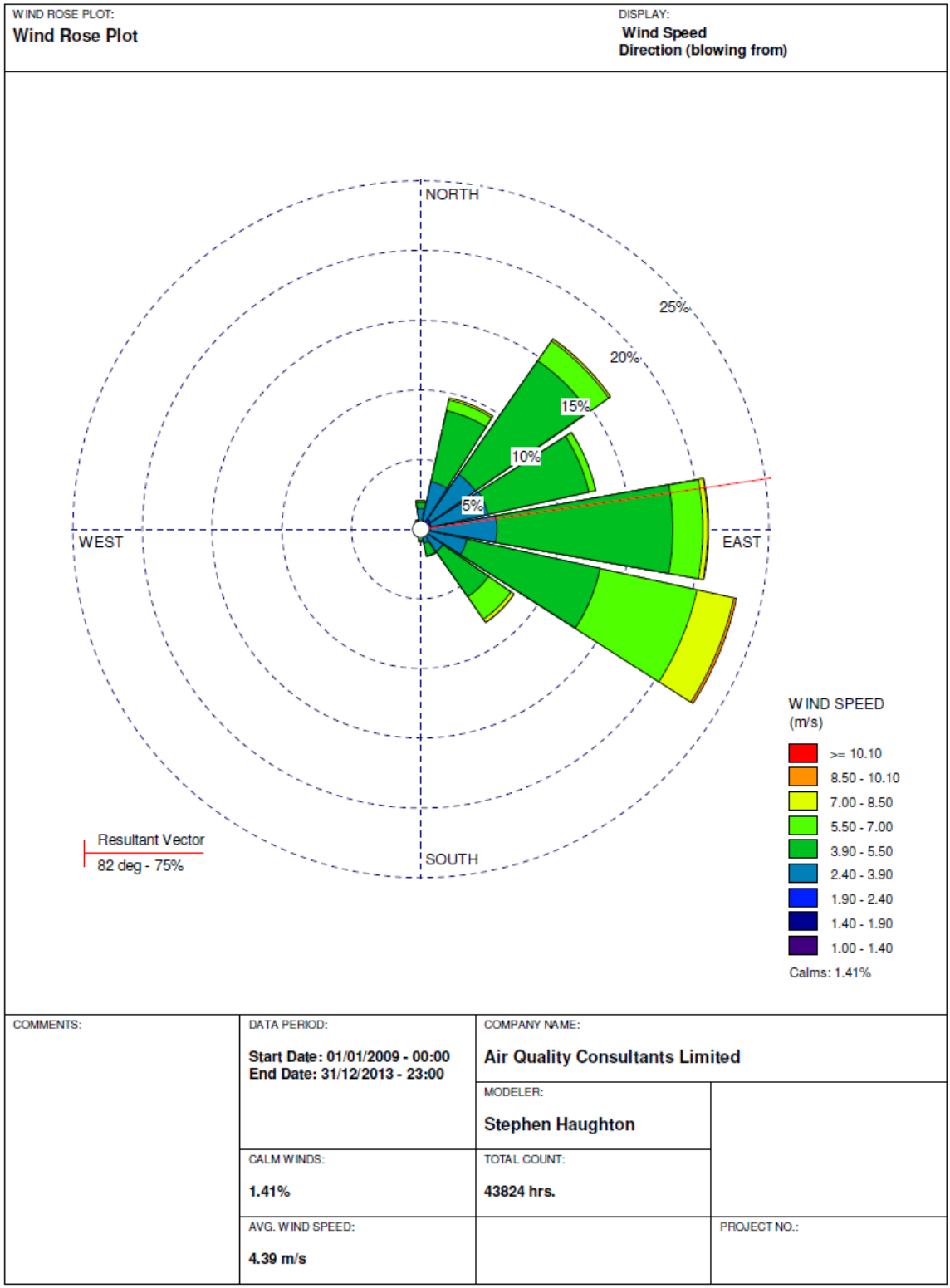


Figure 7-7 Wind rose plot for 009-2013 pre-processed met data

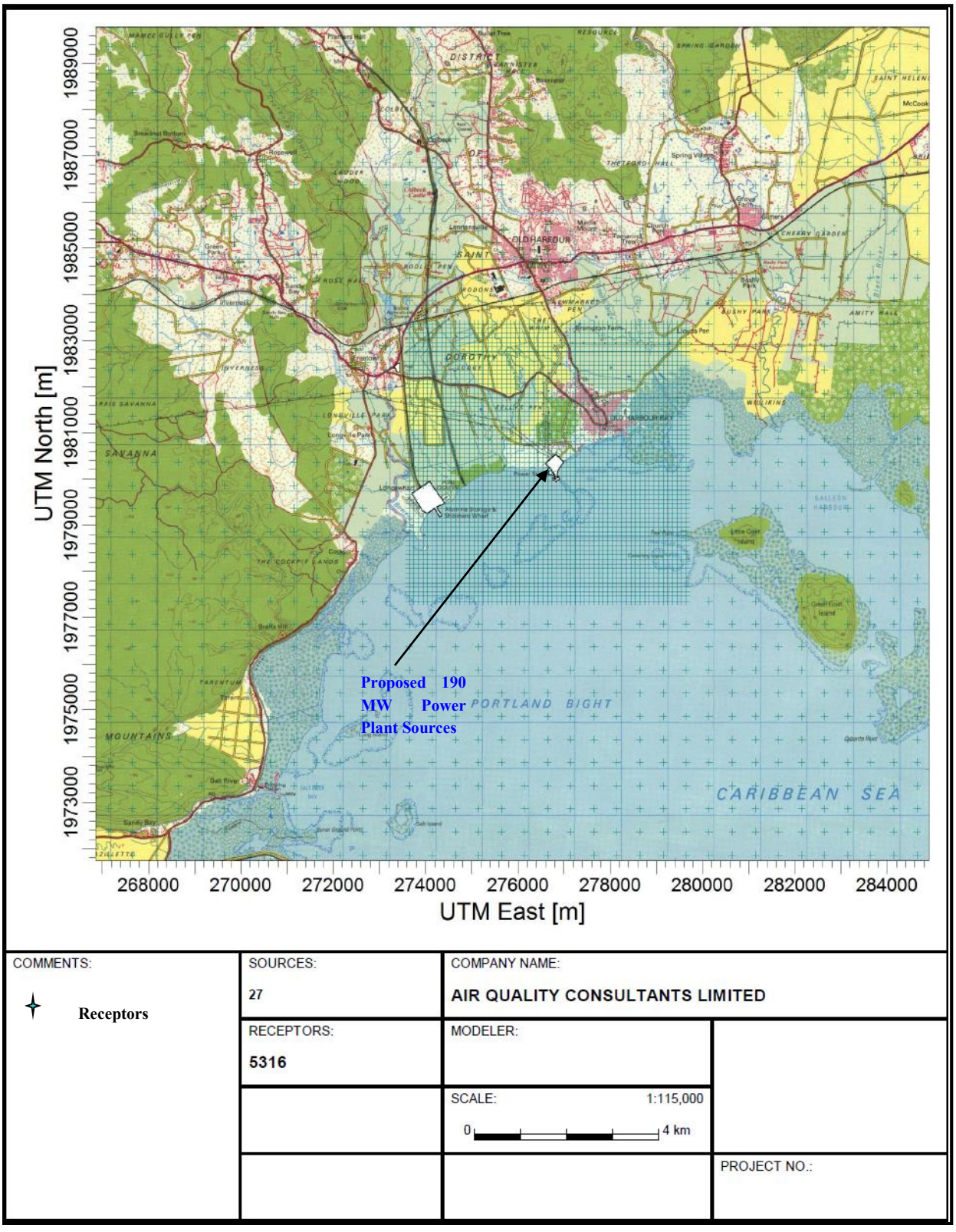


Figure 7-8 Model domain showing the receptor grid

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 Main Stack #2. Certain special receptor locations were also defined, including schools, church buildings, postal agencies, health centres, post offices, police stations and a courthouse.

A total of 5,316 receptors were considered. 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 total of 44 special receptors that include schools, church buildings, postal agencies, health centres, post offices, police stations, a courthouse and air quality monitoring stations (Table 7-30).

Table 7-30 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

Description	X Coordinate, m	Y Coordinate, m	Elevation, m
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

Terrain Considerations

The classification of the land use in the vicinity of the proposed power plant 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 modelling project.

According to the land-use type methodology, a 3 km radius circle was circumscribed about the centre of the proposed power plant boundary. 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 Table 7-31). The majority of the area was cultivated land and sea, and hence the rural option was selected.

Table 7-31 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 power plant 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 and obtained as Digital Elevation Maps derived by the Mona Informatix Limited's personnel. It was determined that the topography from the east through south western directions of the proposed facility, up to 10 km, have terrain elevations less than 20 m and include the marine environment (Figure 7-9). Also, the areas from southwest through to the northern direction had elevations greater than 30 m and up to 400 m. Therefore, since terrain elevations extend above the proposed facility's highest top stack elevation, complex terrain algorithms were included as part of the dispersion modelling analysis.

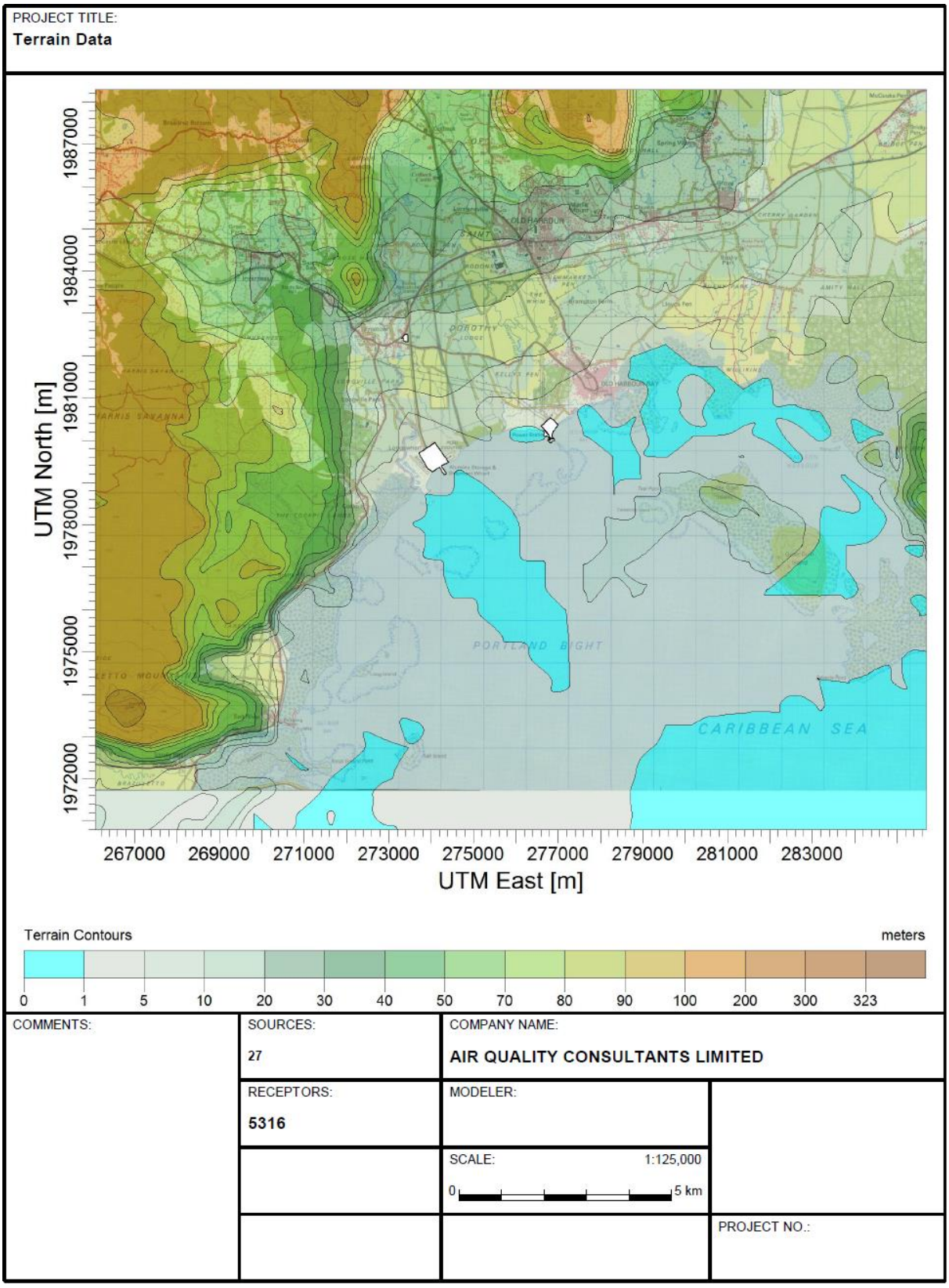


Figure 7-9 Terrain data for the project area

MODEL RESULTS AND IMPACTS

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 at Main Stack #2, and the necessary input files created, model predictions were made for the pollutants SO_2, NO_x, TSP, CO and various priority air pollutants for averaging periods for which there are Jamaican National Ambient Air Quality Standards or Guideline Concentrations. Model runs were conducted for the proposed power plant'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. As part of the future scenario with the new LNG-fired 190 MW power plant being in full operation, the existing oil-fired JPS 190 MW will be retired, and hence those air pollution sources will be removed from the future scenario. During the NO_x model runs, the OLM was applied to convert NOx to NO_2 using the default in-stack NO_2/NOx ratio of 0.1 and an ozone concentration of 12 ug/m^3 which was the annual average ozone concentration as reported by NEPA for the year 2012.

Table 7-32 summarizes the maximum predicted concentrations for the proposed LNG-fired power plant sources, as well as their comparison with the Significant Impact Concentrations and the Jamaican National Ambient Air Quality Standards (JNAAQS) and Guideline Concentrations. The results revealed that when combusting LNG (the primary fuel), the maximum predicted ground level concentrations did not exceed any of the Significant Impact Concentrations (SICs). Additionally, the maximum predicted ground level concentrations plus the background concentrations (as recommended in the Air Quality Guideline Document) were all less than the JNAAQS and Guideline Concentrations.

Figure 7-10 through Figure 7-19 show the pollutant contour plot-files for TSP, NO_x, CO and PM_{10} for the proposed power plant when combusting LNG. 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.

Table 7-32 Model results for the proposed power plant using LNG

Pollutant	Avg. Period	Background (µg/m^3)	Significant Impact Concentration (µg/m^3)	Jamaican NAAQS (µg/m^3)	Proposed 190MW Power Plant Sources		
					Max Conc (µg/m^3)	UTME (m)	UTMN (m)
TSP	24-hr	14	80	150	5.3	270147	1981363
	Annual	20	21	60	0.64	275947	1980663
NO_2	1-hr	0	N/A	400	158.2	277147	1987363
	24-hr	0	80	N/A	26.9	276247	1978963
	Annual	0	21	100	9.5	275947	1980663
SO_2	1-hr	0	N/A	700	32.3	277147	1987363
	24-hr	0	80	280	2.7	270147	1981363
	Annual	0	21	60	0.3	275947	1980663
CO	1-hr	0	2000	40000	285.5	277147	1987363

Pollutant	Avg. Period	Background (µg/m³)	Significant Impact Concentration (µg/m³)	Jamaican NAAQS (µg/m³)	Proposed 190MW Power Plant Sources		
					Max Conc (µg/m³)	UTME (m)	UTMN (m)
	8-hr	0	500	10000	65.6	268647	1981363
Acetaldehyde	1-hr	0	N/A	1250	0.38	277147	1987363
	24-hr	0	N/A	500	0.03	270147	1981363
Acrolein	1-hr	0	N/A	58.75	0.06101	277147	1987363
	24-hr	0	N/A	23.5	0.00512	270147	1981363
Benzene	Annual	0	N/A	1	0.00116	275947	1980663
Formaldehyde	1-hr	0	N/A	162.5	6.7	277147	1987363
	24-hr	0	N/A	65	0.6	270147	1981363
Xylenes	1-hr	0	N/A	5750	0.6	277147	1987363
	24-hr	0	N/A	2300	0.05	270147	1981363

SUMMARY AND CONCLUSIONS

The following conclusions may be made as a result of the conduct of the air dispersion modelling analyses for the proposed LNG-fired power plant:

- The emission rates derived from the use of emission factors for each combustion turbine burning LNG, comply with the CO and PM emission standards, but exceeded the NO_x standards. It was deduced that in order to achieve compliance with the NO_x emission standard, certain changes with the design of the diluent injection technology to be employed for NOx reduction will have to be made.
- The model predictions for the LNG-fired proposed power plant revealed compliance with the CO, TSP, NO_2 and SO_2 ambient air quality standards and the priority air pollutant guideline concentrations for the requisite averaging periods. The incremental impact of the criteria air pollutants were also less than the established values that would have created a significant air quality impact.
- Based on the modelling results, the replacement of the existing JPS oil-fired power plant with the proposed LNG-fired power plant would cause a marked improvement to the prevailing SO_2 ambient air quality concentration within the air shed, while its impact on the prevailing TSP, CO and NOx concentrations will only have marginal improvement.
- Since the proposed LNG fired power plant sources demonstrated compliance with the ambient air quality standards and the guideline concentrations, as well as with the significant impact incremental values, it is envisaged that approval will be granted for the establishment of the facility. Nevertheless, it is anticipated that certain changes would need to be done for each combustion turbine's NOx emissions to achieve compliance with the NOx emission standard for a 40 MW capacity LNG-fired unit.

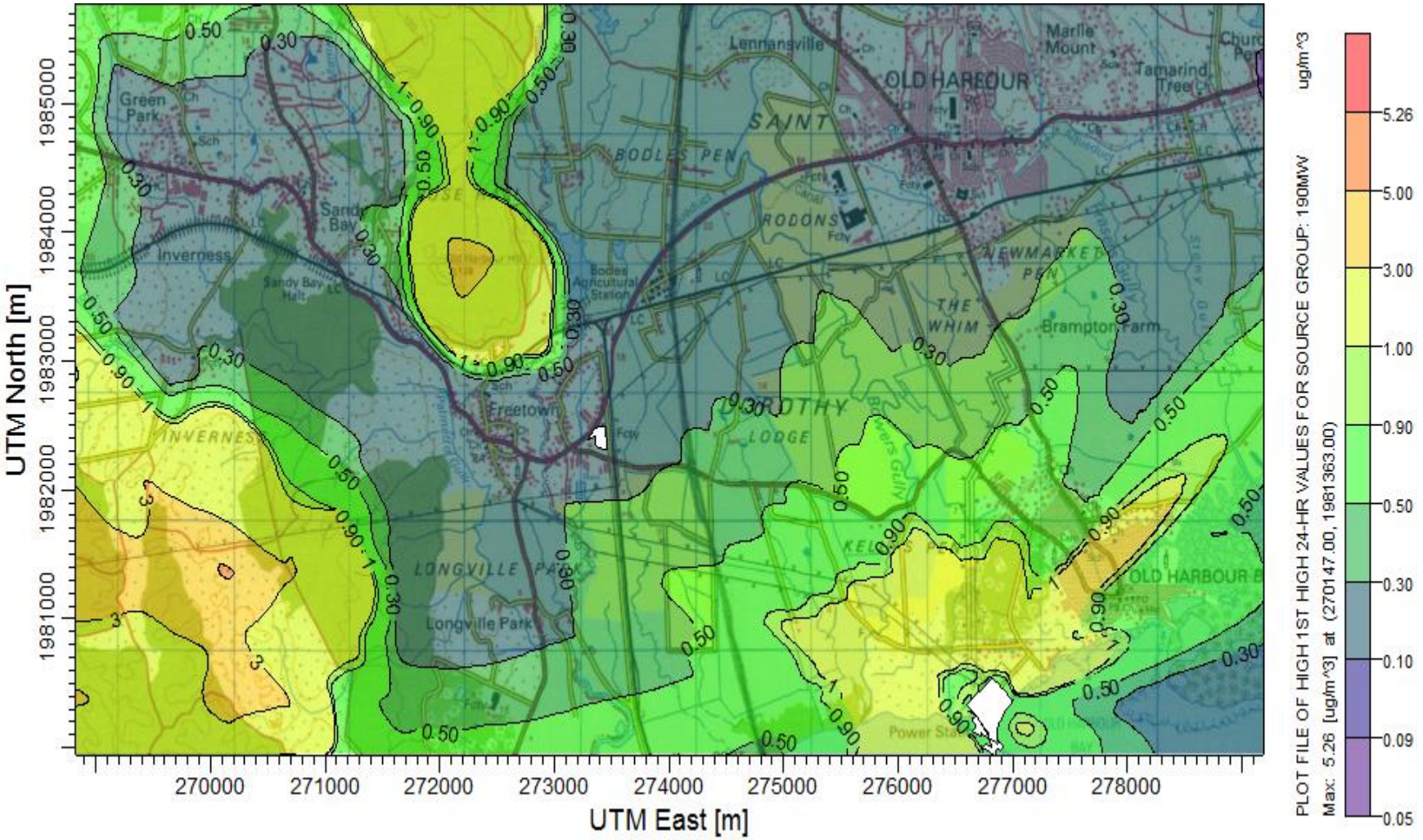


Figure 7-10 Predicted 24h TSP concentrations – proposed LNG Power Plant only

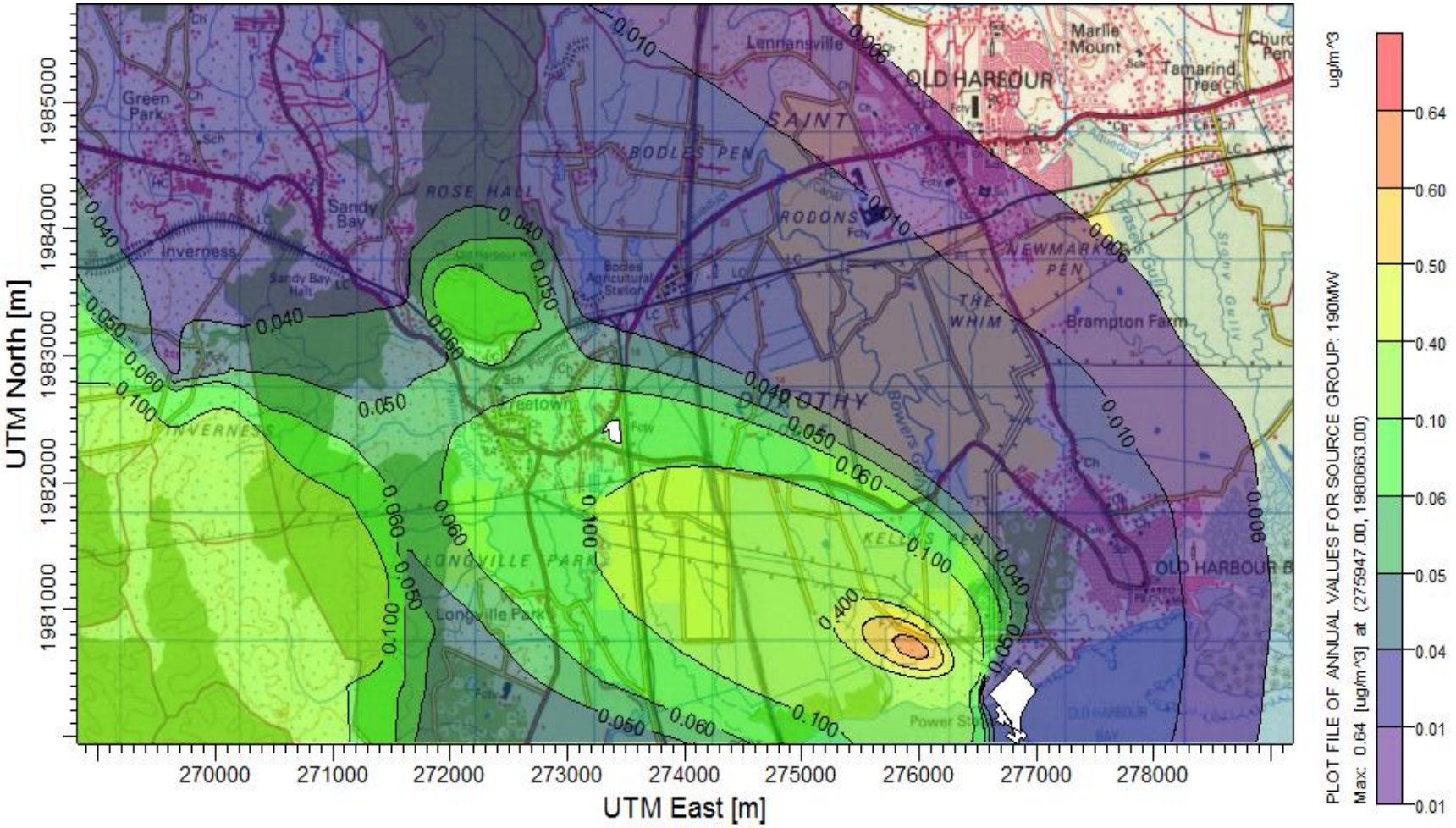


Figure 7-11 Predicted annual TSP concentrations – proposed LNG Power Plant only

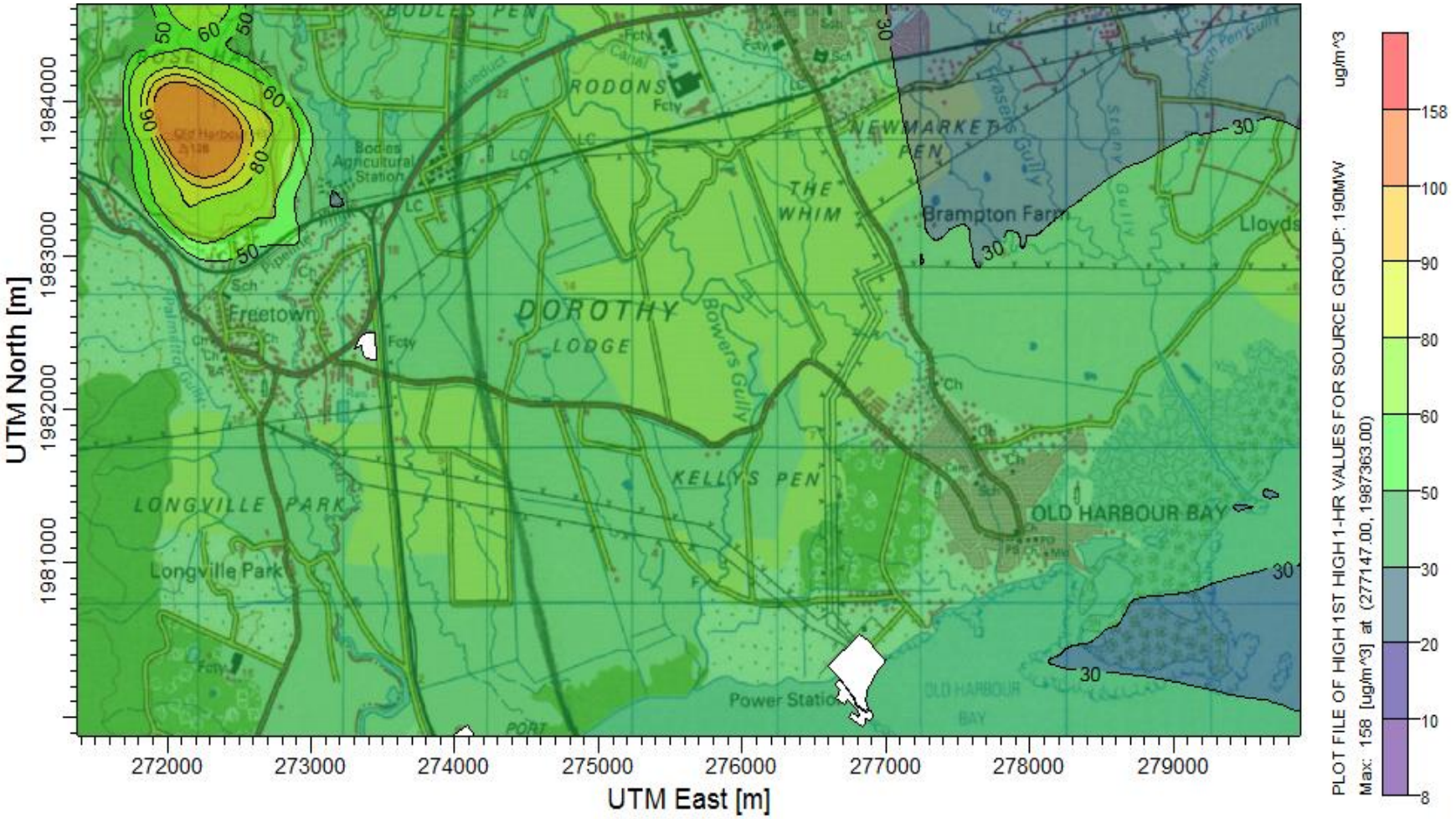


Figure 7-12 Predicted 1h NO_2 concentrations – proposed LNG Power Plant only

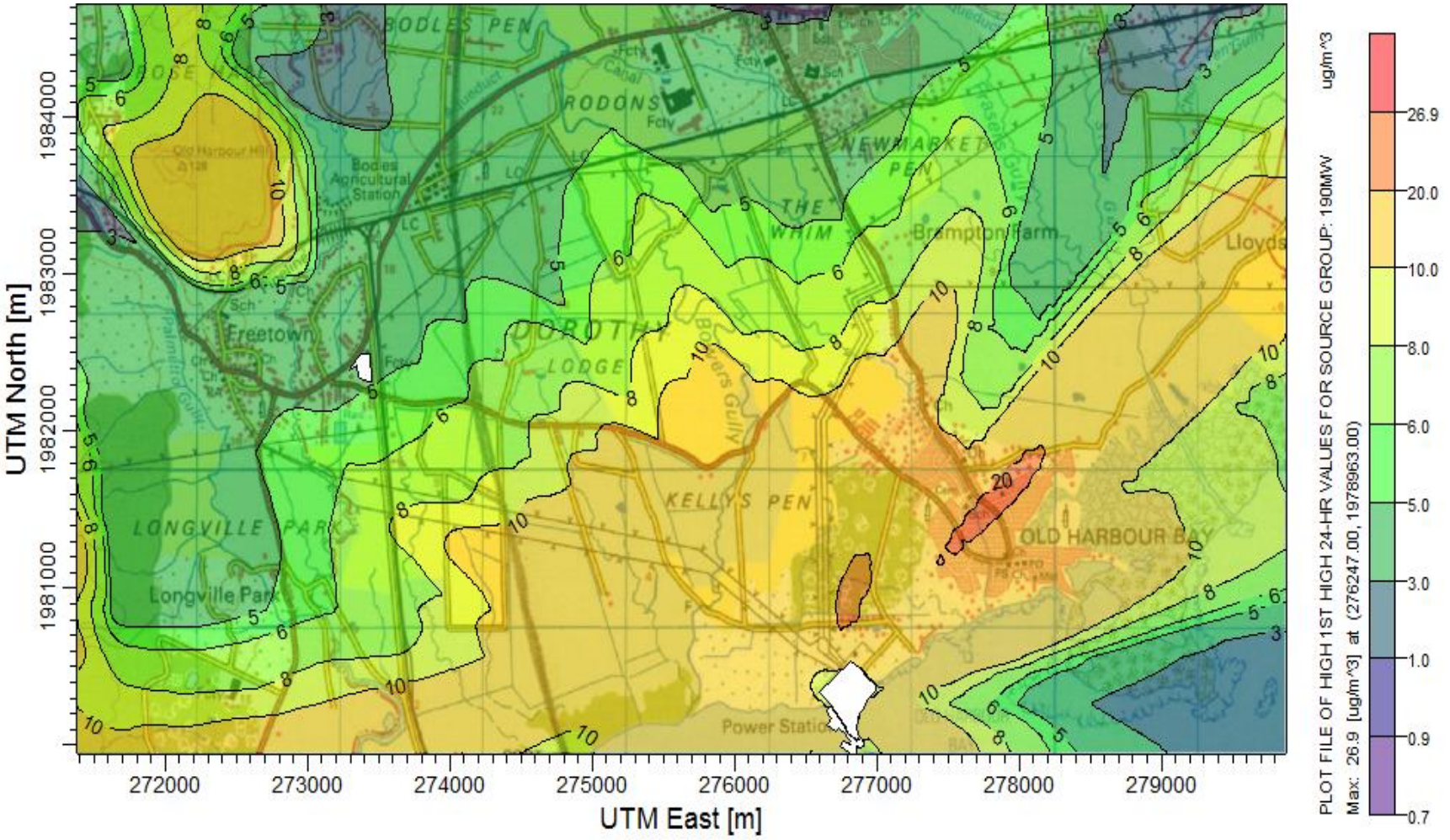


Figure 7-13 Predicted 24h NO_2 concentrations – proposed LNG Power Plant only

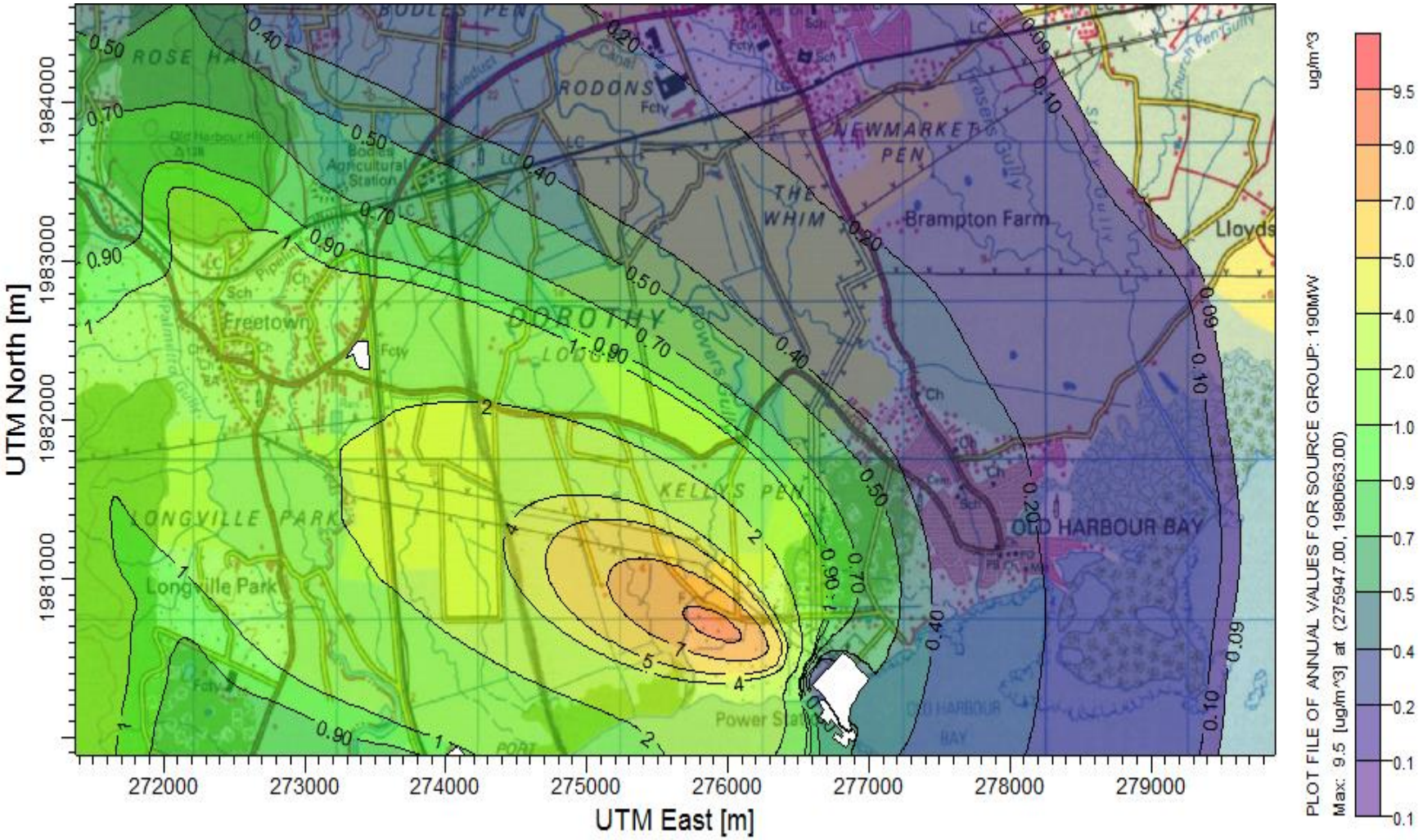


Figure 7-14 Predicted annual NO_2 concentrations – proposed LNG Power Plant only

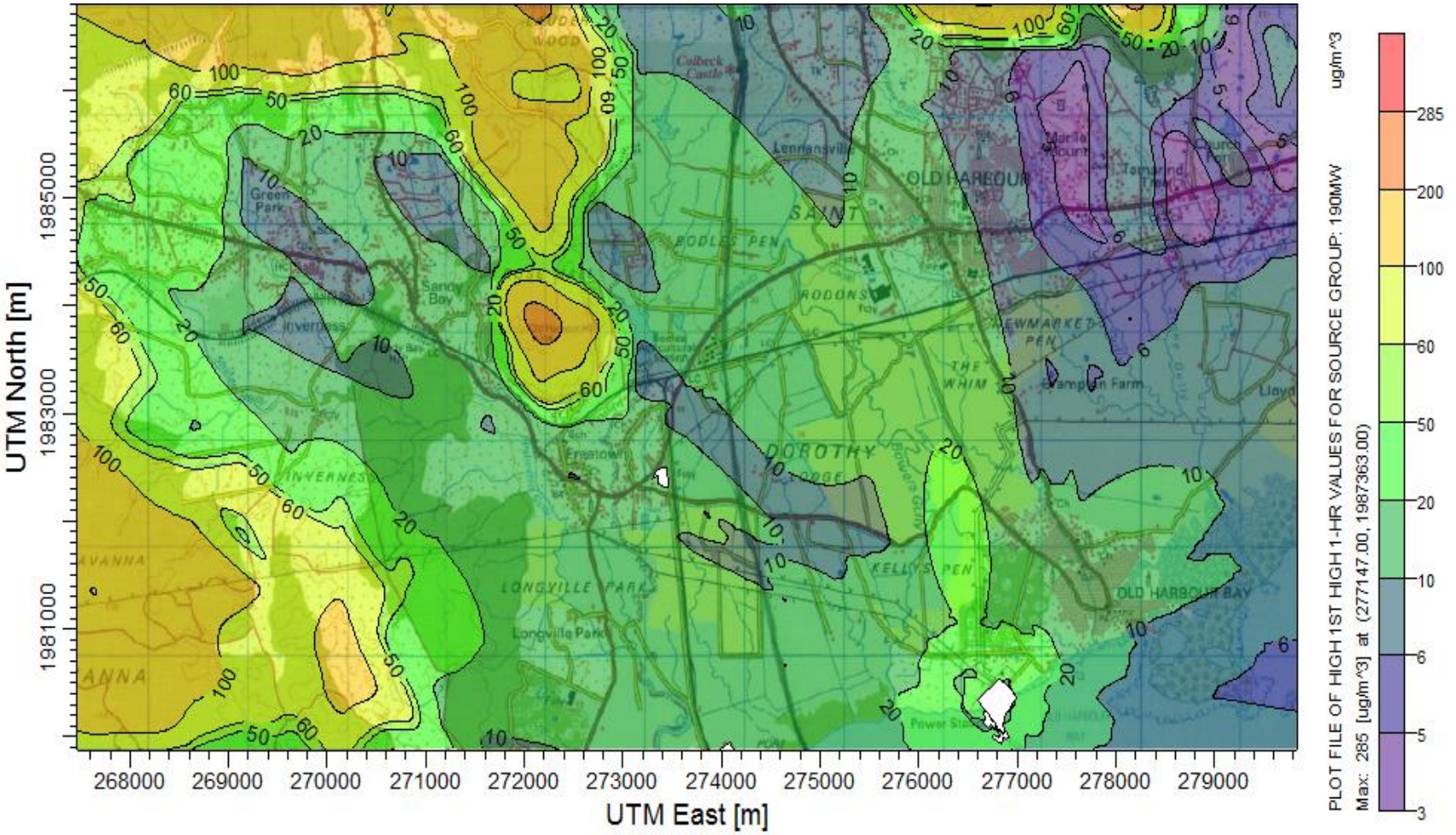


Figure 7-15 Predicted 1h CO concentrations – proposed LNG Power Plant only

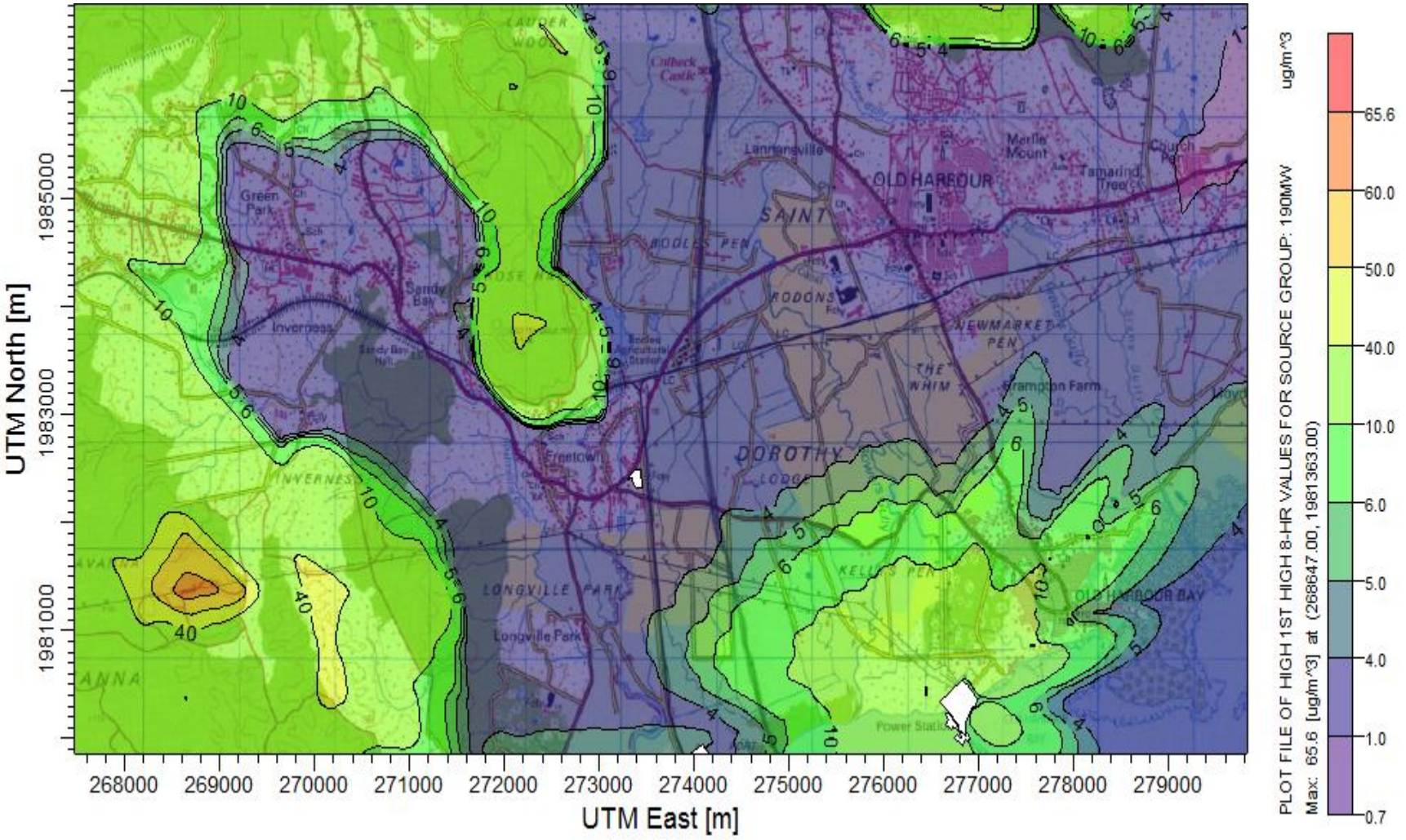


Figure 7-16 Predicted 8h CO concentrations – proposed LNG Power Plant only

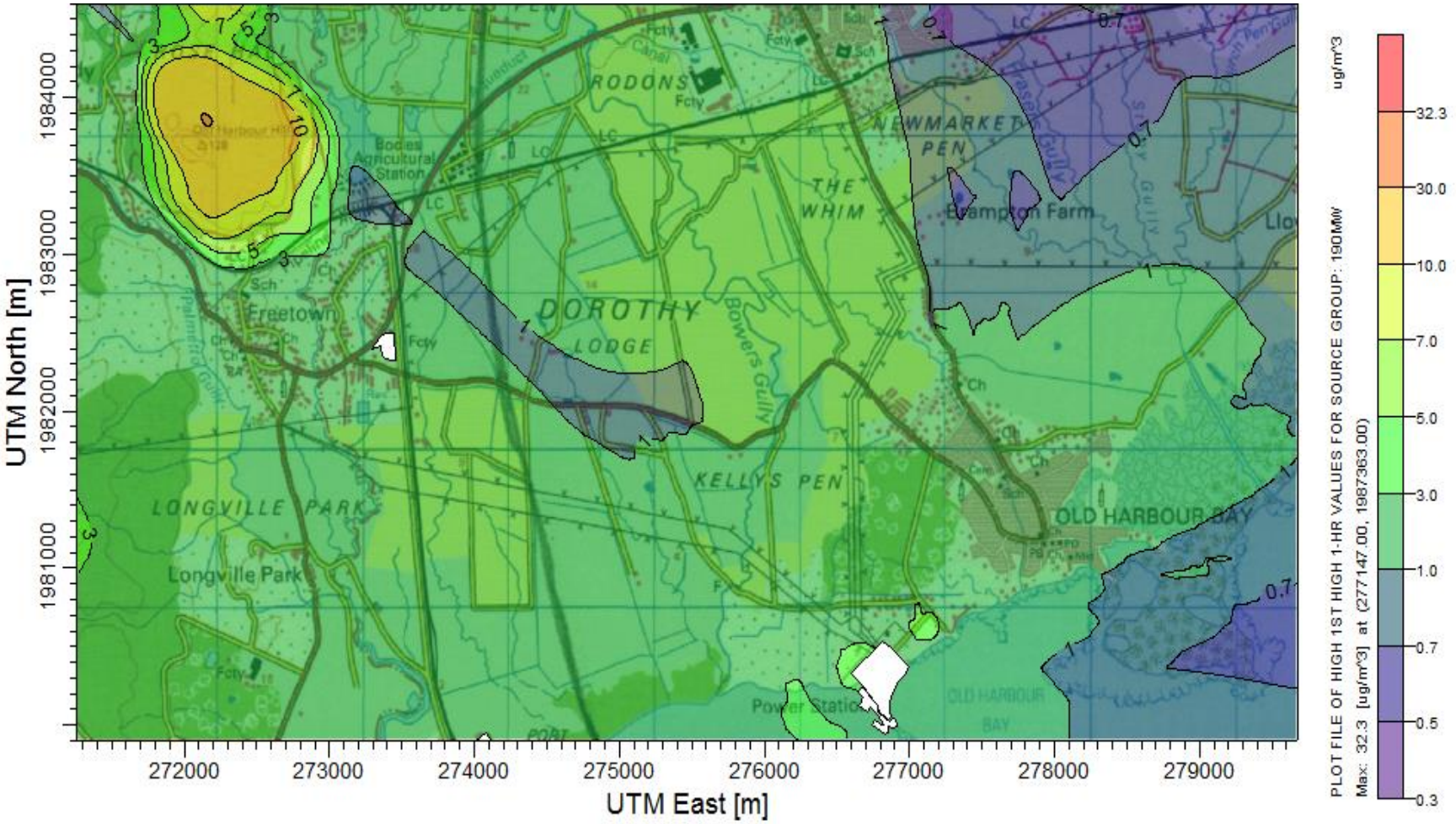


Figure 7-17 Predicted 1h SO_2 concentrations – proposed LNG Power Plant only

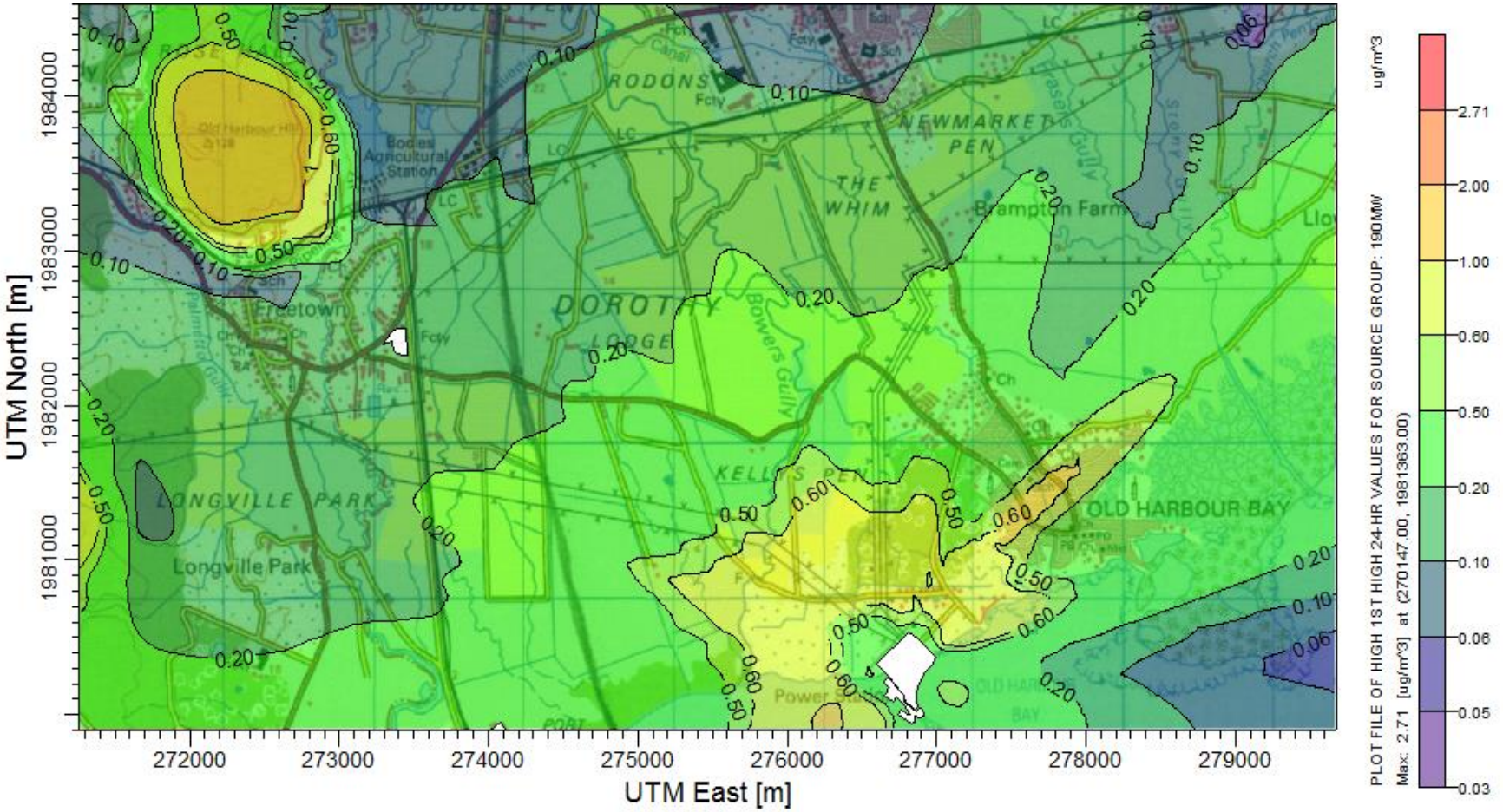


Figure 7-18 Predicted 24h SO_2 concentrations – proposed LNG Power Plant only

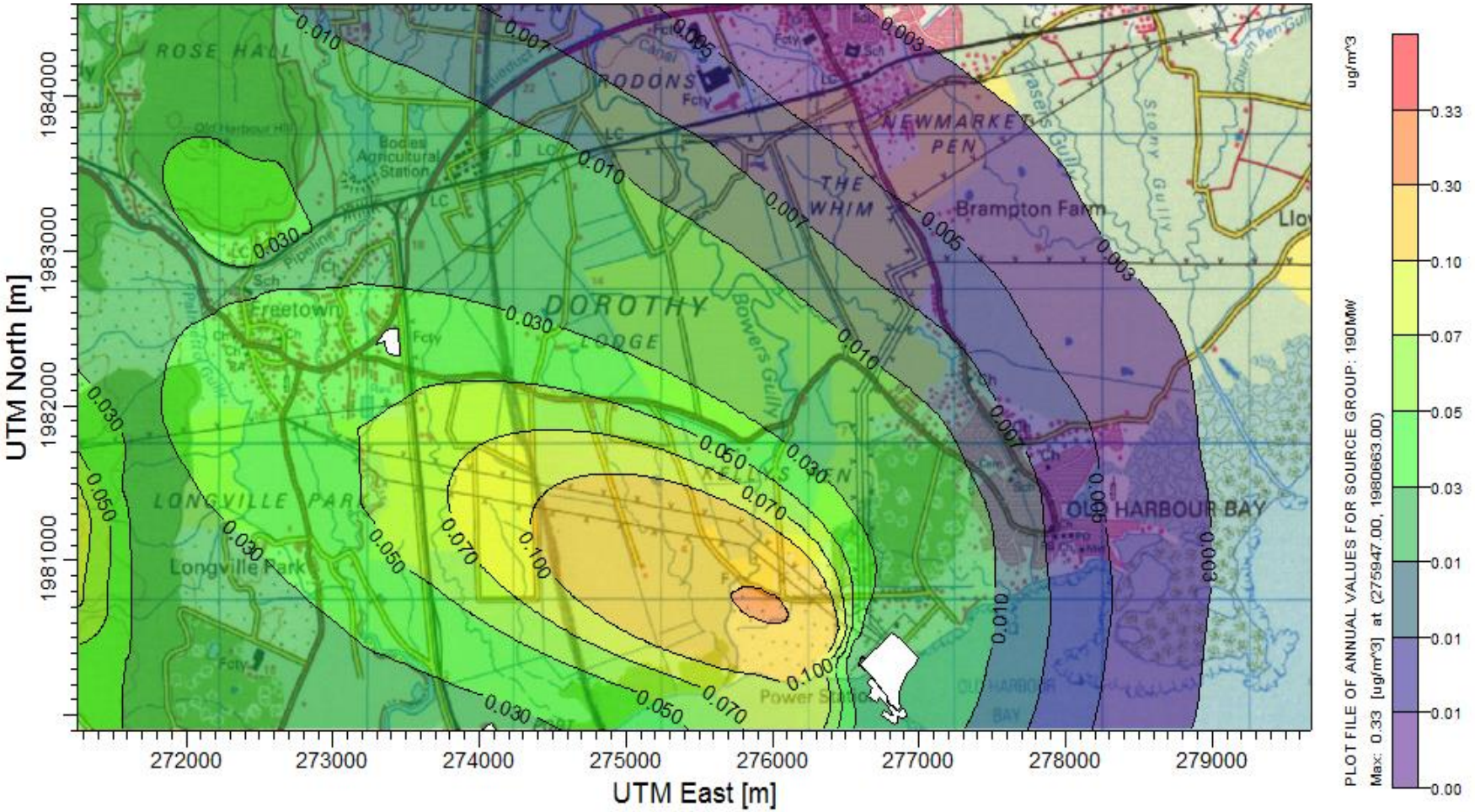


Figure 7-19 Predicted annual SO_2 concentrations – proposed LNG Power Plant only

Greenhouse Gas Emissions

GREENHOUSE GAS (GHG) EMISSIONS FOR EXISTING JPS FACILITY

Using USEPA* greenhouse gas emission factors for Oil-Fired Utility Boilers and a total oil consumption of 306,099,807 L/y, the following emission rates were calculated (Table 7-33):

Table 7-33 Greenhouse Gas Emission rates for Oil-fired Utility Boilers

Facility	Pollutant	Emission Factor, lb/10^3 gal	Emission Factor, kg/L	Facility Emission Rate, tonne/y
Oil-Fired Utility Boilers	CO_2	24,400	2.928	896,260.2
	N_2O	0.53	0.0000636	19.5
	CH_4	0.28	0.0000336	10.3

**United States Environmental Protection Agency. May 2010. Emission Factor Documentation for AP-42: External Combustion Sources, Tables 1.3-3, 1.3-8 and 1.3-12. Office of Air Quality Planning and Standards, Office of Air and Radiation, U.S. Environmental Protection Agency, Research Triangle, North Carolina.*

GREENHOUSE GAS (GHG) EMISSIONS FOR LNG FACILITY

Using USEPA* greenhouse gas emission factors for LNG-Fired Stationary Gas Turbines and the heat consumption rate of 1.383 x 10^9 kJ/h for the LNG to be used, the following emission rates were calculated (Table 7-34):

Table 7-34 Greenhouse Gas Emission rates for LNG Facility

Facility	Pollutant	Emission Factor, lb/MMBtu	Facility Emission Rate, tonne/y
LNG-Fired Combustion Turbine	CO_2	110	5.73E+05
	N_2O	0.003	1.56E+01
	CH_4	0.0086	4.48E+01

**United States Environmental Protection Agency. July 1998. Emission Factor Documentation for AP-42: Stationary Gas Turbines. Office of Air Quality Planning and Standards, Office of Air and Radiation, U.S. Environmental Protection Agency, Research Triangle, North Carolina.*

7.2.2 Natural Hazards

7.2.2.1 Hurricane Waves, Tsunami and Storm Surge

For hurricane wind generated waves from deepwater, the largest predicted wave heights to reach the shoreline were generated from the SE and S directions ranging from 1.5 to 2 m for the 100 year return period; while for the 50 year return period wave heights of up to 1.5m was noticed reaching the shoreline. The site is 0.5m to 2.0m above msl and as such impacts from hurricane waves should be considered. Although tsunami (seismic sea waves) are rare for Jamaica, historical records for Jamaica indicate that the highest inundation elevation ever reported for the Jamaican south coast was 2.2 m at Port Royal (NOAA/NGDC, 2012). A similar event at Old Harbour would immerse some two fifths of the area of interest and most of the site of the proposed power station. In addition, storm surge analysis indicated that the entire project site is susceptible to flooding as a result of the 50 year storm surge. Given the hurricane wave models, historical tsunami evaluation and storm surge inundation modelling, coastal inundation has the potential to affect the project area.

RECOMMENDED MITIGATION

i. All new structures should be built to withstand hurricane, storm surge, tsunami and associated inundation impacts and other mitigative steps taken to protect the proposed project from these hazards should be taken.
ii. Ensure hurricanes and tsunamis are included the emergency response plan.

7.2.2.2 Earthquakes and Liquefaction

The Old Harbour Bay area has a 10% probability of experiencing accelerations of about 260 gals (26% g) per fifty years. As described in the "Liquefaction Potential Analysis" report by Earth Systems Engineering, Ltd., the project site is in a historically active seismic area and the soils types in the vicinity of the proposed marine structures are subject to potential liquefaction in the sandy lenses of the upper 5 to 10 meters caused by seismic distress.

RECOMMENDED MITIGATION

i. Detailed design of the marine structures and the subsea pipeline must take into consideration both the forces induced by design seismic events and the potential for liquefaction in the upper 5 to 10 meters of soil during these event. The "Liquefaction Potential Analysis" report as well as all other governing codes should be used for the detailed design of the marine structures and the subsea pipeline.
ii. Ensure earthquakes and liquefaction are included the emergency response plan.

7.2.2.3 Long Term Sea Level Rise

Projected increases in global and Caribbean mean sea level by 2100 relative to the 1980-1999 is 0.37m[26] (± 0.5 m relative to global mean) and this is equivalent to 3.7 mm/yr.

RECOMMENDED MITIGATION

i. Attention should be paid to the likely changes in sea-level during the design life (and beyond) of the plant.

7.2.2.4 Coastal Erosion

Model results (section 5.2.5.2) show that the shoreline is stable for the 50 year and 100 year wave conditions. Historical data shows the shoreline has been eroding over the years. Even though it have moved in response to short term events, the long term process is significantly more dominant. An erosion model based on SLR indicates most of the erosion could be as a result of long term SLR.

RECOMMENDED MITIGATION

Minimize erosion where possible through hard and soft engineering solutions. Minimum floor levels and setbacks must be observed as per the NWA guidelines.

[26] IPCC 2007

7.2.3 Manmade Hazards

The following outlines various manmade hazards and mitigation measures:

- Fire is one of the major and most common risks. This can result from incidences such as transformer failure and gas and steam turbine malfunctions.
- Correct operation and monitoring of machines is critical. Attention should be paid to all steps in operation, including start up and pre-start checks.
- Improperly controlled maintenance activities can lead to problems. The use of correct components and properly designed spare parts are of equal importance during maintenance activities and manufacturer's guidelines should be properly adhered to. Cleanliness is important in preventing damage to machine blading, as debris or foreign objects left following maintenance activities can get drawn into the turbine can be dangerous and cause damages.
- Quality assurance of component parts and materials is extremely important as gas turbines operate at high speed with high operating temperatures and pressures, and low tolerances between blades and veins. Failure of a relatively minor component within the machine can cause extensive damage.
- Use of proper fuel is very critical. Fuel quality is of importance as rogue chemicals can cause deposits, erosion or corrosion of machine internals leading to long-term damage. Fuel pulsations as a result of varying fuel quality or irregular supply systems can cause vibration in combustion systems and turbine areas leading to mechanical damage that is exacerbated as it is exposed to high temperatures and further operation.

7.2.4 Biological

7.2.4.1 Habitat Fragmentation and Disturbance/Displacement

Seagrass beds occur in distinct patches and form part of the reef crest and should as a result experience little or no fragmentation. The potential pipeline are unlikely to cause any habitat fragmentation. Most mobile invertebrates (meiofauna) should only be temporarily affected/displaced. Fish, larvae, eggs and other plankton and sessile species should also only be temporarily affected. Although turtles are unlikely to use the area (due to larger amounts of activity and noise) for foraging and nesting, if present in the area, should also only experience minimal disturbance and displacement.

7.2.5 Human/Social

7.2.5.1 Solid Waste

Domestic waste from operations will be generated on the power plant site.

RECOMMENDED MITIGATION

Provision of solid waste storage bins and skips. Contracting a private contractor to collect solid waste in a timely fashion to prevent a build-up. Ensure that the solid waste collected is disposed in an approved dumpsite such as the Riverton dump in Kingston.

7.2.5.2 Employment

There is the potential for increased employment during the operation phase. It is anticipated that approximately 45 persons will be employed directly. A number of indirect jobs are expected to be created this further benefitting the community.

7.2.5.3 Land Use and Zoning

Given that the area of the proposed development is an industrialized area with the existing JPS Old Harbour Bay power plant, Port Esquivel, Best Dressed Chicken Feed Mill, Jamaica Energy Partners Dr Bird I and II Barges and Jamaica Broilers Ethanol Dehydration Plant in close proximity, and that it is zoned for "heavy industry" according to the Portmore to Clarendon Park Highway 2000 Corridor Development Plan 2004 – 2025, no negative impact to land use is foreseen.

7.2.5.4 Aesthetics and Landscaping

The proposed development will have little, if any, visual impact on the aesthetics of the location due to the fact that the power plant is being placed in a location that is industrial and zoned for industrial purposes.

7.2.6 Carrying Capacity

Carrying capacity refers to the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and economic environment for present and future generations.

Currently, the use of fossil fuels has artificially increased the carrying capacity of the world by the use of stored sunlight, albeit at many other expenses. In the case of the proposed 190 MW LNG plant it will lower the amount of greenhouse gases emitted compared with the existing JPSCo Old Harbour plant. The lowering of the emissions means that the contribution to global warming is reduced and therefore contributes to the reduction in the increase in sea level rise, thereby reducing the potential negative impact on the coastline of Jamaica and more specifically Old Harbour Bay and even more specific the site of the proposed plant.

The plant will obtain water from existing wells and will not impact on the water supply the community. Wastewater collection, treatment and disposal will be done through facilities on the proposed plant and therefore will not be dependent on existing systems within the SIA. Solid waste will be collected by private contractors and will be disposed of at an approved waste disposal facility. This will not impact on solid waste collection or disposal in the SIA.

There will be no net increase in vehicular traffic (possibly a decrease) as the existing JPSCo Old Harbour plant will be closed after the commissioning of the new 190 MW LNG plant and the vehicular traffic diverted to the new plant site.

The proposed power plant will have its own firefighting facility. It will be equipped with fire tanks, water pumps, hoses, extinguishers, etc. Therefore, it will be able to deal with any eventualities as it relates to fires on the facility.

It is anticipated that with the new JPS 190MW power plant using less water, having lower air and noise emissions and being more fuel efficient coupled with the other factors listed previously, that the proposed development will not negatively impact the carrying capacity of the area.

RECOMMENDED MITIGATION

None required.

8.0 CUMULATIVE ENVIRONMENTAL IMPACTS

8.1 PHYSICAL

8.1.1 Air Dispersion and Quality

As part of the air dispersion modelling 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 power plant, and the consequent retirement of the existing oil-fired 190 MW JPS facility.

Table 8-1 shows the model results for the existing operating sources, and the future sources category, which does not include the three sources on the existing 190 oil-fired JPS power plant. The results for the existing sources revealed predicted highest concentrations that exceed the respective ambient air quality standards for TSP (24h and annual averaging periods), NO_2 (1h averaging period), and all averaging periods for SO_2. When the future sources were modelled, the results revealed similar exceedances except for 24h and annual SO_2. From these results it can be concluded that the replacement of the existing JPS oil-fired power plant with the proposed LNG-fired power plant will significantly improve the prevailing SO_2 ambient air quality concentration within the air shed, while its impact on the prevailing TSP, CO and NOx concentrations will only be marginal improvement.

Table 8-1 Cumulative impacts (with proposed power plant using LNG)

Pollutant	Avg. Period	Background (µg/m³)	NAAQS (µg/m³)	Existing Sources			Future Sources		
				Max Conc (µg/m³)	UTME (m)	UTMN (m)	Max Conc (µg/m³)	UTME (m)	UTMN (m)
TSP	24-hr	14	150	**245.9**	273350.51	1982416.59	**245.4**	273350.51	1982416.59
	Annual	20	60	**83.7**	273350.51	1982416.59	**83.1**	273350.51	1982416.59
NO_2	1-h	0	400	**841.2**	277147	1987363	**731.8**	277147	1987363
	Annual	0	100	28.9	275947	1980463	27.2	275847	1980563
SO_2	1-hr	0	700	**13374.7**	277147	1987363	**1117.8**	277147	1987363
	24-hr	0	280	**1042.2**	277147	1987363	195.2	276854.67	1980036.08
	Annual	0	60	**131.1**	276147	1980663	31.1	273298.33	1982394..39
CO	1-hr	0	40000	504.4	277147	1987363	423.3	277147	1987363
	8-hr	0	10000	103.6	273361.97	1982349.81	103.6	273361.97	1982349.81

Bold type indicate exceedences above the respective standard

8.1.2 Noise

The operation of the proposed 190 MW LNG power plant will result in an increase in the existing noise level (cumulative) (Table 8-2).

The cumulative noise impact takes into account all the existing background noise sources which include the existing Jamaica Public Service Old Harbour power plant, the Jamaica Energy Partners Doctor Bird I and II Barges, Jamaica Ethanol, Operations at Port Esquivel, Hi Pro Feed Mill, and other anthropogenic activities such as night noises. The predicted noise from the new noise source (the proposed 190 MW LNG power plant) is then added to the existing noise levels to determine what if any impact this new development would have on the surrounding community. This is considered a worst case scenario as the existing Jamaica Public Service Old Harbour power plant will be decommissioned once the new 190 MW plant becomes operational.

8.1.2.1 Comparison with NEPA Guidelines

Only Stations 2, 8, 9 and 11 would comply with the NEPA day time standard and Stations 8, 9 and 11 night time guidelines when the cumulative noise levels are calculated and with or without wind influence. It is important to note, that at Stations 5, 7 and 10, the NEPA Guidelines were being exceeded at these locations prior to the addition of the proposed project whether during the day or night time.

8.1.2.2 Comparison with World Bank Guidelines

Stations 1, 2 (with wind), 3, 4, 5 (with wind) and 6 exceeded the World Bank guidelines during the day time. Stations 5 (without wind), 7 and 10 will exceed the World Bank day time guidelines when the cumulative noise levels are calculated, however, they will comply with the 3dBA rule, thus compliant with World Bank guidelines.

Only Stations 5 (no wind), 7, 8, 9 and 11 will comply with the World Bank night time guidelines when the cumulative noise levels are calculated. Only Station 11 will be compliant without applying the 3 dBA rule. The baseline noise levels at Stations 5, 7 and 10 (day time) and Stations 5, 6, 7, 9 and 10 (night time) were above the guidelines prior to the 190MW project.

Of note, the baseline noise levels at Stations 9 and 10 (day and night time) will not change as a result of the 190 MW Power Plant.

Table 8-2 Cumulative noise levels based on results of noise measurements during (7:00 hrs Friday 27th, to 7:00 hrs Monday 30th, April 2012) and historical data

STATION			DAY TIME (7 am. – 10 pm.) (dBA)							NIGHT TIME (10 pm. – 7 am.) (dBA)					
No.	LOCATION	CATEGORY	BASELINE	PREDICTED NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (GP)	PREDICTED NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (CONCAWE)	CUMULATIVE NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (GP)	CUMULATIVE NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (CONCAWE)	NEPA STD.	WORLD BANK GUIDELINE	BASELINE	PREDICTED NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (GP)	PREDICTED NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (CONCAWE)	CUMULATIVE NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (GP)	CUMULATIVE NOISE FROM JPS 190MW & DOCTOR BIRDS I & II (CONCAWE)	NEPA STD.	WORLD BANK GUIDELINE
1	North-Western Property Boundary	Industrial	66.9	74.7	75.7	75.4	76.2	75	70	59.6	74.7	75.7	74.8	75.8	70	70
2	South-Western Property Boundary	Industrial	62.4	71.5	72.7	72.0	73.1	75	70	56.5	71.5	72.7	71.6	72.8	70	70
3	South-Eastern Property Boundary	Industrial	64.0	77.4	77.8	77.6	78.0	75	70	58.0	77.4	77.8	77.4	77.8	70	70
4	North-Eastern Property Boundary	Industrial	62.9	79.1	79.2	79.2	79.3	75	70	59.8	79.1	79.2	79.2	79.2	70	70
5	Informal Settlement	Residential	61.4[27]	60.5	64.4	64.0	66.2	55	55	59.9	60.5	64.4	63.2	65.7	50	45
6	Blackwood Gardens	Residential	52.2[28]	56.0	60.1	57.5	60.8	55	55	46.9	56.0	60.1	56.5	60.3	50	45
7	Old Harbour Bay Police Station	Residential	56.2[29]	48.9	53.2	56.9	58.0	55	55	52.7	48.9	53.2	54.2	56.0	50	45
8	New Harbour Village Phase II	Residential	43.1	43.5	47.4	46.3	48.8	55	55	41.9	43.5	47.4	45.8	48.5	50	45
9	Longville Park	Residential	51.7[30]	34.1	31.4	51.8	51.7	55	55	49.9	34.1	31.4	50.0	50.0	50	45
10	New Harbour Village Phase I	Residential	60.6[31]	41.1	41.6	60.6	60.6	55	55	56.3	41.1	41.6	56.4	56.4	50	45
11	JPS Guard House	Industrial	61.4[32]	59.1	61.8	63.4	64.6	75	70	54.9	59.1	61.8	60.5	62.6	70	70

NB: Numbers in red indicate non-compliance with both NEPA and World Bank guidelines, blue indicate non-compliance with World Bank guideline, green indicate non-compliance with NEPA guidelines but compliance with World Bank guidelines when the 3 dBA rule is applied and purple indicate compliance with NEPA guidelines and compliance with World Bank guidelines when the 3 dBA rule is applied.

[27] Average of noise data from 2007 – 2012 (Campbell 2014), Jamaica Energy Partners Annual Noise Assessment (2013 and 2014) and current measurements
[28] Average of noise datd from Jamaica Public Service Noise Assessments (2010, 2011 and 2013), South Jamaica Public Company EIA (2012) and current measurements
[29] Average of noise data from 2007 – 2012 (Campbell 2014), Jamaica Energy Partners Annual Noise Assessment (2013 and 2014), South Jamaica Public Company EIA (2012) and current measurements
[30] One of noise measurements conducted for the South Jamaica Public Company EIA (2012)
[31] Average of noise data from 2007 – 2012 (Campbell 2014), Jamaica Energy Partners Annual Noise Assessment (2013 and 2014) and South Jamaica Public Company EIA (2012)
[32] One of noise measurements conducted for the South Jamaica Public Company EIA (2012)

8.1.2.3 Sensitive Receptors

Schools

When the predicted noise generated from the operation of the JPS 190MW and the JEP Doctor Birds I and II were considered, the noise did not exhibit the inverse square law for both the General Prediction and Concawe models. When the General Prediction model was used the noise ranged from a low of 34.6 dBA (Longville Park Early Childhood Centre) to a high of 49.9 dBA (Blackwood Gardens Basic School) and when the Concawe model was used it ranged from a low of 32.1 dBA (Longville Park Early Childhood Centre) to a high of 54.6 dBA (Blackwood Gardens Basic School) (Table 8-3).

COMPARISON WITH LOCAL STANDARD AND INTERNATIONAL GUIDELINE

When the predicted noise levels from the operation of the JPS 190MW and the JEP Doctor Birds I and II plants are operational, the noise levels at five school were non-compliant with both NEPA day time standard and World Bank guideline (Table 8-3). The schools that had non-compliant noise levels were:

i. Blackwood Gardens Basic School
ii. Children First Basic
iii. Old Harbour Bay Primary
iv. Baptist Early Childhood Centre
v. St. Wade Basic School

Table 8-3 Schools listed in order of increasing distance (m) from the proposed JPS 190MW power plant with the predicted noise from JPS 190MW and the Doctor Birds I and II power plants

SCHOOLS	DISTANCE FROM DOCTOR BIRD POWER FACILITY (m)	LAeq (16)		NEPA STD	WORLD BANK GUIDELINE
		JPS 190 MW & DOCTOR BIRDS I & II	CONCAWE S – JPS 190 MW & DOCTOR BIRDS I & II		
Blackwood Gardens Basic School	1143.7	49.9	54.6	45	55
Children First Basic	1235.0	49.8	54.2	45	55
Old Harbour Bay Primary	1330.1	48.5	53.4	45	55
Baptist Early Childhood Centre	1353.3	49.0	53.5	45	55
St. Wade Basic School	1415.0	48.0	52.9	45	55
Old Harbour High School	3795.6	37.9	37.0	45	55
Portmore Community College (Old Harbour)	4149.2	37.3	37.2	45	55
Freetown Primary	4409.1	34.8	35.6	45	55
Monsignor Colin Bryan Preparatory	4597.5	35.3	34.6	45	55
Longville Park Early Childhood Centre	4609.3	34.6	32.1	45	55
Old Harbour Early Childhood Institution	5009.3	35.3	35.3	45	55
Old Harbour Primary	5091.8	35.2	35.2	45	55

NB: Numbers in red are non-compliant with NEPA day time standard and World Bank guideline

Churches

When the noise generated from the operation of the JPS 190MW and the JEP Doctor Birds I and II were predicted by both models, the noise levels did not exhibit the inverse law. Noise levels ranged from a low of 34.6 dBA (Longville Park Church) to a high of 50.7 dBA (Mount Refuge Fire Baptize Holiness) when the General Prediction model was used. When the Concawe model was used, noise ranged from a low of 32.2 dBA (Longville Park Church) to a high of 55.5 dBA (Mount Refuge Fire Baptize Holiness) (Table 8-4).

COMPARISON WITH LOCAL STANDARD AND INTERNATIONAL GUIDELINE

With the exception of the predicted noise at Mount Refuge Fire Baptize Holiness when JPS 190MW and JEP Doctor Birds I and II are operational (Concawe), all other predicted noise levels were compliant with both the NEPA daytime standard and the World Bank guideline when both the General Prediction and concawe models were used (Table 8-4).

Table 8-4 List of churches in order of increasing distances (m) from the proposed JPS 190 power plant with the predicted noise from JPS 190MW and Doctor Birds I and II power plants

CHURCHES	DISTANCE FROM DOCTOR BIRD POWER FACILITY (m)	LAeq (16)		NEPA STD	WORLD BANK GUIDELINE
		GP JPS 190 MW & DOCTOR BIRDS I & II	CONCAWE S – JPS 190 MW & DOCTOR BIRDS I & II		
Mount Refuge Fire Baptize Holiness	1038.5	50.7	55.5	55	55
Unnamed Church	1353.0	48.0	52.8	55	55
St Phillips Anglican	1370.9	48.8	53.4	55	55
Refuge Temple Old Harbour Bay	1454.2	47.8	52.6	55	55
Old Harbour Bay Baptist	1499.4	47.6	52.4	55	55
Old Harbour Bay SDA	1564.9	47.0	52.0	55	55
Faith Bible Baptist Church	1792.3	45.9	50.7	55	55
Old Harbour Evangelistic Centre	3471.4	39.0	39.9	55	55
Church of Our Lord Apostolic Faith	3868.2	33.8	32.8	55	55
Jehovah Witness	3948.2	37.8	36.6	55	55
Hebron Gospel Hall	4120.0	37.5	36.4	55	55
Old Harbour SDA	4185.9	37.3	37.2	55	55
Holy Ghost Ministries Inc.	4312.6	35.4	35.0	55	55
Church of the Holy Trinity	4347.4	36.9	35.7	55	55
St. Michael & St. George Anglican	4421.3	35.0	35.6	55	55
Longville Park Church	4611.7	34.6	32.2	55	55
St Dorothy's Anglican Church	4992.7	35.2	35.8	55	55
Old Harbour Baptist	5061.7	35.2	35.0	55	55

NB: Number in red is non-compliant with NEPA day time standard and World Bank guideline

Clinics

The noise levels at two clinics were examined when noise levels were predicted with JPS 190MW and JEP Doctor Birds I and II are operational. The noise levels exhibited the inverse law when either General Prediction or Concawe models were used. The noise levels when the General Prediction model was used varied from 36.5 dBA (Old Harbour Health Centre) and 46.5 dBA (Bay View Medical Centre) and when Concawe model was used 36.5 dBA (Old Harbour Health Centre) and 51.4 dBA (Bay View Medical Centre) (Table 8-5).

COMPARISON WITH LOCAL STANDARD AND INTERNATIONAL GUIDELINE

All predicted noise levels were compliant with both the NEPA daytime standard and the World Bank guideline whether the General Prediction and Concawe models were used (Table 8-5).

Table 8-5 Noise levels at clinics in order of increasing distance (m) from the proposed JPS 190 MW power plant with the predicted noise from JPS 190MW and Doctor Birds I and II power plants

CLINICS	DISTANCE FROM DOCTOR BIRD POWER FACILITY (m)	LAeq (16)		NEPA STD	WORLD BANK GUIDELINE
		GP JPS 190 MW & DOCTOR BIRDS I & II	CONCAWE S – JPS 190 MW & DOCTOR BIRDS I & II		
Bay View Medical Centre	1669.2	46.5	51.4	55	55
Old Harbour Health Centre	4479.2	36.5	36.5	55	55

9.0 RESIDUAL IMPACTS

Section 7.0 (Identification and Assessment of Potential Direct and Indirect Impacts and Recommended Mitigation) described the potential impacts that would occur as a result of different phases of the project and how the proposed mitigation measures would contribute to minimising or eliminating the impacts. Not all impacts can be fully mitigated and therefore residual impacts will be experienced by the environmental and social receptors affected by the project. These are discussed below.

9.1 SITE PREPARATION AND CONSTRUCTION

9.1.1 Noise

The proposed project has the potential to be a noise nuisance during both the construction and the operation phases. Even with the proper mitigative steps, short-term impacts of varying duration such as pile driving, which is a high-noise activity, will be a nuisance to surrounding residential communities.

9.1.2 Air Quality

Fugitive dust has the potential to affect the health of construction workers, the resident population and any surrounding vegetation. Both types of impacts will be of high intensity but of relatively short duration.

9.1.3 Traffic

The construction of the new power plant and associated delivery vehicles may introduce traffic delays thereby increasing the travel time. Negative impacts on traffic are expected during the construction stages, including reduced level of service in the areas surrounding Old Harbour and Old Harbour Bay due to increased large/construction vehicle on the roads.

9.2 OPERATION

9.2.1 Socio-Economic

9.2.1.1 Lower Energy Costs

Electricity costs are calculated to be lower by 30% when the new LNG power plant comes on line. Therefore, there will be a high residual impact of unmet public expectation if the new plant is not operated on LNG and the concomitant lower of electricity costs.

9.2.1.2 Unmet Employment Expectations

Because of the high unemployment rate in the area and in the island in general, residents in directly affected communities who are unsuccessful in their job application are likely to become frustrated

when they do not gain employment on the proposed project. This could create resentment and possibly hostility towards those who are successful in getting jobs, and even towards JPS. The possibility also exists that there will be resentment towards JPS arising from perceptions of bias in the recruitment process.

9.2.1.3 Accidents involving community members

The possibility exists that accidents involving community members will occur at some stage during project construction or operation. This could be traffic-related, or other accidents. A residual impact is created in terms of diminishing the standard of living for a person, negatively impacting his or her household.

10.0 IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

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

This report has identified the major environmental impacts, both adverse and beneficial noted by scientific experts. The project team and the consulting scientists worked together, utilizing findings of these impacts to analyse possible options for the final development. In addition to examining the advantages and disadvantages of potential project alternatives over that which is proposed, the ability to meet project objectives and the feasibility (for example in terms of available technologies, budget constraints and logistics) of each were additional evaluation criteria.

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

- The “No-Action” Alternative
- The proposed development as described in the EIA
- Project Site Alternatives
- Development Alternatives
- Alternative Energy Sources

10.1 THE NO ACTION ALTERNATIVE

The “no action” alternative is required to ensure the consideration of the original environment without any development. This is necessary for the decision-makers in considering all possibilities. The main consideration with this alternative, is that the project goal would not be met, that is, the proposed capacity intended to replace the inefficient heavy fuel oil burning plants will not be achieved. Further, the impacts discussed previously would not occur.

In light of the existing JPS Old Harbour facility already in the vicinity, and the major infrastructure already in place, the “no action” alternative will have a minimal effect on the physical and biological environment. In terms of the socioeconomic environment, the “no-action” alternative would result in increased possibilities of power outages for residents of Jamaica, lower job and industrial productivity in the project area, limited economic improvement, and eliminate job creation opportunities nationally. It is speculative to state the response of energy producers and end users if the project objective is not met by the proposed project. However, it should be considered that this “no action” alternative may possibly lead to the investigation of other energy providing arrangements, including renewable sources or nuclear power (discussed below), or even the greater use of other fossil-fuels that are accompanied by increased environmental adverse impacts, when compared to that of natural gas.

10.2 THE PROPOSED DEVELOPMENT AS DESCRIBED IN THE EIA

The biological, physical and socioeconomic impacts and mitigation measures for this alternative are discussed in detail throughout this report. The positive impacts have been identified in social and economic benefits for local and national individuals due to lower potential of power outages and increased job creation. However, this project also has the potential to adversely impact the air quality of the air shed surrounding the proposed development, and increase noise pollution and water pollution of the surrounding water body. These impacts will require effective mitigation.

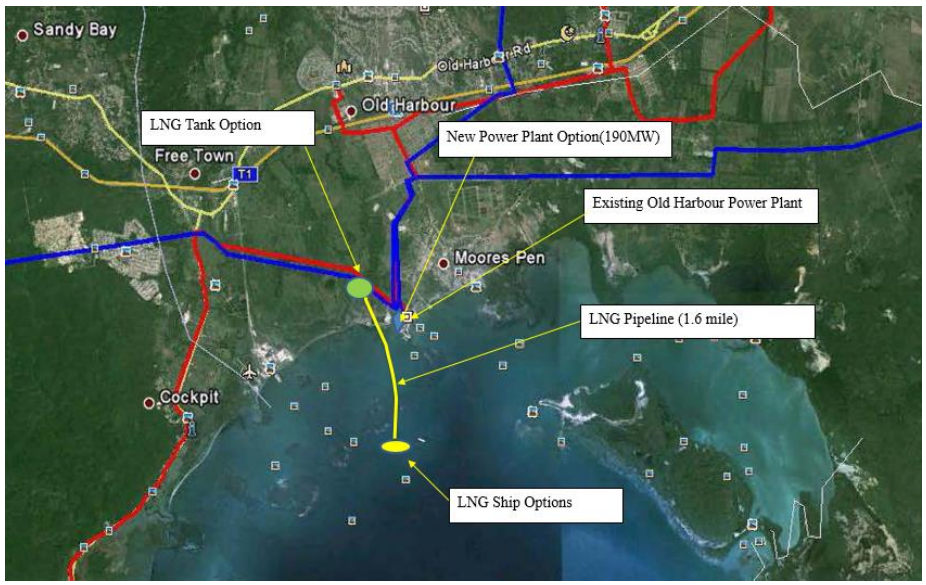
10.3 PROJECT SITE AND LAYOUT ALTERNATIVES

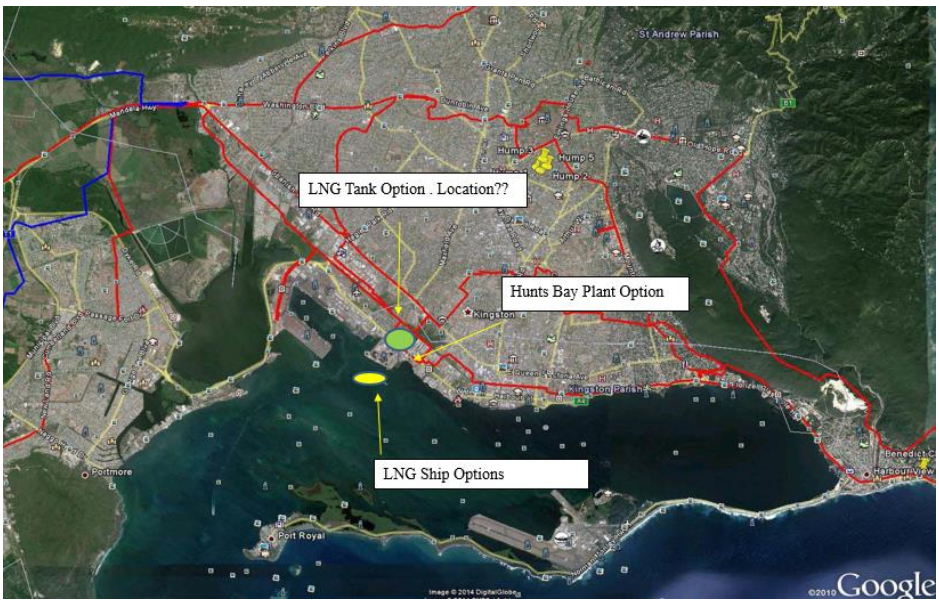
10.3.1 Site Evaluation

Three sites, namely at Old Harbour, Caymanas and Hunts Bay (Table 10-1) were evaluated based on the following criteria:

- Minimize capital and O&M Expenditure (COE impact)
  - Plant and LNG Fuel Infrastructure requirements
  - Transmission Upgrades and Expansions
- Enable speed of delivery of Project (Realisation of COE reduction)
- Network efficiency and stability

Table 10-1 Location of Old Harbour, Hunts Bay and Caymanas site options

Old Harbour	

Caymanas	
Hunts Bay	

The benefits of each site are described in Table 10-2 and based on the full assessment, it was concluded that the Old Harbour saved costs with the use of existing site services. In terms of overall total costs, the Old Harbour option had the lowest cost (≈ 560 million USD), followed by Hunt's Bay (≈ 600 million USD) and Caymanas (≈700 million USD). The Old Harbour site also had the shortest project timeline with a Commercial Operation Date (COD) of June 30, 2017, compared to February 28, 2018 for the remaining two options.

Table 10-2 Pros and cons of each alternative site: Old Harbour, Hunts Bay and Caymanas

	Old Harbour	Hunts Bay	Caymanas
PROS:	Interconnect with existing T&D Infrastructure	System location for Ancillary Services improves grid stability	
	System location for Ancillary Services improves grid stability		
Existing Site Services	Cooling Water Intake (reduced permit risk/cost)	Cooling Water Intake (reduced permit risk/cost)	Green field
	Rights to Ground Water (reduced permit risk/cost)	Rights to Ground Water (reduced permit risk/cost)	Re-use of grey water from Soap Berry waste water plant
	Demineralized Water system (makeup) infrastructure	Demineralized Water system (makeup) infrastructure	
	Existing Site shop, warehouse, security and land.	Existing Site shop, warehouse, security and land.	
Reliability	Seawater Cooling	Seawater Cooling	
	Interconnect OH4 Steam Turbine as Back-up for CCGT; US$2.3 Million fuel cost per annum @ 2% forced outage	Interconnect B6 Steam Turbine as Back-up for CCGT; US$2.3 Million fuel cost per annum @ 2% forced outage.	
CONS:		Would require additional ground water rights	Flight path impact to LNG carriers & LNG Tank
		Sea water Cooling impact on Kingston Harbour risky	Distance of LNG Pipeline & Infrastructure
		LNG Shipping impact on Kingston Harbour	LNG Impact in Kingston Harbour
			High operating cost of using grey water

10.3.2 Layout Alternatives

Various sections of the property were assessed as project site alternatives.

10.3.2.1 General Project Area

A rapid assessment of the general area was carried out in 2012 and 2014. The southernmost portion of the property consisted of large areas of bare, sandy-clay soil, occupied by vegetation islands while the shoreline itself had more sensitive species (*Rhizophora mangle* - Red Mangrove and *Avicennia germinans* - Black Mangrove).

10.3.2.2 Option 2

This site was located just northeast of the existing power plant. The vegetation here was a remnant of the thorn savannah, which was severely influenced by anthropogenic activity. Evidence of grazing and fire damage was present at the time of this survey.

10.3.2.3 Option 3

The site is includes a recreation complex, opposite Option 2. Here, the plant types consist mainly of ornamental/cultivated plants, which surrounded a local sports field.

10.4 DEVELOPMENT ALTERNATIVES

10.4.1 LNG Technology Options

Gas is the only fuel that accommodates renewables and LNG is believed to be a dependable, long-term, secured source in Jamaica. It is also the most attractive priced energy form, followed by ethane and propane. Various technology LNG options including technologies (turbines and reciprocating engines) and different manufacturers were evaluated. Resulting from this assessment, it was concluded that the 190 MW, 3x1 Power Island will provide the lowest system cost of energy to integrate renewable resources.

10.5 ALTERNATIVE ENERGY SOURCES

Energy alternatives theoretically can support the generation of electric power. Renewable energy resources such as solar, hydroelectric, biomass and wind, as well as more traditional forms such as coal and oil are energy alternatives discussed in subsequent sections.

10.5.1 The Proposed Development as described in the EIA but using ADO as the primary fuel

Using ADO as the primary fuel instead of LNG was investigated.

IMPACTS

- Physical: LNG produces less air emissions and pollutants than diesel oil.
- Socioeconomic: LNG is also more cost effective than ADO therefore results in cheaper costs to generate electricity with spinoff impacts to the National economy.

10.5.2 Generating the Required Power but using Nuclear Energy as an Alternative to Fossil Fuels

IMPACT

- Socioeconomic: A nuclear energy plant would result in the need for strict security and maintenance. Certain mitigation would also be required for this type of plant. For these reasons the development of such a power plant in Old Harbour is not practical at this time.

10.5.3 Generating the Required Power but using Renewable Energy Resources as an Alternative to Fossil Fuels

Wind, solar and hydro energy as renewable energy sources were also considered. Although all three are clean forms of energy there are some limitations and generally, continued resource constraints limit the full value of renewable resources.

10.5.3.1 Wind Energy

IMPACT

- Physical: Wind turbines would not be able to produce enough energy for this size of plant as the largest turbines to date are producing 3MW. This would require 120 wind turbines to generate the required power. There are two inherent problems with this; the land space required to establish these turbines and the unreliability (fluctuation) in wind doesn't make it suitable to be used for base power.

10.5.3.2 Solar Energy

IMPACT

- Physical: The acreage (land area) required for solar panels to produce the required energy makes it unsuitable for this area.

10.5.3.3 Hydroelectricity

The Government of Jamaica has embarked on a study in an effort to determine the feasibility of hydroelectric plants at five locations around the island. Additionally, the Jamaica Public Service Company Limited has enhanced and rehabilitated some of their hydroelectric plants. The largest hydroelectric plant to date in the island is the Maggotty 6.3 MW hydroelectric plant. This coupled with the fact that most of our rivers are relatively small means that the probability of producing 360 MW of base power from hydroelectricity is low.

10.5.4 Generating the Required Power but using Coal as the Fuel

Using coal as the primary fuel instead of LNG was investigated.

IMPACTS

- Physical: LNG produces less air emissions and pollutants than coal. A coal-fired plant also utilizes much more land space than a LNG plant, because of the need for a coal ash landfill area.
- Socioeconomic: LNG is more cost effective than coal therefore results in cheaper costs to generate electricity. In addition, the public sentiments toward the use of coal are unfavourable.

10.6 OVERVIEW OF ALTERNATIVE ANALYSIS

Based on the above, the development as proposed in the EIA is the most economical option that will result in the provision of the needed power generating capacity with reduced potential impacts which can be mitigated.

11.0 EMERGENCY PREPAREDNESS AND RESPONSE

The following points will be taken into consideration with respect to Emergency Response Planning:

- A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers.
- The JPS construction management team should have onsite first aid kits and make arrangements for the nurse and doctor on call for the construction site.
- Make prior arrangements with health care facilities such as the Old Harbour Health Centre, Kingston Public Hospital or the Spanish Town Hospital to accommodate any eventualities.
- Arrange with health practitioners to be on call during the construction period.
- Design and implement an emergency response plan or update the existing plan to reflect the issues of the new power plant.
- Staff should be trained in Cardio Pulmonary Resuscitation (CPR).
- Coordinate with mutual aid organisations/agencies such as with the local fire brigade.
- Material Safety Data Sheets (MSDS) should be stored onsite.
- Conduct emergency response drills.

In addition, it is proposed that JPS Emergency Response Plan reflect the following issues:

- Earthquake
- Hurricane
- Flooding
- Explosion
- LNG Accidents
- Oil /Hazardous Material Spill
- Community and Outside Liaison
- Unrest and Riots
- Act of Terrorism and Armed Attack
- Bomb Threats and Acts of Sabotage
- Serious or Multiple Injury; and
- Illegal Trespassing

The plan should also include emergency call lists of persons on and offsite, building plans, site maps and evacuation routes.

The existing JPS Old Harbour Power Plant emergency response plan will be updated to reflect the new technologies.

12.0 COST BENEFIT ANALYSIS

12.1 METHODOLOGY

The UNIDO Approach for Social Cost Benefit Analysis as prescribed by United Nation Industrial Development Organization (UNIDO) was applied to a thermal coal power plant and a hydro plant hence is an appropriate methodology to be used to analyse the JPS natural gas power plant in Jamaica.

The United Nation Industrial Development Organization (UNIDO) and the Centre for Organization of Economic Cooperation and Development (COECD) have come with useful publications dealing with the problem of measuring social costs and social benefits. It may be noted, in this context, that the actual cost or revenues from the goods and/or services to the organization do not necessarily reflect the monetary measurement of the cost and or benefit to the society. This is because these figures are grossly distorted on account of restriction and controls imposed by the government. Hence a different yardstick has to be used for evaluating a particular good and/or service in terms of cost and sacrifice on the part of the society. Such payments are easily valued at opportunity cost or shadow prices to judge their real impact in terms of cost to society for the purpose of social cost benefit evaluation.

UNIDO Approach is a five stage methodology:

1. Calculation of financial profitability measured at market prices.
2. Obtaining the net benefit of the project measured in terms of economic prices.
3. Adjustment for the impact of the project on savings and investment.
4. Adjustment for the impact of the project on income distribution.
5. Adjustment for the impact of the project on merit goods and demerit goods

12.1.1 Calculation of Financial Profitability Measured at Market Prices

A good technical and financial analysis must be done before a meaningful economic evaluation can be made. For this reason, financial profitability is a prerequisite in all cases.

Financial profitability produces an estimate of the project's financial profit or the net present value of the project when all inputs and outputs are measured at market prices. The first step in stage one is to complete standard tables of income statement, balance-sheet and cash-flow. The financial income statement is the central table in this analysis as it is used to record the inputs and outputs of the project. Cash flow statement is also important here as the financial income statement only shows the annual profit and disguise investment. The net cash flow is derived from the financial income statement by standard accounting procedures and is equal to the gross cash flow (operating profit before interest and taxes plus allowances for depreciation) minus capital investments.

12.1.2 Obtaining the Net Benefit of the Project Measured in Terms of Economic Prices

Stage two of the UNIDO approach is concerned with the determination of the net benefit of the project in terms of economic prices, also referred to as shadow prices. Market prices represent shadow prices only under conditions of perfect markets which are almost invariably not fulfilled in developing countries. Hence, there is a need for developing shadow prices and measuring net economic benefit in terms of these prices.

12.1.3 Adjustment for the Impact of the Project on Savings and Investment

Most of the developing countries face scarcity of capital. Hence, the governments of these countries are concerned about the impact of a project on savings and its value thereof. Stage three of the UNIDO method, concerned with this, seeks to answer the following questions:

1. Given the income distribution impact of the project what would be its effects on savings?
2. What is the value of such savings to the society?

Impact on Savings

The saving impact of a project is equal to:

$$\sum_i \Delta Y_i \times MPS_i$$

Where ΔY_i is the change in income of group *i* as a result of the project, and MPS_i is the marginal propensity to save of group *i*.

12.1.4 Adjustment for the Impact of the Project on Income Distribution

Many governments regard redistribution in favour of economically weaker sections or economically backward regions as a socially desirable objective. Due to practical difficulties in pursuing the objective of redistribution entirely through the tax, subsidy, and transfer measures of the government, investment projects are also considered as investments for income redistribution and their contribution toward this goal is considered in their evaluation. This calls for suitably weighing the net gain or loss by each group, measured earlier, to reflect the relative value of income for different groups and summing them.

Determination of Weights: If there are only two groups in a society, poor and rich, the determination of weight is just an iterative process between the analysts (at the bottom) and the planners (at the top). This is called “bottom-up” approach. When more than two groups are involved, weights are calculated by the elasticity of marginal utility of income. The marginal utility of income is the weight attached to an income is:

$$w_i = (b/c_i)n$$

Where,

w_i = weight of income at c_i level
c_i = level of income of group
b = base level of income that has a weight of 1.00
n = elasticity of the marginal utility of income

12.1.5 Adjustment for the Impact of the Project on Merit Goods and Demerit Goods

The steps of adjustment procedure are:

- Estimating the present economic value
- Calculating the adjustment factor
- Multiplying the economic value by the adjustment factor to obtain the adjusted value
- Adding or subtracting the adjusted value to or from the net present value of the project as calculated in stage four.

12.2 Application of UNIDO Approach to the JPS Power Plant

12.2.1 Calculation of Financial Profitability Measured at Market Prices

Table 12-1 presents the estimates of revenue collected by the project during its lifetime.

Table 12-1 Estimates of financial flows of revenue earned by the project during its lifetime

Year	Old	New	Year	Old	New	Year	Old	New
2018	213.0	128.7	2027	213.0	128.7	2036	128.7	2036
2019	213.0	128.7	2028	213.0	128.7	2037	128.7	2037
2020	213.0	128.7	2029	213.0	128.7	2031	128.7	2031
2021	213.0	128.7	2030	213.0	128.7	2032	128.7	2032
2022	213.0	128.7	2031	213.0	128.7	2033	128.7	2033
2023	213.0	128.7	2032	213.0	128.7	2044	128.7	2044
2024	213.0	128.7	2033	213.0	128.7	2045	128.7	2045
2025	213.0	128.7	2034	213.0	128.7	PV	1300	784.70
2026	213.0	128.7	2035	213.0	128.7	NPV		515.3

** Cost is measured in millions of US$ Dollars. This uses a discount rate of 16%. Assuming that the exchange rate remains stable and oil prices are the same as 2012*

The Office of Utility regulation have a rate of return of 12.5%. Given that the rate of return is guaranteed, a calculation of financial profitability is just a comparison between cost of the old plant and the new plant. The rate of return is important in calculating the reduction of final prices to the consumer. The NPV of the difference of the total fixed costs, total variable operating and maintenance, and fuel and transportation cost is US$ 515,000,000. The capital expenditure for capital, construction is US$ 219,465,000. Therefore the calculation of NPV at market prices for the Power Plant turned out to be US$ 515,000,000, therefore as per financial evaluation of the project since NPV is US$ 295,500,000, project should be under taken if financial consideration and private benefits was the only consideration.

12.2.2 Obtaining the Net Benefit of the Project Measured in Terms of Economic Prices

12.2.2.1 Identification of Economic (Social) Benefits and Costs

Social Benefits/Cost:

- The major benefit of setting up this Power Plant would be the manufacturing section which will benefit from the lower cost of electricity and the establishment of the more reliable power supply. This will lead to more possibility of manufacturing that will lead to creation of employment opportunities for unskilled and skilled workers. This is hard to quantify and hence the number are not adjusted for it. Which means that the social benefit stated below is a lower bound.
- The use of natural gas instead of oil will lead the reduction of the import oil bill and save foreign exchange. Leading to less pressure on the exchange rate which could lead to less inflation of about 1 percentage point. (These number from a simple regression of the net international reserve on the JA$/US$ exchange rate.)
- Using natural gas would lead to a reduction in greenhouse gases hence lead to a reduction of environmental cost.
- There is the potential for increased employment during the pre-clearance and construction phases. It is anticipated that approximately 70 persons will be employed directly during the site clearance and an average of 200 persons to a maximum of 400 -450 persons at the peak during construction. Approximately 70% of the work force will be obtained from local labour. In addition it is anticipated that approximately 1,140 and 1,520 - 1,710 indirect and induced jobs are expected to be created during the site clearance and construction phases respectively; thus further benefitting the community. This represents a significant level of employment within the study area and has the potential to be a significant positive impact. This labour would be otherwise unemployed or under employed in the Jamaican economy.
- Revenue earned by the government in the form of taxes from the increase earnings and employment provided by the project.
- The decrease in pollutants and hence the reduction in the environment cost from switching from Oil power plant to a Natural Gas plant.
- Decrease costs of power to end consumers due to rising fuel and coal costs.

Table 12-2 shows the Operation and Maintenance (O&M) cost of the project in terms of shadow (economic) prices.

Table 12-2 Estimates of financial flows of operation and maintenance (O&M) expenditures in terms of Shadow Prices (During its Lifetime)

Year	Old	New	Year	Old	New	Year	Old	New
2018	210	125	2027	210	125	2036	210	125
2019	210	125	2028	210	125	2037	210	125
2020	210	125	2029	210	125	2031	210	125
2021	210	125	2030	210	125	2032	210	125
2022	210	125	2031	210	125	2033	210	125
2023	210	125	2032	210	125	2044	210	125
2024	210	125	2033	210	125	2045	210	125
2025	210	125	2034	210	125	PV	1358	808
2026	210	125	2035	210	125	NPV		550

The NPV calculation was done after doing the below mentioned adjustments for social costs and social benefits.

- The O&M cost components i.e. spares, salaries and other expenses were multiplied by factor of 1.1, 0.8 and 1 to convert into corresponding components in shadow prices. Labour cost makes up 25% of O&M cost.
- The exchange rate effect is used to reduce the discount rate from 16% to 15%.

12.2.2.2 Environmental Impact Comparisons - Greenhouse Gas Emissions

Greenhouse Gas (Ghg) Emissions for Existing JPS Facility

Using USEPA* greenhouse gas emission factors for Oil-Fired Utility Boilers and a total oil consumption of 306,099,807 L/y, the following emission rates were calculated (Table 12-3):

Table 12-3 Greenhouse Gas Emission rates for Oil-Fired Facility

Facility	Pollutant	Emission Factor, lb/103 gal	Emission Factor, kg/L	Facility Emission Rate, tonne/y
Oil-Fired Utility Boiler	CO2	24,400	2.928	896,260.2
	N2O	0.53	0.0000636	19.5
	CH4	0.28	0.0000336	10.3

**United States Environmental Protection Agency. May 2010. Emission Factor Documentation for AP-42: External Combustion Sources, Tables 1.3-3, 1.3-8 and 1.3-12. Office of Air Quality Planning and Standards, Office of Air and Radiation, U.S. Environmental Protection Agency, Research Triangle, North Carolina.*

Greenhouse Gas (Ghg) Emissions for LNG Facility

Using USEPA*greenhouse gas emission factors for LNG-Fired Stationary Gas Turbines and the heat consumption rate of 1.383 x 109 kJ/h for the LNG to be used, the following emission rates were calculated (Table 12-4):

Table 12-4 Greenhouse Gas Emission rates for LNG Facility

Facility	Pollutant	Emission Factor, lb/MMBtu	Facility Emission Rate, tonne/y
NG-Fired Combustion Turbine	CO2	110	573,000
	N2O	0.003	15.6
	CH4	0.0086	44.8

**United States Environmental Protection Agency. July 1998. Emission Factor Documentation for AP-42: Stationary Gas Turbines. Office of Air Quality Planning and Standards, Office of Air and Radiation, U.S. Environmental Protection Agency, Research Triangle, North Carolina.*

The difference in pollutants for CO_2, N_2O, and CH_4 are; 323,260.2, -3.9, and 34.5 tonne/y respectively. Using a social of US$40 for CO_2, US$29,000 for N_2O and US$2,000 for CH_4. See Marten, Alex L., and Stephen C. Newbold (2012) for calculations. Therefore net reduction in pollutants are valued at US$13,000,000 per year with a present value of US$84,030,000 over 25 year using a discount rate of 15%.

12.2.2.3 Social Benefit from Employment

There is the potential for increased employment during the pre-clearance and construction phases. It is anticipated that approximately 70 persons will be employed directly during the site clearance and an average of 200 persons to a maximum of 400 -450 persons at the peak during construction.

Approximately 70% of the work force will be obtained from local labour. In addition it is anticipated that approximately 1,140 and 1,520 .1,710 indirect and induced jobs are expected to be created during the site clearance and construction phases respectively; thus further benefitting the community. This represents a significant level of employment within the study area and has the potential to be a significant positive impact. This labour will be otherwise unemployed or underemployed in the Jamaican economy. Using the standard 1.6 multiplier for job creation the value of the employment effect is US$61,000,000. Note that 25% of the construction is labour cost and 70% of the labour will be local labour.

12.2.2.4 Benefit from Lower Electric Cost

There is an annual fuel savings of US$ 74,200,000 which is 38% reducing in cost assuming a 75% pass through to the consumer and a 25% mixed of the generating capacity of the JPS then this result in a 7% reduction in consumer prices (Table 12-5).

Table 12-5 Electricity consumption by income/consumption distribution

Consumption Percentile	Electricity Bill (JA$)	EX Rate (JA$ to US$)	Electricity Bill (US$)	Savings /household (US$)	Total Savings(US$)
0-20th Percentile	35,059	88.75	395	27.65	431,340
21-40th Percentile	44.799	88.75	505	35.35	551,460
41-60th Percentile	54,143	88.75	610	42.7	666,120
61-80th Percentile	67,057	88.75	756	52.92	825,552
81-100th Percentile	97,113	88.75	1094	76.58	1,194,648
Total					3,669,120
NPV					23,720,000

**The JPS have 78000 paying households.*

NPV of the project after Stage 2 turns out to be US$718,750,000. This shows that after taking into account the net social benefits and costs, it is worthwhile to take up the project as NPV is positive even after including the environmental impact (Table 12-6).

Table 12-6 Net Social Present Value of the project

Components	NPV (Millions US$)
(O&M) cost economic prices.	550.00
Green House Gas	84.03
Employment effect	61
Electricity cost	23.72
Total NSPV	718.75

12.2.3 Adjustment for the Impact of the Project on Savings and Investment

Following are the groups which will be benefited by the project:

- Government
- JPS
- Labour
- Consumers/producers

Table 12-7 gives the calculation of saving impact on the above mentioned stake holders.

Table 12-7 Calculation of saving impact on stakeholders

Stake holders	Net Benefit	MPS	Savings Impact
JPS	550.00	0.55	302.5
Workers	61.00	0.29	17.7
Consumers/producers	23.72	0.60	14.2
			334.4

The Net Savings Impact turns out to be US$ 334,400,000.

Calculation of Social Value of Savings Social value or shadow price of savings is calculated as follows:

$$I = r(1 - a)/(k - ar)$$

Where,

- *I* is the social value of US$ of savings (investment),
- *r* is the marginal productivity of capital,
- *a* is the reinvestment rate on additional income arising from investment,
- *k* is the social discount rate.

The value of *I* used in this study is 1.55, which is taken from the study done by Murty (1980) in which he has explored the problems related to the evaluation of income distributional effects of public investment projects.

Therefore, Net saving impact in terms of shadow prices is:

= *Total savings* x *I*

= 334,400, 000 x 1:55

= 518, 354, 100

Table 12-8 gives the calculation of NPV at Stage 3

Table 12-8 Calculation of NPV at Stage 3

NPV From stage two	718.75
Net saving Impact	518.4
NPV at Stage 3	1237.15

Thus, the NPV after taking into account the savings impact turns out to be US$1,237,150,000.

12.2.4 Adjustment for the Impact of the Project on Income Distribution

Given that the consumer and workers will benefit, the impact on the income distribution is neutral. Thus, the NPV after Income Distribution Impact turns out to be US$1,237,150,000.

12.2.5 Adjustment for the Impact of the Project on Merit Goods and Demerit Goods

The adjustment factor turns out to be 1.40. This shows that social value of the project exceeds its economic value by 140%.

Calculation of Adjustment Factor and Adjusted NPV: Table 12-9 gives the Calculation of NPV at Stage 5.

Table 12-9 Calculation of NPV at Stage 5

Adjustment Factor	Unit	1.40
NPV at Stage 4	1237.15	
New NPV after Stage 5		1733.04

Thus, the final NPV of the project after application of Social Cost Benefit Analysis turns out to be US$ 1,733,040,000. Hence, the project should be undertaken as it has multiple social benefits which are reflected in the final positive NPV of the project.

12.3 CONCLUSION

The cost benefit shows that the project has a positive NPV using all recommended methodologies.

13.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

13.1 MONITORING DURING SITE PREPARATION FOR THE PROPOSED POWER PLANT

- A noise survey should be undertaken to determine workers exposure and construction equipment noise emission.
  Any organization with the capability to conduct monitoring of the listed parameters should be used to perform this exercise. It is recommended that a report should be given to NEPA at the end of the monitoring exercise. The estimated cost for this exercise is J $157,500.
- 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.
  Person(s) appointed by JPS may perform this exercise.
- Daily monitoring of vehicle refuelling and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of soil contamination from spills. Spot checks should be conducted by NEPA.
- Person(s) appointed by JPS may perform this exercise.

13.2 MONITORING DURING THE CONSTRUCTION PHASE OF THE PROPOSED POWER PLANT

- Daily inspection of the power plant construction to ensure they are following the proposed plan and to ensure that site drainage systems are not impacting the coastal environment. Check and balance can be provided by NEPA and the St. Catherine Parish Council
  Person(s) appointed by JPS may perform this exercise.
- Undertake monthly water quality monitoring to ensure that the construction works are not negatively impacting the marine environment quality. The parameters that should be monitored are temperature, salinity, dissolved oxygen, pH, turbidity, TDS, nitrates, phosphates, FOG, total suspended solids and faecal coliform. This is estimated to cost approximately J$88,750 per monitoring exercise.

Any organization with the capability to conduct monitoring of the listed parameters should be used to perform this exercise. It is recommended that a report should be given to NEPA at the end of each monitoring exercise.

- Monthly noise surveys should be undertaken to determine workers exposure and construction equipment noise emission.
  Any organization with the capability to conduct monitoring of the listed parameters should be used to perform this exercise. It is recommended that a report should be given to NEPA at the end of the monitoring exercise. The estimated cost for this exercise is J $157,500.
- Daily monitoring to ensure that fugitive dust from cleared areas and raw materials are not being entrained in the wind and creating a dust nuisance.
  Person(s) appointed by JPS may perform this exercise.
- Undertake daily inspections of trucks carrying raw material to ensure that they are not over laden as this will damage the public thoroughfare.
  Person(s) appointed by JPS may perform this exercise.
- Undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal. Additionally, solid waste generation at the construction site should also be monitored.
  Person(s) appointed by JPS may perform this exercise.
- Weekly assessment to determine that there are adequate numbers of portable toilets and that they are in proper working order. This will ensure that sewage disposal will be adequately treated.
  Person(s) appointed by JPS may perform this exercise.
- Monitor and approve the suppliers and sources of local materials. Inspection of the quarry should be conducted to ensure that they are legal. Copies of these licences should be kept on file.
  Person(s) appointed by JPS may perform this exercise.
- Daily monitoring of vehicle refuelling and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of soil contamination from spills. Spot checks should be conducted by NEPA.
  Person(s) appointed by JPS may perform this exercise.
  No additional cost is anticipated for this exercise.
- Where possible, construction crews should be sourced from within the study area. This will ensure that the local community will benefit from the investment. The Old Harbour Bay Citizens Association could be used as the watchdog to ensure that this is achieved.
  Person(s) appointed by JPS may perform this exercise.

13.3 MONITORING DURING THE OPERATION PHASE OF THE PROPOSED POWER PLANT

- Annual noise assessments should be conducted starting with the initial commissioning of the power plant. This should be contracted out by JPS to a third party company or individual that specializes in performing such tests. The contracted party shall have a proven experience in noise monitoring. All monitoring should be conducted according to generally accepted industry standards and the plant shall conform to the World Bank Ambient Noise Levels and the National Environment and Planning Agency Standards. The annual noise assessment is estimated to cost approximately J$375,000 per assessment.
- Undertake monthly inspection of drainage and wastewater systems to ensure that they are in proper working order to negate potential detrimental environmental impacts from malfunctioning infrastructure.
  Person(s) appointed by JPS may perform this exercise.
- If the power plant is to be run on LNG, then no ambient air quality monitoring stations need to be set up.

13.4 REPORTING REQUIREMENTS

13.4.1 Noise Assessment

A report shall be prepared by the Contracted Party. This report shall include the following data:

i. Dates, times and places of test.
ii. Test Method used.
iii. Copies of instrument calibration certificates.
iv. Noise level measurements in decibels measured on the A scale (dBA) and wind direction.
v. Noise levels measured in low, mid and high frequency bands (dBL)
vi. A defined map of each location with distance clearly outlined in metric
vii. Assessment done according to varying loads of the facility
viii. Any other relevant operating information (such as unusual local noise source, SJPC loading).
ix. Evaluation of data, discussions and statement giving a professional opinion of the noise impact of the facility.

- The report shall be submitted to Plant Manager or his designate within two weeks after completion of testing.

- The Plant Management shall distribute the report within forty five (45) days of testing being completed.
- In the event that emissions do not meet the required criteria, investigations shall be carried out and corrective actions were necessary taken and a re-test shall be scheduled at the earliest possible time and a new report submitted.
- Reports will be maintained on file at the plant for a minimum of three years.

13.4.2 Water Quality Assessment

A report shall be prepared by the Contacted party. It shall include the following data:

i. Dates, times and places of test.
ii. Weather condition.
iii. A defined map of each location with distance clearly outlined in metric.
iv. Test Method used.
v. Parameters measured
vi. Results
vii. Conclusions

- The report will be submitted to the Plant Manager or his designate within two weeks of the monitoring being completed.
- Plant management shall distribute the report within forty five (45) days of testing being completed.
- In the event that parameters do not meet the required criteria, investigations shall be carried out and corrective actions were necessary taken and a re-test shall be scheduled at the earliest possible time and a new report submitted.
- Reports will be maintained on file at the plant for a minimum of three years.

13.4.3 Air Emissions

If the plant is to be operated on LNG then no ambient air quality stations need to be set up.

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15.0 APPENDICES

Appendix 1 – EIA Terms of Reference

TERMS OF REFERENCE
ENVIRONMENTAL IMPACT ASSESSMENT
FOR PROPOSED OLD HARBOUR 190 MW POWER PLANT
HARBOUR BAY, ST. CATHERINE, JAMAICA

The Terms of Reference (TOR) for conducting the EIA are based on the General Guidelines for Conducting EIAs (NEPA revised 2007) for prescribed categories under the NRCA Act.

The Environmental Impact Assessment will include but not necessarily be limited to:

Cover Page

Table of Contents

1. Executive Summary
2. Introduction
3. Policy, Legal and Administrative Framework
4. Public Participation and Consultation
5. Comprehensive Description of the Proposed Project
   - 5.1. The Proponent
   - 5.2. Project Concept & Description
   - 5.3. Project Infrastructure
   - 5.4. Project Operations and Maintenance
6. Description of the Existing Environment
   - 6.1. Physical
   - 6.2. Natural hazards
   - 6.3. Biological
   - 6.4. Heritage
   - 6.5. Human Social
7. Identification and Assessment of Potential Direct and Indirect Impacts
   - 7.1. Physical
   - 7.2. Natural Hazards
   - 7.3. Manmade Hazards
   - 7.4. Biological
   - 7.5. Heritage
   - 7.6. Human/Social
   - 7.7. Carrying Capacity
8. Cumulative Environmental Impacts
9. Recommended Mitigation
10. Residual Impacts
11. Identification and Analysis of Alternatives
12. Cost Benefit Analysis
13. Environmental Management of the Project

14. References
15. Appendices
    - 15.1. EIA Terms of Reference
    - 15.2. Glossary of Technical Terms
    - 15.3. Reference Documents
    - 15.4. Specific Technical Studies/Reports including Decommissioning Plan
    - 15.5. Data Tables
    - 15.6. Photographs & Maps
    - 15.7. Composition of the Research Team (including names, qualification and roles 15.8. Notes of Public Consultation Sessions
    - 15.9. Instruments used in Community Survey

Additional Requirements

The EIA study should also take into consideration the Transmission line requirements and easement and the sphere of influence of their impact on the development of adjoining/surrounding properties.

The proposed zoning of the site in the Highway 2000 corridor Portmore to Clarendon Park Development Plan must be stated and discussed.

The EIA should seek to propose mechanisms for the reduction of discharges from the plant.

To ensure that a thorough environmental impact assessment is carried out, it is expected that the following tasks be undertaken:

Task # 1 - Description of the Project

Provide a comprehensive description of the project including any information necessary to identify and assess the potential environmental impacts of the project. This should include project

- An overall master plan of the site, including current, proposed and future use of the lands
- Objectives and information on, rationale for the project;
- Project Background, the nature, location/existing setting, timing, duration, frequency, general layout including construction of any additional power lines and high voltage transmission line and their impacts on the surroundings communities, as well as the impact of the turbines on the power supply and carbon footprint of the energy sector are to also be discussed;
- Pre-construction activities,
- Construction methods, works and duration
- Post construction plans
- A description of raw material inputs (including source of raw material for any proposed land reclamation), technology and processes to be used as well as products and by-products generated, should be provided.

- Outline of areas to be reserved for construction and areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment.

Task # 2 - Description of the Environment/Baseline Studies Data Collection and Interpretation

This section should include a detailed description of the proposed site and surrounding environment. Baseline data should be generated in order to give an overall evaluation of the existing environmental conditions, including a historical meteorological evaluation to include but not be limited to wind characteristics and analysis, values and functions of the area, as follows:

i.) Physical environment
ii.) Biological environment
iii.) Socio-economic and cultural constraints

It is expected that methodologies employed to obtain baseline and other data be clearly detailed. Baseline data will include:

Physical

i.) A description of the existing soil and geology, landscape, aesthetic values and hydrology. Special emphasis should be placed on storm water run-off, drainage patterns, and aquifer characteristics. Any slope stability issues that could arise should be thoroughly explored. Any slope stability issues that could arise should be thoroughly explored.

ii.) Baseline data of ambient air parameters must be collected in an area extending at least 5 km from the project boundary by observation at a number of locations. Specific importance should be attached to areas in close proximity of the project site, particularly those areas in within 1 km of the project site. All possible sources of air pollution within the area of influence shall be identified and quantified and ranked as major, significant or insignificant in accordance with the NRCA (Air Quality) Regulations, 2006. Data are to be collected and monitored for one wet and one dry season with at least one station in the up-wind/ non-impact/ non-polluting area (control site). Data collected should include

- nitrogen dioxide
- sulphur dioxide

Factors such as historical wind speed and direction, precipitation, relative humidity and ambient temperature data shall be assessed pre development.

iii.) Water quality of any existing wells, gullies, rivers, ponds, streams or coastal waters in the vicinity of the development. The water quality of the coastal water in the vicinity of any discharge points/sites in Old Harbour Bay and the potential cumulative impact of such discharges on the environment.
iv.) The likely constituents of any discharge.
v.) Noise levels of undeveloped site and the ambient noise in the area of influence

vi.) Sources of existing pollution and extent of contamination

The Physical Impacts should also be classified based on:

- Land Impacts
  - Onsite impacts
  - Offsite impacts
- Water Impacts
  - Pollution of water bodies
- Air Impacts
  - Changes to the micro climate of the area

Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic if applicable) of the area, with special emphasis on rare, threatened, endemic, protected, endangered, and economically important species. Migratory species, biological loss and habitat loss and fragmentation due to construction and operation should also be considered and assessed.

i.) Identification and description of the different terrestrial and marine ecosystem types, the structure of these ecosystems including species dominance, dependence and diversity, habitat specificity and community structure

ii.) The description of the coastal and marine ecosystem should including but not limited to, any wetlands including mangroves, seagrass and coral community with indication of its function and value in the project area.

Socio-economic & cultural

Present and proposed land use; transportation of heavy equipment, road widening and associated traffic considerations particularly in the construction phase of the project, planned development activities; issues relating to squatting and relocation; public health and safety. The historical importance (heritage, archaeological sites and feature) and other material assets of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings and/or questionnaires/surveys.

i.) Availability of solid waste management facilities

Task #3 - Policy, Legislative and Regulatory Considerations

Outline the pertinent regulations and standards 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 NRCA Act, the Public Health Act, the Town and Country Planning Act and the appropriate international convention/protocol/treaty where applicable.

Examine the Government National Energy Policy and renewable projects. Discuss briefly the 190 MW in relation to the National Energy Policy.

Task # 4 - Identification and Assessment/Analysis of Potential Impacts

Examine and identify the major potential environmental and public health issues of concern and indicate their relative importance to the development project. These should include the occupational exposure, health and safety measures and population exposure in the appropriate study area(s) and changes and or enhancement in emergency response plan. The identification of the major potential impacts or the ranking of the impacts should be done using an appropriate technique and the method for the ranking must be included in the EIA report.

Identify potential impacts as they relate to, (but are not restricted by) the following:

- Change in drainage patterns
- Flooding potential if necessary
- Landscape impacts of excavation, land reclamation and construction
- Loss of species and natural features
- Habitat loss and/or fragmentation
- Biodiversity/ecosystem functions including impacts on bird and bat mortality
- Air quality
- Socio-economic and cultural impacts
- Impact of flooding, excavation and construction on the historic landscape, architecture and archaeology of the site
- Potential impact of high voltage transmission lines (sphere of influence)
- Noise and vibration
- Solid waste disposal
- Soil
- Change in land use

- Visual impacts – aesthetics
- Impact on traffic associated with road widening and the transportation of heavy equipment to the site
- Impacts on aircrafts in the area
- Pollution of potable, surface or ground water should be explored to include the marine environment
- Sewage and trade effluent treatment systems and discharge. The cooling water source and implications inclusive of existing demands and any effluents that may be likely as a consequence. The cooling water discharge and its impact must also be addressed.
- Natural hazard risks – Risk assessment of the plant in relation to tsunamis, hurricanes, tropical storm, flooding must be undertaken. In light of the concentration of significant power generation capacity at Old Harbour Bay, a risk analysis of the threat to the supply of power to the national grid from the proposed plan during emergencies should be assessed. A seismic hazard analysis of the site and surrounding areas shall be done to determine the peak horizontal ground motion and site spectral response for short and long period waves of 0.2 seconds and 1 second respectively using probabilistic ground motion models. Additionally, Storm surge modelling and risk analysis shall be done to assist in determining the mitigation measures necessary to protect the facility, considering sea level rise and increase in the intensity of storm events projected for the future.

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts to include discussion on site restoration and residual impacts and the proposed mitigation measures. Identify avoidable as well as irreversible impacts. Cumulative impacts of this and other proposed and/or existing developments will be explored.

Characterize the extent and quality of the available data, 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 will be represented in matrix form.

Task #5 - Drainage Assessment

An assessment of Storm Water Drainage should be conducted. The EIA Report will cover but not be limited to where necessary:

i.) Drainage for the site during construction to include mitigation for sedimentation to the aquatic including marine environment

ii.) Drainage for the site during operation, to include mitigation for sedimentation to the aquatic and marine environment

iii.) Drainage control for crossings of rivers and/or gullies, to include impacts that drainage control features could have on aesthetics, water quality and sedimentation of rivers and/or gullies.

iv.) Storm water runoff should be assessed based on existing situation and the impact that the proposed plant is expected to have.

v.) Drainage assessment should also include impact of the development on the hydrodynamics of the general area. Of note is that the Old Harbour Bay, which is 5 kilometres from the site, is impacted by flooding.

vi.) All possible efforts should be made to retain all of the surface drainage/storm water runoff on the site. The natural drainage should not be impacted.

Task # 6 - Mitigation & Emergency Preparedness and Response

Prepare guidelines for avoiding or reducing (e.g. restoration and rehabilitation), as far as possible, any major potential impacts identified in Task # 4 due to proposed usage of the site and utilising of existing environmental attributes for optimum development. Where suitable mitigation measures cannot be identified for an identified major potential impact, alternatives to the activity resulting in the impact or a justification for the lack of alternatives or mitigation measures must be provided. In addition, the EIA should seek to propose mechanisms for the reduction of discharges from the plant. Quantify and assign financial and economic values to mitigating methods.

Indicate the emergency preparedness and response plans for dealing with risks and hazards identified at Task 4.

Task # 7 - EHS Management and Monitoring Plan

Design a plan for the management of the natural, historical and archaeological environments of the project to monitor implementation of mitigatory or compensatory measures and project impacts during construction and occupation/operation of the units/facility. Preparation of an EHS Management Plan and Historic Preservation Plan (if necessary) for the long-term operations of the site.

An outline of a monitoring programme (if necessary) 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 and report should include:

- An introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit and/or licence(s) granted.
- Raw data collected
- Discussion of results with respect to the development in progress, highlighting any parameter (s) which exceeds the expected standard (s).

- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- Project maintenance and decommissioning
- The methodology to be employed and the frequency of monitoring.
- 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
- Tables and graphs are to be used where appropriate

Task # 8 - Project Alternatives

Examine alternatives to the project or to specific aspects of the project. Include an assessment of the impacts of all the alternatives examined, including the no-action alternative. This examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself. The assessment of alternatives shall include but not be limited to an examination of the physical, socio-economic and biological impacts of each alternative

Project alternatives should be discussed in the EIA

Task # 9 – Cost Benefit Analysis

Conduct a Cost Benefit Analysis of the project. A cost benefit analysis of the use-change as per the proposed project and the existing state must be included. The cost benefit analysis is to compare the annual value of lost welfare associated with impacts of the project with the net social gain from the project.

All data and survey instruments should be included in the appendices.

Task #10 - Public Participation/Consultation Programme

Conduct public presentation(s) on the findings of the EIA to inform, solicit and discuss comments from the public on the proposed development if necessary.

- Document the public participation programme for the project.
- Describe the public participation methods, timing, type of information to be provided to the public, and stakeholder target groups.
- Summarise the issues identified during the public participation process
- Discuss public input that has been incorporated into the proposed project design; and environmental management systems

Fourteen hard copies and an electronic copy of the report will be required for submission to the National Environment and Planning Agency.

Appendix 2 – NEPA Guidelines for Public Participation

NATIONAL ENVIRONMENT AND PLANNING AGENCY

NATURAL RESOURCES CONSERVATION AUTHORITY

GUIDELINES FOR CONDUCTING PUBLIC PRESENTATIONS

2007-10-25

SECTION 1: GENERAL GUIDELINES

1.1 Introduction

There are usually two forms of public involvement in the Environmental Impact Assessment (EIA) process. The first is direct involvement of the affected public or community in public consultations during the EIA study. These consultations allow the developer to provide information to the public about the project and to determine what issues the public wishes to see addressed. The extent and results of these consultations are included in the documented EIA report.

The second level of involvement takes place after the EIA report and addendum, if any, have been prepared after the applicant has provided the information needed for adequate review by NEPA and the public.

Public involvement in the review process is in keeping with Principle 7 of the United Nations Environment Programme (UNEP) decision published as Goals and Principles of Environmental Impact Assessment [Decision 14/25 of the Governing Council of UNEP, of 17, June, 1987]

1.2 Purpose

These guidelines are prepared for the use of the developer/project proponent; the consultants involve in conducting the EIA study and prepared the EIA report and the public.

SECTION 2: SPECIFIC GUIDELINES FOR PUBLIC PRESENTATIONS

2.1 **Requirements**

Arrangements for the public presentation must be made in consultation with NEPA in respect of date, time, venue, chairperson and participants.

A permanent record of the meeting is required hence, the project proponent/consultant will submit to NEPA a copy of the verbatim report of the public presentation within seven (7) days of the date of the meeting.

2.2 Public Notification

The public must be notified at least three weeks before the date of the public presentation. The developer/consultants must seek to ensure that in addition to specific invitation letters, at least three (3) notices are placed in the most widely circulated newspapers advertising the event. The notice shall also be forwarded to NEPA for posting on the website. To ensure that the notice is distributed as widely as possible, other methods of notification such as community notice board, flyers, town criers etc. shall be utilized as appropriate. In addition, specific notice to relevant local NGOs and community groups should be made by the developer/consultants.

The notice should indicate that:-

- the EIA has been submitted to NEPA;
- the purpose of the meeting;
- how to access the EIA report for review
- the date, time and venue of the public presentation.

The public presentation should be conducted no less than 3 weeks after the EIA has been made available to the public and no less than 3 weeks after the first notice announcing public presentation has been published by the applicant.

(A typical notice is in Appendix 1).

2. 3 Responsibility of Developer/Consultant Team

The developer/consultant is responsible for distribution of copies of the EIA Report to make them available to the public at least three weeks before the public presentation.

Copies should be placed in the Local Parish Library and the Parish Council Office as well as at the nearest NEPA Regional Office and other community locations as agreed upon.

A summary of the project components and the findings of the EIA in non-technical language should also be prepared for distribution at the public presentation.

2.4 Conduct of the Meeting

With respect to the conduct of the meeting, the chairperson should be independently selected so as to ensure his/her neutrality. NEPA should be consulted regarding the selection of a chairperson. The role and responsibilities of the chairperson are outlined ***Appendix 3***.

The technical presentation by the project proponent/consultant should be simple, concise and comprehensive. The main findings of the EIA including adverse and beneficial impacts identified and analyzed should be presented.

Mitigation measures and costs associated with these measures should be presented. The presentation should inform the public on how they will get access to monitoring results during the construction and operational phases of the project, bearing in mind that the public and non-governmental groups are expected to be involved in post-approval monitoring. Graphic and pictorial documentation should support the technical presentation.

Presenters are advised to keep the technical presentation simple and within a time limit of 20-30 minutes depending on the complexity of the project and to allow a minimum of 30 minutes for questions.

The project proponent/consultant will submit to NEPA a copy of the verbatim report of the public presentation within seven (7) days of the date of the meeting.

Please note that the public will be given a period of thirty (30) days after the Public Presentation to send in written comments to NEPA.

(A typical agenda for a meeting is given in Appendix 2)

APPENDIX 1

NOTIFICATION OF PUBLIC MEETING

THERE WILL BE A PUBLIC PRESENTATION ON THE ENVIRONMENT IMPACT ASSESSMENT REPORT

OF:

VENUE:

DATE:

TIME:

THE PUBLIC IS INVITED TO PARTICIPATE IN THE PRESENTATION BY WAY OF ASKING QUESTIONS RELATING TO THE PROPOSED PROJECT.

A COPY OF THE ENVIRONMENTAL IMPACT ASSESSMENT REPORT MAY BE CONSULTED AT THE

_____ PARISH LIBRARY
_____ PARISH COUNCIL OFFICE

For further information contact:

APPENDIX 2

AGENDA

1. WELCOME AND INTRODUCTION

2. PRESENTATION OF EIA FINDINGS AND MEASURES TO MINIMIZE IMPACTS

3. QUESTION AND ANSWER SESSION

4. CLOSING REMARKS

APPENDIX 3

ROLE AND RESPONSIBLITIES OF THE CHAIRPERSON

The chairperson has the main role of guiding the conduct of the meeting and seeing to it that the concerns of the public are adequately aired and addressed by the proponent/ consultants.

The responsibilities of the chairperson include explaining the NEPA approval process, that is, the steps involved and the role of the NEPA at these public presentations. In other words, the chairperson should explain the context within which the meeting is taking place.

The chairperson should ensure that adequate time is allowed for questions and answers, and must understand clearly and communicate the purpose of the meeting to the audience. The chairperson is responsible for introducing the presenters.

The chairperson should contribute to but not monopolize the meeting.

Appendix 3 - Relevant Sections of the "IFC General EHS Guidelines" and "Thermal Power: Guidelines for New Plants"

Table 1.7.1- Noise Level Guidelines[54]		
	One Hour L_{Aeq} (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

Table 2.3.1. Noise Limits for Various Working Environments		
Location /activity	**Equivalent level LA_{eq},8h**	**Maximum LA_{max},fast**
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light industry (decreasing demand for oral communication)	50-65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45-50 dB(A)	-
Individual offices (no disturbing noise)	40-45 dB(A)	-
Classrooms, lecture halls	35-40 dB(A)	-
Hospitals	30-35 dB(A)	40 dB(A)

Table 6 (B) - Emissions Guidelines (in mg/Nm³ or as indicated) for Combustion Turbine

Note:

- Guidelines are applicable for new facilities.
- EA may justify more stringent or less stringent limits due to ambient environment, technical and economic considerations provided there is compliance with applicable ambient air quality standards and incremental impacts are minimized.
- For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the EA considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits.
- EA should demonstrate that emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards, and more stringent limits may be required.

Combustion Technology / Fuel	Particulate Matter (PM)		Sulfur Dioxide (SO_2)		Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
Combustion Turbine			NDA/DA		NDA/DA	
Natural Gas (all turbine types of Unit > 50MWth)	N/A	N/A	N/A	N/A	51 (25 ppm)	15%
Fuels other than Natural Gas (Unit > > 50MWth)	50	30	Use of 1% or less S fuel	Use of 0.5% or less S fuel	152 (74 ppm)[a]	15%

General notes:

- MWth = Megawatt thermal input on HHV basis; N/A = not applicable; NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly; S = sulfur content (expressed as a percent by mass); Nm³ is at one atmospheric pressure, 0 degree Celsius; MWth category is to apply to single units; Guideline limits apply to facilities operating more than 500 hours per year. Emission levels should be evaluated on a one hour average basis and be achieved 95% of annual operating hours.
- If supplemental firing is used in a combined cycle gas turbine mode, the relevant guideline limits for combustion turbines should be achieved including emissions from those supplemental firing units (e.g., duct burners).
- (a) Technological differences (for example the use of Aeroderivatives) may require different emissions values which should be evaluated on a cases-by-case basis through the EA process but which should not exceed 200 mg/Nm3.

Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):

- Natural Gas-fired Combustion Turbine – NOx
  - Guideline limits: 51 (25 ppm)
  - EU: 50 (24 ppm), 75 (37 ppm) (if combined cycle efficiency > 55%), 50*η / 35 (where η = simple cycle efficiency)
  - US: 25 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 15 ppm (> 850 MMBtu/h (≈ 249 MWth))
  - (Note: further reduced NOx ppm in the range of 2 to 9 ppm is typically required through air permit)
- Liquid Fuel-fired Combustion Turbine – NOx
  - Guideline limits: 152 (74 ppm) – Heavy Duty Frame Turbines & LFO/HFO, 300 (146 ppm) – Aeroderivatives & HFO, 200 (97 ppm) – Aeroderivatives & LFO
  - EU: 120 (58 ppm), US: 74 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 42 ppm (> 850 MMBtu/h (≈ 249 MWth))
- Liquid Fuel-fired Combustion Turbine – SOx
  - Guideline limits: Use of 1% or less S fuel
  - EU: S content of light fuel oil used in gas turbines below 0.1% / US: S content of about 0.05% (continental area) and 0.4% (non-continental area)

Source: EU (LCP Directive 2001/80/EC October 23 2001), EU (Liquid Fuel Quality Directive 1999/32/EC, 2005/33/EC), US (NSPS for Stationary Combustion Turbines, Final Rule – July 6, 2006)

Table 7 – Typical Air Emission Monitoring Parameters / Frequency for Thermal Power Plants
(Note: Detailed monitoring programs should be determined based on EA)

Combustion Technology / Fuel	Emission Monitoring			Stack Emission Testing				Ambient Air Quality	Noise
	Particulate Matter (PM)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NOx)	PM	SO_2	NOx	Heavy Metals		
Reciprocating Engine								If incremental impacts predicted by EA >/= 25 % of relevant short-term ambient air quality standards or if the plant >/= 1,200 MWth: - Monitor parameters (e.g., $PM_{10}/PM_{2.5}/SO_2$/NOx to be consistent with the relevant ambient air quality standards) by continuous ambient air quality monitoring system (typically a minimum of 2 systems to cover predicted maximum ground level concentration point / sensitive receptor / background point). If incremental impacts predicted by EA < 25% of relevant short term ambient air quality standards and if the facility < 1,200 MWth but >/= 100 MWth - Monitor parameters either by passive samplers (monthly average) or by seasonal manual sampling (e.g., 1 weeks/season) for parameters consistent with the relevant air quality standards. Effectiveness of the ambient air quality monitoring program should be reviewed regularly. It could be simplified or reduced if alternative program is developed (e.g., local government's monitoring network). Continuation of the program is recommended during the life of the project if there are sensitive receptors or if monitored levels are not far below the relevant ambient air quality standards.	If EA predicts noise levels at residential receptors or other sensitive receptors are close to the relevant ambient noise standards / guidelines, or if there are such receptors close to the plant boundary (e.g., within 100m) then, conduct ambient noise monitoring every year to three years depending on the project circumstances. Elimination of noise monitoring can be considered acceptable if a comprehensive survey showed that there are no receptors affected by the project or affected noise levels are far below the relevant ambient noise standards / guidelines.
Natural Gas (Plant >50 MWth to <300 MWth)	N/A	N/A	Continuous or indicative	N/A	N/A	Annual	N/A		
Natural Gas (Plant >/= 300 MWth)	N/A	N/A	Continuous	N/A	N/A	Annual	N/A		
Liquid (Plant >50 MWth to <300 MWth)	Continuous or indicative	Continuous if FGD is used or monitor by S content.	Continuous or indicative	Annual					
Liquid (Plant >/=300 MWth)	Continuous or indicative		Continuous						
Biomass	Continuous or indicative	N/A	Continuous or indicative	Annual	N/A	Annual	N/A		
Combustion Turbine									
Natural Gas (all turbine types of Unit > 50MWth)	N/A	N/A	Continuous or indicative	N/A	N/A	Annual	N/A		
Fuels other than Natural Gas (Unit > 50MWth)	Continuous or indicative	Continuous if FGD is used or monitor by S content.	Continuous or indicative	Annual					
Boiler									
Natural Gas	N/A	N/A	Continuous or indicative	N/A	N/A	Annual	N/A		
				Annual	Annual	Annual	N/A		
Other Gaseous fuels	Indicative	Indicative	Continuous or indicative	Annual					
Liquid (Plant >50 MWth to <600 MWth)	Continuous or indicative	Continuous if FGD is used or monitor by S content.	Continuous or indicative						
Liquid (Plant >=600 MWth)		Continuous							
Solid (Plant >50 MWth to <600 MWth)		Continuous if FGD is used or monitor by S Content.	Continuous or indicative						
Solid (Plant >/=600 MWth)		Continuous							

Note: Continuous or indicative means "Continuously monitor emissions or continuously monitor indicative parameters". Stack emission testing is to have direct measurement of emission levels to counter check the emission monitoring system.

Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges[a]		
Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b] / 100 ml	400[a]

Notes:
[a] Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation.
[b] MPN = Most Probable Number

Table 5 - Effluent Guidelines (To be applicable at relevant wastewater stream: e.g., from FGD system, wet ash transport, washing boiler / air preheater and precipitator, boiler acid washing, regeneration of demineralizers and condensate polishers, oil-separated water, site drainage, coal pile runoff, and cooling water)	
Parameter	mg/L, except pH and temp
pH	6 – 9
TSS	50
Oil and grease	10
Total residual chlorine	0.2
Chromium - Total (Cr)	0.5
Copper (Cu)	0.5
Iron (Fe)	1.0
Zinc (Zn)	1.0
Lead (Pb)	0.5
Cadmium (Cd)	0.1
Mercury (Hg)	0.005
Arsenic (As)	0.5
Temperature increase by thermal discharge from cooling system	• Site specific requirement to be established by the EA. • Elevated temperature areas due to discharge of once-through cooling water (e.g., 1 Celsius above, 2 Celsius above, 3 Celsius above ambient water temperature) should be minimized by adjusting intake and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.

Note: Applicability of heavy metals should be determined in the EA. Guideline limits in the Table are from various references of effluent performance by thermal power plants.

Table 2.3.3. Minimum Limits For Workplace Illumination Intensity	
Location / Activity	**Light Intensity**
Emergency light	10 lux
Outdoor non working areas	20 lux
Simple orientation and temporary visits (machine storage, garage, warehouse)	50 lux
Workspace with occasional visual tasks only (corridors, stairways, lobby, elevator, auditorium, etc.)	100 lux
Medium precision work (simple assembly, rough machine works, welding, packing, etc.)	200 lux
Precision work (reading, moderately difficult assembly, sorting, checking, medium bench and machine works, etc.), offices.	500 lux
High precision work (difficult assembly, sewing, color inspection, fine sorting etc.)	1,000 – 3,000 lux

Table 8 - ICNIRP exposure limits for occupational exposure to electric and magnetic fields.		
Frequency	Electric Field (V/m)	Magnetic Field (μT)
50 Hz	10,000	500
60 Hz	8300	415
Source: ICNIRP (1998) : "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)		

Table 2.7.1. Summary of Recommended Personal Protective Equipment According to Hazard

Objective	Workplace Hazards	Suggested PPE
Eye and face protection	Flying particles, molten metal, liquid chemicals, gases or vapors, light radiation.	Safety Glasses with side-shields, protective shades, etc.
Head protection	Falling objects, inadequate height clearance, and overhead power cords.	Plastic Helmets with top and side impact protection.
Hearing protection	Noise, ultra-sound.	Hearing protectors (ear plugs or ear muffs).
Foot protection	Falling or rolling objects, pointed objects. Corrosive or hot liquids.	Safety shoes and boots for protection against moving & falling objects, liquids and chemicals.
Hand protection	Hazardous materials, cuts or lacerations, vibrations, extreme temperatures.	Gloves made of rubber or synthetic materials (Neoprene), leather, steel, insulating materials, etc.
Respiratory protection	Dust, fogs, fumes, mists, gases, smokes, vapors.	Facemasks with appropriate filters for dust removal and air purification (chemicals, mists, vapors and gases). Single or multi-gas personal monitors, if available.
	Oxygen deficiency	Portable or supplied air (fixed lines). On-site rescue equipment.
Body/leg protection	Extreme temperatures, hazardous materials, biological agents, cutting and laceration.	Insulating clothing, body suits, aprons etc. of appropriate materials.

Appendix 4 – No Objection Letter (NLA)

NATIONAL LAND AGENCY
20 North Street, Kingston
Tel: (876) 750-5263/946-5263 • Fax (876) 948-9382
website: www.nla.gov.jm

Reference No.: SN/306

5th October 2015

Mr. Peter Knight
Chief Executive Officer
National Environment and Planning Agency
10 Caledonia Avenue
Kingston 5

Re: Application to Purchase Land –
Part of Bourkesfield, Old Harbour, St. Catherine

Cabinet has approved the Electricity Sector Enterprise Team (ESET), for the development of new electricity generation capacity. The Terms of Reference for the ESET include the management of the procurement process in consultation the Office of Utilities Regulation (OUR), the JPSCo and the Minister of Science, Technology, Energy and Mining.

The Commissioner of Lands is in receipt of an application from the Jamaica Public Service Company Limited (JPSCo), seeking to purchase 25.1 acres of land, part of the captioned property, owned by the Commissioner of Lands (COL), which adjoins its Old Harbour Bay Plant. This is to facilitate the construction of a new power plant.

The COL is minded to recommend the divestment of the subject property to facilitate the construction of the new Power Plant. However, this is subject to the approval of the Hon. Minister with responsibility for lands.

Yours sincerely,

for Peter Baker
Manager, Property Services
for Commissioner of Lands

Appendix 5 - Hydrolab Calibration Certificate

HACH®
Hydromet

Certificate of Instrument Performance

Agency Name: **CL Environmental**

Certification for Job# **3073519**

Part/Model Number: MiniSonde5	Serial Number: **49186**

RECEIVED CONDITION: *(One must be checked)*	X	Within Tolerance Within Tolerance but Limited *(*see service report)* Out of Tolerance *(*see service report)*
RETURNED CONDITION: *(One must be checked)*	X	Within Tolerance Within Tolerance but Limited *(*see service report)*

Test Equipment Used, (ID#): ASTM – N.I.S.T traceable glass thermometer (Thermo-Fisher Scientific, Serial ***1781)*** and a Cole-Parmer *"PolyStat"* Constant Temperature Circulator

Environmental Conditions:

Actual Temperature:	Instrument Reading:	Error
10 °C	10.02°C	.02°C
20 °C	20.00°C	.00°C
30 °C	29.95°C	.05°C

Hach Company does hereby certify that the above listed equipment meets or exceeds all Manufacturers' Service Specifications (unless limited conditions apply). Test equipment used for performance verification are calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Where such standards do not exist, the basis for calibration is documented. The proper operation of the above instrument was established at the time of certificate issuance. To insure continued performance, user must adhere to all requirements listed in the instrument manual.

Certified by: _____ Title: Instrument Service Technician

Certification Date: 08/12/2013 08/12/2013

5600 Lindbergh Drive ● Loveland, CO 80538
(800) 227-4224 / FAX (970) 461-3924

Rev. 2

Appendix 6 – Noise QC 10 Calibration Certificate

3M Oconomowoc
Personal Safety Division

3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066-4828
www.3M.com/detection
262 567 9157 800 245 0779
262 567 4047 Fax

3M

Certificate of Calibration

Certificate No: 5507895QIG030085

Submitted By: C.L. ENVIRONMENTAL CO

22 FORT GEORGE HEIGHTS, OLD STONY HILL RD, KINGSTON 9, JAMAICA

Serial Number:	QIG030085	Date Received:	9/11/2014
Customer ID:		Date Issued:	9/17/2014
Model:	QC-10 CALIBRATOR	Valid Until:	9/17/2015
Test Conditions:		**Model Conditions:**	
Temperature:	18°C to 29°C	As Found:	IN TOLERANCE
Humidity:	20% to 80%	As Left:	IN TOLERANCE
Barometric Pressure:	890 mbar to 1050 mbar		

SubAssemblies:

Description:	**Serial Number:**

Calibration Procedure: 56V981

Reference Standard(s):

I.D. Number	Device	Last Calibration	Date Calibration Due
ET0000556	B&K ENSEMBLE	12/15/2013	12/15/2014
T00230	FLUKE 45 MULTIMETER	2/14/2014	2/14/2016

Measurement Uncertainty:

+/- 1.1% ACOUSTIC (0.1DB) +/- 1.4% VAC +/- 0.012% HZ
Estimated at 95% Confidence Level (k=2)

Calibrated By: JAMES NEUMAN **Service Technician** 9/17/2014

Reviewed/Approved By: **Technical Manager/Deputy** 9/17/2014

This report certifies that all calibration equipment used in the test is traceable to NIST or other NMI, and applies only to the unit identified under equipment above. This report must not be reproduced except in its entirety without the written approval of 3M Detection Solutions.

098-393 Rev. B

An ISO 9001 Registered Company
ISO 17025 Accredited Calibration Laboratory

ACCREDITED

Appendix 7 – Flora Species

SPECIES ENCOUNTERED ON JPS AND SJPC LANDS, PRIMARILY WITHIN THE THREE PROPOSED SITES

Scientific name	Common name	Growth form	DAFOR Ranking	Location (SJPC, 1, 1+, 2, 3) [33]
Antigonon leptopus	Coralita	Climbers/Twiners	F-A	SJPC, 1+
Cissus trifoliata	Sorrel Vine		F	1+, 2
Ipomoea sp.			F	1+
Ipomoea triloba			O	1+
Passiflora maliformis	Sweet Cup		O	1+
Ricinus communis	Castor Oil Plant, Oil Nut		R	1+, 3
Urechites lutea	Nightshade, Nightsage		O	1+, 3
Batis maritima	Jamaican Sapphire	Herbs	F-A	SJPC, 2
Cynodon dactylon	Bermuda Grass, Bahama Grass		A	1, 1+, 2, 3
Euphorbia prostrata	Milkweed		F	1+
Gomphrena decumbens			F	1+, 2
Musa sapientum	Banana		R	SJPC
Oeceoclades maculata	Monk Orchid/Ground Orchid		O	SJPC
Panicum maximum	Guinea Grass		A	SJPC
Portulaca sp.	Pussley		A	2
Rhynchospora nervosa	Star Grass		F	2
Sansevieria trifasciata	Tiger Cat			SJPC
Sesuvium portulacastrum	Seaside Purslane		O	2, 3
Spilanthes urens	Pigeon Coop		O-F	1+, 2
Sporobolus indica			F	1+, 2
Sporobolus virginicus			R	2, 3
Stemodia maritima			O-F	SJPC, 1+
Allamanda cathartica	Yellow Allamanda	Shrubs	R	1+
Cajanus cajan	Gungo Peas, Pigeon Peas			SJPC
Duranata repens	Angel's Whisper		R	3
Harrisia gracilis	Torchwood Dildo		R	1+
Ixora sp.			R	3
Jatropha gossypifolia	Belly-Ache-Bush		O	2, 3
Lantana camara	White Sage, Wild Sage	Shrubs (cont'd)	R	3
Nerium oleander	Oleander		O	3

[33] SJPC = SJPC lands; 1 = primary development area; 1+ = lands adjacent the primary development area; 2 = NE lands – thorn savannah; 3 = recreation area.

Scientific name	Common name	Growth form	DAFOR Ranking	Location (SJPC, 1, 1+, 2, 3)[33]
Pluchea carolinensis	Wild Tobacco		R	1+
Stenocereus hystrix	Dildo Pear		O	1+
Abutilon sp.		Shrubby Herbs	O	3
Bambusa vulgaris	Bamboo			SJPC
Desmanthus depressus			O	1+, 2
Gynerium saggitatum	Wild Cane			SJPC
Saccharum officinarum	Sugar Cane			SJPC
Sida acuta	Broomweed		A	1+
Turnera ulmifolia	Ram-Goat Dashalong		O	1+
Urena lobata	Ballard Bush, Bur Mallow		F	1+
Waltheria indica	Rachie		F	2
Acacia tortuosa	Wild Poponax	Trees	A	1+, 2, 3
Anacardium occidentale	Cashew			SJPC
Carica papaya	Papaya			SJPC
Cassia emarginata	Senna Tree, Yellow Candle Wood		R	SJPC, 3
Casurina equisetifolia	Willow		O	3
Cocus nucifera	Coconut		R	3
Cordia alba	Duppy Cherry		R	3
Ficus sp.	Fig		R	3
Guaiacum officinale	Lignum Vitae		O	1+
Guazuma ulmifolia	Bastard Cedar		A	SJPC
Leucaena leucosephala	Lead Tree		O	SJPC, 3
Mangifera indica	Mango			SJPC
Rhizophora mangle	Red Mangrove			SJPC
Samanea saman	Guango		F	SJPC
Ziziphus mauritiana	Coolie Plum		R	3

SPECIES ENCOUNTERED ON SJPC LANDS (CL ENVIRONMENTAL, 2012)

Scientific name	Common name	Growth form	DAFOR Ranking
Abrus precatorius	Crab Eyes	Climbers/Twiners	R
Antigonon leptopus	Coralita		R
Cissus sicyoides	Soldier Withe, Snake Withe, Pudding Withe		F-A
Cryptostegia grandiflora	Indian Rubber Vine		O
Ipomoea sp.			F
Ipomoea triloba			O
Mikania micrantha	Guaco		O
Momordica balsamina	Cerasee		R
Passiflora ?triflora			R
Passiflora maliformis	Sweet Cup		O
Phaseolus vulgaris	Red Peas		R
Pithecoctenium echinatum	Monkey Comb		O-F
Selenicereus grandiflorus	Queen-of-the-Night		O
Trichostigma octandra	Basket Withe		F
Urechites lutea	Nightshade, Nightsage		O-F
Achyranthes indica	Devil's Horse-whip	Herbs	A
Adropogon sp.			F-A
Asclepias curassavica	Red Top, Redhead		R
Batis maritima	Jamaican Sapphire		O
Bidens pilosa	Spanish Needle		O
Bromelia penguin	Pingwing		R
Commelina diffusa	Water Grass		R
Cynodon dactylon	Bermuda Grass, Bahama Grass		F
Cyperus sp.			O
Eleocharis sp.			O
Emilia javanica	Cupid's Shaving Brush		O
Gomphrena sp.			O
Heliotropium angiospermum	Dog's Tail		R
Leonotis nepetifolia	Christmas Candlestick		R
Mimosa pudica	Shame-o-lady		O
Musa sapientum	Banana		R
Oeceoclades maculata	Monk Orchid/Ground Orchid		O
Panicum maximum	Guinea Grass		A
Paspalum sp.			O
Rhynchospora nervosa	Star Grass		F
Rivina humilis	Bloodberry		F
Sesuvium portulacastrum	Seaside Purslane		O

Scientific name	Common name	Growth form	DAFOR Ranking
Sporobolus indica			F-A
Sporobolus jacquemontii			A
Sporobolus virginicus			R
Stemodia maritima			R
Talinum traingulare			R
Typha domingensis	Reedmace		O
Vernonia cinerea			O
Allamanda cathartica	Yellow Allamanda	Shrubs	O
Allamanda violacea	Purple Allamanda		O
Capparis baducca			R
Chromalaena (Eupatorium) odoratum	Christmas Bush		R
Lantana camara	White Sage, Wild Sage		R
Malpighia sp.			R
Pisonia aculeata	Cockspur		O
Pithecellobium unguis-cati	Privet		R
Pluchea carolinensis	Wild Tobacco		R
Plumbago sp.			R
Randia aculeata	Box Briar, Indigo Berry, Ink Berry		R
Ricinus communis	Castor Oil Plant, Oil Nut		R
Sida acuta	Broomweed		A
Stenocereus hystrix	Dildo Pear		R
Harrisia gracilis	Torchwood Dildo	Shrubby Herbs	R
Urena lobata	Ballard Bush, Bur Mallow		F
Acacia tortuosa	Wild Poponax	Trees	A
Avicennia germinans	Black Mangrove		R
Caesalpinia bonduc	Grey Nickal/Grey Nicker		R
Cassia emarginata	Senna Tree, Yellow Candle Wood		R
Cocus nucifera	Coconut		R
Comocladia pinnatifolia	Maiden Plum		R
Cordia sp.			R
Guazuma ulmifolia	Bastard Cedar		A
Haematoxylum campechianum	Logwood		O
Nectandra sp.			R
Samanea saman	Guango		F
Tecoma stans			O

Appendix 8 – Perception Survey Questionnaires

JAMAICA PUBLIC SERVICE COMPANY
190 MW COMBINED CYCLE PLANT

COMMUNITY QUESTIONNAIRE

DATE:_____ **INTERVIEWER:**_____

LOCATION:_____

Following the revocation of the EWI licence to construct a 360 MW Power Plant, and the awarding to JPS by the Office of Utilities Regulation, The Jamaica Public Service Company (JPS) is proposing to construct a 180-200 MW (Megawatt) combined cycle power plant on the existing Old Harbour facility which has 220 MW of generation and houses major transmission and distribution operation along with a privately owned diesel power plant. The proposed location for this new power plant is on the storage area for the existing 220 MW plant. This proposed project is expected to be undertaken from 2015 to 2017 and is part of the solution to replace aged heavy fuel-oil burning plants. The proposed plant is being designed to use natural gas as the primary gas.

COHORT DESCRIPTION

1. (i) Male (ii) Female

2. Age group (i) < 20 yrs (ii) 20- 29 yrs (iii) 30-39 yrs (iv) 40-49 yrs (v) 50 – 59 yrs (vi) older than 65 yrs

3. Are you a fisher (man/woman) (i) yes (ii) no

4. Not counting you, is anyone in your household a fisher (man/woman) (i) yes (ii) no

5. Are you a fish vendor (i) yes (ii) no

6. Not counting you, is anyone in your household a fish vendor (i) yes (ii) no

7. Are you the head of your household (i) yes (ii) no

   a. **If no** who is the head of the household? (i) father (ii) mother (iii) grandparents (iv) uncle (v) aunt (vi) other_____

8. What is the age of the household head? (i) 18- 25 yrs (ii) 26-33 yrs (iii) 34-41 yrs (iv) 42 – 50 yrs (v) 51 – 60 yrs (vi) older than 60 yrs

9. What is the main employment status of the household head? (If the interviewee is not the head of the household). (i) part time, (ii) seasonal, (iii) full time, (iv) unemployed (v) retired (vi) self employed (v)other _____

10. What is the trade of the household head? _____

11. Do you have a partner/spouse living in the same household? (i) yes (ii) no
    a. If yes what is the trade of the partner? _____

12. How many persons in the household are presently employed? _____

13. Are you currently (i) employed (ii) unemployed (iii) retired

14. If employed do you work (i) part time, (ii) seasonally, (iii) full time (vi) self employed (v) other _____

15. **If employed, what do you do?** _____
    (i) casual labour (ii) semi - skilled (iii) skilled (iv) artisan (v) professional

16. Where do you work? _____

    How far is your work from home? (i) less than a km, (ii) 1- 5km, (iii) 6- 15km (iv) >15km.

PERCEPTION

17. Did you know that the Jamaica Public Service (JPS) owns and operates the Old Harbour Power Station in Old Harbour Bay? (i) yes; (ii) no

18. Did you know that JPS uses fuel oil in the production of electricity? (i) yes; (ii) no

    _____

19. Are you aware that the Office of Utilities Regulation revoked Energy World International's license to construct a 360 MW Power Plant ? (i) yes; (ii) no

20. Are you aware of any plans by the Jamaica Public Service Company to construct a 180-200 MW (Megawatt) combined cycle power plant on to the existing Old Harbour facility ? (i) yes; (ii) no

a. If yes what do you know? _____

_____

21. Do you have any concerns about the project as proposed? (i) yes; (ii) no (iii) not sure

b. If yes what are they? _____

22. Do you think this project will affect your life? (i) positively; (ii) negatively, (iii) not at all (iv) not sure

c. If yes how? _____

23. Do you depend on the proposed location for any type of business/farming/ residence? (i) yes; (ii) no

d. If yes for what purpose and how?

_____

24. Do you know of anyone who depends on the proposed location for any type of business/farming/ residence? (i) yes; (ii) no

e. If yes for what purpose and how?

_____

INCOME

25. What is the average weekly income of the household head?
(i) Below $1000, (ii) $1001 - $2000, (iii) $2001 - $4000, (iv) $4000 - $6000, (v) $6001 - $8000, (vi) Over $8000

26. What is the average weekly income of the partner?
(i) Below $1000, (ii) $1001 - $2000, (iii) $2001 - $4000, (iv) $4000 - $6000, (v) $6001 - $8000, (vi) Over $8000

27. What is the average weekly income of the household? (All sources)
(i) Below $1000, (ii) $1001 - $2000, (iii) $2001 - $4000, (iv) $4000 - $6000, (v) $6001 - $8000, (vi) Over $8000

EDUCATION

28. Does anyone in your household currently attend school? f (i) yes; (ii) no

29. If yes how many persons and what are their ages? _____

Basic [ ] Primary [ ] All Age [ ] Junior High [ ] New Secondary [ ] Secondary High [ ] Comprehensive High [ ] Technical High [ ] Vocational Agricultural [ ] Community College [ ] Teachers College [ ] University [ ] HEART [ ] Other [ ]
_____

Age/ # of Persons	NAME / TYPE OF SCHOOL	DISTANCE FROM HOME (Km)

HOUSING & SOCIAL AMENITIES

30. Approximately how old is the house you are living in?

0 - 5 yrs. [ ] 6 - 11 yrs. [ ] 12 - 17 yrs. [ ] 18 - 24 yrs. [ ] 25 - 30yrs. [ ] Over 30 yrs. [ ]

31. Is the house that you live in (i) rented (ii) owned (iii) leased (iv) other _____

32. How long have you (household) been living here?

0 - 5 yrs. [ ] 6 - 11 yrs. [ ] 12 - 17 yrs. [ ] 18 - 24 yrs. [ ] Over 24 yrs. [ ]

33. Number of bedrooms? _____

34. Do you know of landlines in the community? (i) Yes (ii) No

35. Do you have a telephone? (i) Yes (ii) No

f. If yes which do you have (a) landline (b) cell phone (c) both

NATURAL HAZARDS

36. Do you have any problems with domestic/household water supply (i) yes (ii) no

a. If yes what is the problem? (i) no water at all (ii) no pipes run to the area (iii) irregular water supply (iv) low water pressure (v) other _____

b. If yes how do you cope with the problem (i) collect rain water (ii) buy water (iii) collect water from a spring/river (iv) water truck supplies water (v) other _____

c. How do you store water (i) drums and other containers (ii) underground tank (iii) aboveground tank (iv) other _____

37. Is your community affected by flooding (i) yes; (ii) no
d. If yes how? _____

38. Is the proposed project site affected by flooding (i) Yes (ii) No

e. If yes how? _____

f. How frequently does flooding occur at the proposed site? (i) once per week (ii) once per month (iii) once every 3 months (iv) once every 6 months (v) other _____(how often)

39. How high does the water level rise at the proposed site? (i) less than 0.3m (1ft); (ii) 0.3 – 1.0m (1– 3ft); (iii) 1.0 – 1.5m (3 – 5ft) (iv) greater than 1.5m (5ft)

40. Are there problems with frequent fires at the proposed site? (i) yes (ii) no

g. If yes how frequently does fires occur? (i) once per week (ii) once per month (iii) once every 3 months (iv) once every 6 months (v) other _____(how often)

41. During past hurricanes were you affected by storm surge or sea level rise? (i) Yes (ii) No
If yes give details_____

42. During past hurricanes was the proposed site affected by storm surge or sea level rise? (i) Yes (ii) No
If yes give details _____

SERVICES, COMMUNITY COHESIVENESS & DEVELOPMENT

43. How do you travel? (i) Bus (ii) Personal vehicle (iii) Taxi (iv) Other _____

44. How much do you pay to travel? _____

45. Where do you normally shop for the household? _____

46. Where do you go to market? _____

47. Where do you go for health care when you are sick? _____

Over the past twelve months did you or any member of your household have frequent:
(i) bouts of diarrhoea (ii) coughing (iii) suffocating feelings (iv) congestion (v) chest pains?

If yes how often? _____

48. Are there any church groups in your area? (i) Yes _____(ii) No

49. Are there any environmental groups in your area? (i) Yes _____
(ii) No

50. Are there any other organizations in your area? (i) Yes _____
(ii) No

51. How active are these organizations? _____

52. Are you actively involved in any of these groups? (i) Yes (ii) No (iii) Used to be
_____

RECREATION & CONSERVATION

53. Are there any recreational facilities nearby? (i) Yes (ii) No

54. If yes, name and location of facility _____

55. Are you aware of any historic or cultural areas / sites in your community or nearby?
(i) Yes _____ (ii) No

56. If yes, what do you know about the site? _____

57. Are you aware of any nature reserves in your community or nearby? (i) Yes (ii) No

If yes, where is the site? _____

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

_____

_____

59. Any other comments:

CONTINUE TO THESE QUESTIONS IF THE PERSON IS A FISHER OR FISH VENDOR

60. How long have you been a fisher or fish vendor?
(i) 0 - 5 yrs. (ii) 6 - 11 yrs. (iii) 12 - 17 yrs. (iv) 18 - 24 yrs. (v) 25 - 30yrs. (vi) Over 30 yrs.
61. Where do you fish? _____
62. How has your pound catch/ sale/ yield changed over time? (i) increase (ii) decrease
63. Is there a time/ season when the fish catch/ sale is high? (i) yes (ii) no
    g. If yes explain _____
64. Have you noticed a change in the size and types of fish you catch or sell? (i) yes increase (ii) yes decrease (ii) no change
    h. If yes what do you think is the reason (s)? _____
65. Do you think that the proposed project will affect your business/ trade? (i) positively (ii) negatively (iii) not at all (iv) not sure
    i. Explain _____

Signature: .....
Interviewer

JAMAICA PUBLIC SERVICE COMPANY
360 MW COMBINED CYCLE PLANT

FISHERS QUESTIONNAIRE

DATE:_____ **INTERVIEWER:**_____

LOCATION:_____

Following the revocation of the EWI licence to construct a 360 MW Power Plant, and the awarding to JPS by the Office of Utilities Regulation, The Jamaica Public Service Company (JPS) is proposing to construct a 180-200 MW (Megawatt) combined cycle power plant on the existing Old Harbour facility which has 220 MW of generation and houses major transmission and distribution operation along with a privately owned diesel power plant. The proposed location for this new power plant is on the storage area for the existing 220 MW plant. This proposed project is expected to be undertaken from 2015 to 2017 and is part of the solution to replace aged heavy fuel-oil burning plants. The proposed plant is being designed to use natural gas as the primary gas

COHORT DESCRIPTION

1. (i) Male (ii) Female
2. Age group (i) < 20 yrs (ii) 20- 29 yrs (iii) 30-39 yrs (iv) 40-49 yrs (v) 50 – 59 yrs (vi) older than 65 yrs
3. Are you a fisher (man/woman) (i) yes (ii) no
4. Not counting you, is anyone else in your household a fisher (man/woman) (i) yes (ii) no
   a. If yes how many persons _____
5. Are you a fish vendor (i) yes (ii) no
6. Not counting you is anyone else in your household a fish vendor (i) yes (ii) no
   a. If yes how many persons _____
7. Are you the head of your household (i) yes (ii) no
   a. **If no** who is the head of the household? (i) father (ii) mother (iii) grandparents (iv) uncle (v) aunt (vi) other_____
8. What is the age of the household head? (i) 18- 25 yrs (ii) 26-33 yrs (iii) 34-41 yrs (iv) 42 – 50 yrs (v) 51 – 60 yrs (vi) older than 60 yrs
9. What is the main employment status of the household head? **(If the interviewee is not the head of the household)**. (i) part time, (ii) seasonal, (iii) full time, (iv) unemployed (v) retired (vi) self-employed (v)other _____
10. What is the trade of the household head? _____
11. Do you have a partner/spouse living in the same household? (i) yes (ii) no
    a. If yes what is the trade of the partner? _____
12. How many persons in the household are presently employed? _____
13. Are you currently (i) employed (ii) unemployed (iii) retired
14. If employed do you work (i) part time, (ii) seasonally, (iii) full time (vi) self-employed (v) other _____
15. How long have you been a fisher or fish vendor?
    (i) 0 - 5 yrs. (ii) 6 - 11 yrs. (iii) 12 - 17 yrs. (iv) 18 - 24 yrs. (v) 25 - 30yrs. (vi) Over 30 yrs.
16. Where do you sell fish? _____
17. Where do you fish? _____
18. What do you use for fishing (i) line (ii) spear (iii) net (iv)fish pot (v) other _____
19. What type of vessel do you use for fishing (i) canoe without engine (ii) canoe with engine (iii) large boat with net (trawler) (iv) other _____
    a. If your vessel has an engine how many engines does it have_____ and what is the engine size _____
20. Including you how many persons work on your vessel? _____
    _____
21. Including you does anyone else sell fish with you? (i) yes (ii) no
    a. If yes how many persons _____
22. How many times per week do you sell fish? _____
23. How many times per week do you go fishing? _____
24. What species/ type of fish do you catch? _____
    _____
25. How many pounds of fish do you usually catch ? _____

26. Can you give an y idea of the pound catch for fish you catch? _____

_____

27. How has your pound catch/ sale/ yield changed over time? (i) increase (ii) decrease (iii) no change
28. Is there a time/ season when the fish catch/ sale is high? (i) yes (ii) no
    a. If yes explain _____
29. Have you noticed a change in the size and types of fish you catch or sell? (i) yes increase (ii) yes decrease (ii) no change
    If yes what do you think is the reason (s)? _____
30. What is the average weekly income of fish sales?
    (i) Below $1000, (ii) $1001 - $2000, (iii) $2001 - $4000, (iv) $4000 - $6000, (v) $6001 - $8000, (vi) Over $8000
31. Have you noticed a change in money earned from sales? (i) yes increase (ii) yes decrease (ii) no change
    If yes what do you think is the reason (s)? _____

PERCEPTION

32. Did you know that the Jamaica Public Service (JPS) owns and operates the Old Harbour Power Station in Old Harbour Bay? (i) yes; (ii) no
33. Did you know that JPS uses fuel oil in the production of electricity? (i) yes; (ii) no

    _____
34. Are you aware that the Office of Utilities Regulation revoked Energy World International's license to construct a 360 MW Power Plant ? (i) yes; (ii) no
35. Are you aware of any plans by the Jamaica Public Service Company to construct a 180-200 MW (Megawatt) combined cycle power plant on to the existing Old Harbour facility ? (i) yes; (ii) no
    b. If yes what do you know? _____

    _____
36. Do you have any concerns about the project as proposed? (i) yes; (ii) no (iii) not sure
    c. If yes what are they? _____
37. Do you think this project will affect your life? (i) positively; (ii) negatively, (iii) not at all (iv) not sure
    d. If yes how? _____
38. Do you depend on the proposed location for any type of business/farming/ residence? (i) yes; (ii) no
    e. If yes for what purpose and how?

    _____
39. Do you know of anyone who depends on the proposed location for any type of business/farming/ residence? (i) yes; (ii) no
    f. If yes for what purpose and how?

    _____

40. Is there anything in particular that you would like to tell us?

_____

_____

Any other comments:

Signature: .....
Interviewer

Appendix 9 –Perception Survey Results by Community

BLACKWOOD GARDENS

13.6% of respondents were interviewed in the Blackwood Gardens Community. Of this, 63.6% were male and 36.4% were female. Respondents were of the age cohort 20-29 (36.4%), 30-39 (27.3%), 50-59 (9.1%) and >65 years (27.3%). No one interviewed was in the <20 and 40-49 years cohort. 90.9% of respondents stated that they were not fishers. 90.9% of respondents stated they were not fish vendors. 100% of respondents indicated that no other person in their household was a fisher, or fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay, and were also aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 54.5% of respondents were aware of the revocation while 45.5% indicated they were not aware. 27.3% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. Although, it could not be statistically presented, it was observed that some respondents mistook this current project proposal with that proposed previously. 72.7% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 36.4% of respondents indicated that they had concerns about the project. 63.6% of respondents indicated that they did not have any concerns related to the project. Of the 36.4% of respondents expressing concern about the project 25% were concerned about the project being safe for the area and whether benefits were to be had for the community. 25% expressed concern about possible air pollution. 25% expressed concern regarding whether or not the project would generate employment opportunities and 25% were concerned about how the plant would affect health.

36.4% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities. Of the 18.2% of respondents indicating a negative impact on their lives, all respondents indicated that the project would result in pollution, with 50% anticipating noise pollution and 50% anticipating air pollution which could trigger asthma. 9.1% of respondents did not anticipate an effect on their lives while 36.4% were uncertain about potential effects on their lives. 9.1% of the respondents indicated that they depended on the proposed location for business specifically stating periodic fishing while 90.9% indicated that they did not depend on the proposed location. 9.1% of respondents indicated that they knew of someone who depended on the proposed location for business, specifically for farming. 90.9% of interviewees indicated that they did not know of anyone who depended on the proposed site.

9.1% of those interviewed indicated that they had a problem with domestic water supply, with the problem being low water pressure. During the interviews process it was learnt that the Blackwood

Gardens community was supplied with water by the National Water Commission. 90.9% of respondents indicated that there was no issue with domestic water supply.

27.3% of respondents indicated that their community was affected by flooding while 72.7% stated that it was not. Regarding whether the proposed site was affected by flooding, 9.1% of respondents indicated that the proposed site was affected while 90.9% indicated the site was not. 100% of respondents indicated that the site was not affected by frequent fires.

45.5% of those interviewed indicated that they were affected by storm surge or sea level rise. Respondents indicated that there was flooding in the community and that the drains overflowed. When asked if the proposed site was affected by storm surge or sea level rise, 27.3% of respondents stated that the site was affected. 72.7% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

81.8% of respondents stated that the area had a recreational facility with all respondents naming the Blackwood Gardens Community Centre. 27.3% of respondents indicated the presence of a historic or cultural site in or nearby the area. Of the 27.3% of respondents 66.7% indicated Goat Island as a historic and cultural areas and 33.3% indicated the St. Philip's Anglican Church. 45.5% of interviewees indicated awareness of the presence of any nature reserves, with 40% of these respondents naming Goat Island, 40% naming the fish sanctuary and 20% naming Terminal.

DAGGER BAY

4.9% of respondents were interviewed in the Dagger Bay Community. Of this, 75% were male and 25% were female. Respondents were of the age cohort under 20 years of age (25%), 20-29 (25%), 30-39 (25%) and 50-59 (25%). No one interviewed was in the 40-49 years and over 65 years cohort. 75% of respondents stated that they were not fishers. 100% of respondents stated they were not fish vendors. 25% of respondents indicated that someone else in their household was a fisher while 75% indicated that no other person in their household was a fisher. 50% of respondents indicated that, not including them, someone in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay, and were also aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 25% of respondents were aware of the revocation while 75% indicated they were not aware. None of the respondents interviewed (100%) was aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant.

On the issue of project concerns 50% of respondents indicated that they had concerns about the project. 25% of respondents indicated that they did not have any concerns related to the project while 25% were not sure. Of the 50% of respondents expressing concern about the project 50% were concerned that the proposed plant was too close in proximity to their dwelling while the other 50%

were concerned about how long term exposure to chemicals may affect persons as well as possible sea level rise and its effects on construction.

25% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities. Of the 25% of respondents indicating a negative impact on their lives, all respondents indicated that it may be harmful to inhale emissions. 0.0% of respondents did not anticipate an effect on their lives while 50% were uncertain about potential effects on their lives. 100% of interviewees indicated that they did not depend on the proposed location and further indicated that they did not know of anyone who depended on the proposed site.

25% of those interviewed indicated that they had a problem with domestic water supply, with the problem being that no pipes are run in the area. 75% of respondents indicated that there was no issue with domestic water supply.

75% of respondents indicated that their community was affected by flooding while 25% stated that it was not. It was indicated that flooding in the community occurs in time of hurricane when there are heavy rains and when the tide is high. Regarding whether the proposed site was affected by flooding, 0.0% of respondents indicated that the proposed site was affected while 100% indicated the site was not. 100% of respondents indicated that the site was not affected by frequent fires.

100% of those interviewed indicated that they were affected by storm surge or sea level rise; however no details were provided. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

50% of respondents stated that the area had a recreational facility. Of these respondents 50% named the Blackwood Gardens Community Centre and 50% referred to an open lot in the Dagger Bay Community. 50% of respondents indicated the presence of a historic or cultural site in or nearby the area, with all respondents stating the Goat Islands and 50% of the respondents stating that within the mangroves there still exists brick ruins; this however could not be verified. 75% of interviewees indicated awareness of the presence of any nature reserves and stated the Goat Islands and Fish Sanctuary.

STATION LANE

3.7% of respondents were interviewed in the Station Lane Community. Station Lane is also known as Old Market Street. Of this, 0.0% were male and 100% were female. Respondents were of the age cohort 20-29 (33.3%) and 30-39 (66.7%). No one interviewed was in the <20, 40-49, 50-59, and older than 65 years cohorts. 100% of respondents stated that they were not fishers. 66.7% of respondents stated they were not fish vendors while 33.3% stated that they were. 66.7% of respondents indicated another person in their household was a fisher and 33.3% indicated that no other person in their

household was a fisher. 100% of respondents indicated that no other person in their household was a fish vendor.

66.7% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay while 100% stated that they were aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 33.3% of respondents were aware of the revocation while 66.7% indicated they were not aware. Of respondents interviewed no one was aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant.

On the issue of project concerns 66.7% of respondents indicated that they had concerns about the project. 33.3% of respondents indicated that they did not have any concerns related to the project. Of the 66.7% of respondents expressing concern about the project, 50% were concerned about whether employment opportunities would arise and 50% expressed concern about the community deaths being as a result of the power plant.

33.3% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating direct employment associated with new plan. 33.3% of respondents indicated that they anticipated a negative impact on their lives, with all respondents indicating health issues as a result of the new plant. 33.4% of respondents did not anticipate an effect on their lives. 100% of interviewees indicated that they did not depend or know of anyone who depended on the proposed site for any type of business, residence or farming.

100% of those interviewed indicated that they did not have a problem with domestic water supply.

100% of respondents indicated that their community was affected by flooding, with 33.3% stating that flooding occurred during times of hurricane/storms, 33.3% indicated flooding in times of very heavy rains and 33.4% did not provide details. Regarding whether the proposed site was affected by flooding, 100% of respondents indicated that the proposed site was not affected by flooding. 100% of respondents indicated that the site was not affected by frequent fires.

100% of those interviewed indicated that they were affected by storm surge or sea level rise. Flooding of homes and the community in general was the main issue reported (66.7%). 33.3% did not give details. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

66.7% of respondents stated that the area had a recreational facility. Of the 66.7% indicating the presence of a recreational facility, 100% mentioned the Blackwood Gardens Community Centre. 33.3% of respondents indicated the presence of a historic or cultural site in or nearby the area, specifically naming the Church of England (Anglican Church). 66.7% of interviewees indicated awareness of the presence of any nature reserves, with respondents naming the Goat Islands (50%) and a fish sanctuary (50%). 33.3% of respondents stated that they did not know of any nature reserves, in or nearby their community.

BAY BOTTOM

9.9% of respondents were interviewed in the Bay Bottom Community. Of this, 50.0% were male and 50.0% were female. Respondents were of the age cohort under 20 years (12.5%), 20-29 (12.5%), 30-39 (12.5%), 40-49 (25%), 50-59 (25%) and >65 years (12.5%). 25% of respondents stated that they were fishers while 75% stated that they were not fishers. 100% of respondents stated they were not fish vendors. 12.5% of respondents indicated that another person in their household was a fisher while 87.5% indicated that no other person in their household was a fisher. 12.5% of respondents indicated that another person in their household was a fish vendor while 87.5% indicated that no other person in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay, and were also aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 50.0% of respondents were aware of the revocation while 50.0% indicated they were not aware. 50.0% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. Although, it could not be statistically presented, it was observed that some respondents mistook this current project proposal with that proposed previously. 50.0% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 12.5% of respondents indicated that they had concerns about the project, with all respondents expressing concern about possible health effects and emissions. 75.0% of respondents indicated that they did not have any concerns related to the project. 12.5% of respondents were uncertain about whether or not they were concerned about any aspect of the project as proposed.

25% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with 50.0% of respondents anticipating the creation of employment opportunities and 50% anticipating lower electricity bills. 0.0% of respondents indicated that they expected negative impact on their lives. 37.5% of respondents did not anticipate an effect on their lives while 37.5% were uncertain about potential effects on their lives.

100% of the respondents indicated that they did not depended on the proposed location for business, farming or residence and further indicated that they did not know of anyone who depended on the proposed location for business, farming or residence.

37.5% of those interviewed indicated that they had a problem with domestic water supply, with 33.3% of interviewees stating the problem as low water pressure and 66.7% stating irregular water supply.

87.5% of respondents indicated that their community was affected by flooding further indicating that the community is flooded in times of very heavy rains occurring during rainy months where there is continuous rain for days or during hurricanes. 12.5% of individuals stated that Bay Bottom was not

affected by flooding. Regarding whether the proposed site was affected by flooding, 100% indicated the site was not. 100% of respondents indicated that the site was not affected by frequent fires.

87.5% of those interviewed indicated that they were affected by storm surge or sea level rise. Respondents indicated that there was the overflowing of gullies and drains, flooding of homes and the community at large with water levels reaching between one and two metres. When asked if the proposed site was affected by storm surge or sea level rise, 12.5% of respondents stated that the site was affected, however no details were given. 87.5% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

62.5% of respondents stated that the area had a recreational facility while 37.5% indicated that Bay Bottom had no recreational facility. Of the 62.5% indicating the presence of a recreational facility, all respondents mentioned the Blackwood Gardens Community Centre. 37.5% of respondents indicated the presence of a historic or cultural site in or nearby the area. 33.3% of respondents respectively indicated Goat Island, the Church of England (Anglican Church) and the Burkesfield Area (controlled by Spaniards in the past) as historic or cultural sites. 75% of interviewees indicated awareness of the presence of any nature reserves with 25% indicating that there were not aware. Of the 75.0% indicating awareness of a nature reserve 16.7% stated Old Harbour Bay and 83.3% stated the Goat Islands, with some respondents stating the fish sanctuary and the presence of iguanas on the Goat Islands.

BURKESFIELD MEADOWS

3.7% of respondents were interviewed in the Burkesfield Meadows Community. Of this, 100% were male. Respondents were of the age cohort under 20 years (0.0%), 20-29 (0.0%), 30-39 (0.0%), 40-49 (66.7%), 50-59 (33.3%) and >65 years (0.0%). 66.7% of respondents stated that they were fishers while 33.3% stated that they were not fishers. 100% of respondents stated they were not fish vendors. 100% indicated that no other person in their household was a fisher. 33.3% of respondents indicated that another person in their household was a fish vendor while 66.7% indicated that no other person in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay, and were also aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 100% of respondents were aware of the revocation. 33.3% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. 66.7% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 100% of respondents indicated that they had concerns about the project. 33.3% were concerned about whether or not the project was safe indicating that they object to the project if it is unsafe in any way. 33.3% expressed concern about noise from the JPS plant and 33.4% were concerned about smoke stack emissions as the emissions pose health issues.

33.3% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities which should result in a reduction in crime and idlers on the roads. 33.3% of respondents indicated that they expected negative impact on their lives, with all interviewees indicating negative impact from noise and the "acid smell" from the plant which blows towards the sea. 33.4% of respondents did not anticipate an effect on their lives while 0.0% were uncertain about potential effects on their lives.

100% of the respondents indicated that they did not depended on the proposed location for business, farming or residence and further indicated that they did not know of anyone who depended on the proposed location for business, farming or residence.

33.3% of those interviewed indicated that they had a problem with domestic water supply, with all interviewees stating the problem "green water with morass that is not fit for drinking". It should be noted that during the interview exercise it was learnt that the residents of Burkesfield Meadows are not connected to the National Water Commission's network; instead they receive water from a line run by the Jamaica Public Service. It was learnt further that JPS has advised persons connected to their line that the water is not for drinking purposes.

100% of individuals stated that Burkesfield Meadows was not affected by flooding. Regarding whether the proposed site was affected by flooding, 33.3% indicated that the site was affected by flooding in times of very heavy rains with flood water flowing from the town of Old Harbour via the Bowden Gully; while 66.7% indicated the site was not. 33.3% of interviewees stated that the proposed site was affect by frequent fires stating that in an effort to bush land; fires are set. 66.7% of respondents indicated that the site was not affected by frequent fires.

100% of those interviewed indicated that they were not affected by storm surge or sea level rise. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

100% of respondents stated that the area had a recreational facility. 66.7% mentioned the Blackwood Gardens Community Centre and 33.3% mentioned a park within the Burkesfield Meadows community. 66.7% of respondents indicated the presence of a historic or cultural site in or nearby the area, with the respondents indicating Goat Islands. 100% of interviewees indicated awareness of the presence of any nature reserves. Goat Islands was again stated as a nature reserve. Welcome Beach, Port Esquivel and Galleon Harbour were also stated as nearby nature reserves.

MAIN STREET OLD HARBOUR BAY

7.4% of respondents were interviewed in the Main Street Old Harbour Bay Community. Within the Main Street Area were Panton Town, Thompson Pen and Nurain/Noreign Avenue. Of this 7.4%, 83.3% were male and 16.7% were female. Respondents were of the age cohort under 20 years (0.0%), 20-29 (0.0%), 30-39 (16.7%), 40-49 (33.3%), 50-59 (33.3%) and >65 years (16.7%). 83.3% of respondents stated that they were fishers while 16.7% stated that they were not fishers. 100% of

respondents stated they were not fish vendors. 16.7% indicated that another person in their household was a fisher while 83.3% indicated that no other person in the household was a fisher. 16.7% of respondents indicated that another person in their household was a fish vendor while 83.3% indicated that no other person in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay. 83.3% of interviewees were also aware that JPS uses fuel oil to generate electricity while 16.7% were not aware. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 33.3% of respondents were aware of the revocation the remaining 66.7% were not aware. 50% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. 50% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 16.7% of respondents indicated that they had concerns about the project with all respondents expressing concern about how the proposed project will affect the local fishers. 83.3% of those interviewed expressed no concern.

33.3% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with 50.0% of these respondents anticipating the creation of employment opportunities for family members and 50.0% expecting a reduction in electricity rates. 16.7% of respondents indicated that they expected negative impact on their lives, with all interviewees indicating negative impact on the local fishers. 33.3% of respondents did not anticipate an effect on their lives while 16.7% were uncertain about potential effects on their lives.

83.3% of the respondents indicated that they did not depended on the proposed location for business, farming or residence and further indicated that they did not know of anyone who depended on the proposed location for business, farming or residence. 16.7% of respondents indicated that they depended on the proposed site for fishing and knew of others who also depended on the area for fishing.

16.7% of those interviewed indicated that they had a problem with domestic water supply, with all interviewees stating the problem as low water pressure.

50% of individuals stated that Main Street Old Harbour Bay was affected by flooding, with flooding occurring in times of very heavy rains and hurricane with the yard area being flooded. Regarding whether the proposed site was affected by flooding, 100% indicated the site was not. 100% of respondents indicated that the site was not affected by frequent fires.

33.3% of those interviewed indicated that they were not affected by storm surge or sea level rise while 66.7% indicated that they were affected. 25.0% of respondents did not give details, while 25.0% respectively stated that the area was flooded, hurricane Dean resulted in water levels rising 1.0 - 2.0 metres and water levels in the vicinity of the fishing beach entrance has in past times risen to more than 1.75 metres. When asked if the proposed site was affected by storm surge or sea level rise,

100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

83.3% of respondents stated that the area had a recreational facility, with all persons naming the Blackwood Gardens Community Centre. 16.7% of respondents indicated the presence of a historic or cultural site in or nearby the area, with these respondents indicating the wharf where the East Indians landed. 66.7% of interviewees indicated awareness of the presence of any nature reserves. Goat Islands was again stated as a nature reserve. The fish sanctuary was also stated as a nearby nature reserve.

BUDDHO

7.4% of respondents were interviewed in the Buddho Community. Of this, 33.3% were male and 66.7% were female. Respondents were of the age cohort under 20 years (0.0%), 20-29 (33.3%), 30-39 (016.7%), 40-49 (16.7%), 50-59 (16.7%) and >65 years (16.7%). 16.7% of respondents stated that they were fishers while 83.3% stated that they were not fishers. 100% of respondents stated they were not fish vendors. 50% respectively indicated that another person in the household and no other person in their household was a fisher. 66.7% of respondents indicated that another person in their household was a fish vendor while 33.3% indicated that no other person in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay, and were also aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 50% of respondents were aware of the revocation and 50% were not aware. 16.7% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. 83.3% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 16.7% of respondents indicated that they had concerns about the project. With these concerns relating to how the project will impact health. 83.3% of respondents did not have any concerns.

16.7% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities for family members. 33.3% of respondents indicated that they expected negative impact on their lives, with 50.0% of interviewees indicating negative impact from chimney noise blast which is loud and frightening and 50% indicating negative impact due to vibrations from the plant damaging homes and smoke causing asthma. 33.3% of respondents did not anticipate an effect on their lives while 16.7% were uncertain about potential effects on their lives.

100% of the respondents indicated that they did not depended on the proposed location for business, farming or residence and further indicated that they did not know of anyone who depended on the proposed location for business, farming or residence.

66.7% of those interviewed indicated that they had a problem with domestic water supply, with interviewees stating the problem as low water pressure (75%), no pipes being run in the area (25%) and irregular water supply (25%).

83.3% of individuals stated that Buddho was affected by flooding, with flooding occurring in times of very heavy rains, at which time the drains overflow. Regarding whether the proposed site was affected by flooding, 100% indicated that the site was not affected by flooding. 100% of respondents indicated that the site was not affected by frequent fires.

83.3% of those interviewed indicated that they were affected by storm surge or sea level rise. Respondents indicated that the community flooded in past hurricanes and residents had to evacuate the area. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

83.3% of respondents stated that the area had a recreational facility. 60% mentioned the Blackwood Gardens Community Centre, 20% stated community centre but did not indicate if the centre had a name and 20.0% mentioned the Old Harbour Community Centre. 16.7% of respondents indicated the presence of a historic or cultural site in or nearby the area, with the respondents indicating the Church of England. 33.3% of interviewees indicated awareness of the presence of any nature reserves and named the Old Harbour Bay Fishing Port and a fish sanctuary.

TERMINAL/TERMINAL ROAD

25.9% of respondents were interviewed in the Terminal Community. Of this, 66.7% were male and 33.3% were female. Respondents were of the age cohort under 20 years (9.5%), 20-29 (19.0%), 30-39 (19.0%), 40-49 (14.3%), 50-59 (33.3%) and >65 years (4.8%). 9.5% of respondents stated that they were fishers while 90.5% stated that they were not fishers. 4.8% of respondents stated that they were fisher vendors while 95.2% of respondents stated they were not fish vendors. 14.3% of respondents indicated that another person in their household was a fisher while 85.7% indicated that no other person in their household was a fisher. 19.0% of respondents indicated that another person in their household was a fish vendor while 81.0% indicated that no other person in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay. 90.5% of interviewees were also aware that JPS uses fuel oil to generate electricity while 9.5% were not aware. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 66.7% of respondents were aware of the revocation while 33.3% indicated they were not aware. 57.1% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. Although, it could not be statistically presented, it was observed that some respondents mistook this current project proposal with that proposed previously. 42.9% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 19.0% of respondents indicated that they had concerns about the project. 25% of these respondents did not specify the concern; 25% were concerned about whether or not the new plant would be the same as the existing plant; 25% we concerned about the possible future health effects once the plant is operational and 25% were concerned about the possibility of being employed. 76.2% of respondents indicated that they did not have any concerns related to the project. 4.8% of respondents were uncertain about whether or not they were concerned about any aspect of the project as proposed.

38.1% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities. 9.5% of respondents indicated that they expected negative impact on their lives with all respondents indicating pollution, specifically noise and smoke. 28.6% of respondents did not anticipate an effect on their lives while 23.8% were uncertain about potential effects on their lives.

4.8% of the respondents indicated that they depended on the proposed location for farming, while 95.2% indicated that they did not depend on the lands for any business, farming or residence. 9.5% of interviewees indicated that they knew of someone who depended on the proposed location for farming while 90.5% of respondents indicated that they did not know of anyone who depended on the proposed location for business, farming or residence.

28.6% of those interviewed indicated that they had a problem with domestic water supply, with 16.7% of interviewees stating the problem as low water pressure, 16.3% stating no water at all and 67.0% stating irregular water supply. 71.4% of respondents indicated that they did not have any problems with domestic water supply

52.4% of respondents indicated that their community was affected by flooding. While some respondent did not provide details on flooding other respondents stated that flooding occurred in times of hurricane, times of extremely heavy rains or during flood rains. 47.6% of individuals stated that their community was not affected by flooding. Regarding whether the proposed site was affected by flooding, 14.8% indicated the site was affected while 85.7% indicated the proposed site was not. 100% of respondents indicated that the site was not affected by frequent fires.

33.3% of those interviewed indicated that they were affected by storm surge or sea level rise. Respondents who provided details on how they were affected by storm surge or sea level rise indicated that the sea has in past hurricanes deposited mud on land and that sea level changes resulted in boats being dumped on land. It was also mentioned that water comes up river and on to roadways and that shops and other buildings on the beach were destroyed. When asked if the proposed site was affected by storm surge or sea level rise, 4.8% of respondents stated that the site was affected, however no details were given. 95.2% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

90.5% of respondents stated that the area had a recreational facility while 9.5% indicated that Terminal had no recreational facility. Of the 90.5% indicating the presence of a recreational facility,

77.7% respondents mentioned the Blackwood Gardens Community Centre 22.3% of respondents named the Old Harbour Bay Community Centre. During the interview exercise, some respondents indicated that the community centre located in Blackwood Gardens was to serve the entire Old Harbour Bay area and that the centre was present before the Blackwood Gardens Housing Scheme and was originally the Old Harbour Bay Community Centre. This information however could not be verified. 28.6% of respondents indicated the presence of a historic or cultural site in or nearby the area. 16.7% of interviewees did not provide details, 16.6% of respondents indicated Goat Island, 16.7% indicated Colbeck Castle and 50% the Church of England (Anglican Church) as historic or cultural sites. 61.9% of interviewees indicated awareness of the presence of any nature reserves with 38.1% indicating that there were not aware. Of the 61.9% indicating awareness of a nature reserve 69.2% stated the Goat Islands. 7.7% stated a fish sanctuary, 7.7% stated Century Farm and 15.4% stated Terminal with some respondents (50%) stating the presence of crocodiles.

KELLY PEN

3.7% of respondents were interviewed in the Kelly Pen Community. Of this, 66.7% were male and 33.3% were female. Respondents were of the age cohort under 20 years (0.0%), 20-29 (66.7%), 30-39 (0.0%), 40-49 (0.0%), 50-59 (0.0%) and >65 years (0.0%). 100% of interviewees stated that they were not fishers or fish vendors. 100% of respondents indicated that no other person in their household was a fisher or fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay and were also aware that JPS uses fuel oil to generate electricity. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 33.3% of respondents were aware of the revocation while 66.7% indicated they were not aware. 33.3% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. Although, it could not be statistically presented, it was observed that some respondents mistook this current project proposal with that proposed previously. 66.7% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 100% of respondents indicated that they did not have concerns about the project.

33.3% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities. 0.0% of respondents indicated that they expected negative impact on their lives. 33.3% of respondents did not anticipate an effect on their lives while 33.4% were uncertain about potential effects on their lives.

100% indicated that they did not depend on the lands for any business, farming or residence and further indicated that they did not know of anyone who depended on the proposed location for business, farming or residence.

66.7% of those interviewed indicated that they had a problem with domestic water supply, with all interviewees stating the problem as low water pressure. 33.3% of respondents indicated that they did not have any problems with domestic water supply

100% of individuals stated that their community was not affected by flooding. Regarding whether the proposed site was affected by flooding, 100% indicated the proposed site was not. 100% of respondents indicated that the site was not affected by frequent fires.

100% of those interviewed indicated that they were not affected by storm surge or sea level rise. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

66.7% of respondents stated that the area had a recreational facility with all persons naming the Blackwood Gardens Community Centre. 100% of respondents indicated that they were not aware of the presence of a historic or cultural site in or nearby the area. 100% of interviewees indicated that they were not aware of the presence of any nature reserves within or nearby their community.

SETTLEMENT

16.0% of respondents were interviewed in the Settlement Community. Of this, 61.5% were male and 38.5% were female. Respondents were of the age cohort under 20 years (0.0%), 20-29 (7.7%), 30-39 (15.4%), 40-49 (23.1%), 50-59 (38.5%) and >65 years (15.4%). 100% stated that they were not fishers. 23.1% of respondents stated that they were fisher vendors while 76.9% of respondents stated they were not fish vendors. 15.4% of respondents indicated that another person in their household was a fisher while 84.6% indicated that no other person in their household was a fisher. 15.4% of respondents indicated that another person in their household was a fish vendor while 84.6% indicated that no other person in their household was a fish vendor.

92.3% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay while 7.7% indicated that they were not aware. 84.6% of interviewees were also aware that JPS uses fuel oil to generate electricity while 15.4% were not aware. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 53.8% of respondents were aware of the revocation while 46.2% indicated they were not aware. 30.8% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. Although, it could not be statistically presented, it was observed that some respondents mistook this current project proposal with that proposed previously. 69.2% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 46.2% of respondents indicated that they had concerns about the project. Multiple concerns were stated by some respondents. 33.3% expressed concern about possible health effects; 33.3% expressed concern about pollution of the air and sea; 16.6% were concerned about smoke emissions from chimney damaging callaloo and other crops; 16.7% of respondents were

concerned about whether or not they would be employed and 16.6% were concerned about the need for compensation for Old Harbour Bay. 38.5% of respondents indicated that they did not have any concerns related to the project. 15.3% of respondents were uncertain about whether or not they were concerned about any aspect of the project as proposed.

30.8% of interviewees indicated that they expected a positive effect on their lives as a result of the project, with all respondents anticipating the creation of employment opportunities. 15.4% of respondents indicated that they expected negative impact on their lives with 50% of respondents indicating that pollution of the sea will result in a reduction in fish yield and 50% anticipating that chemicals may affect children or "poison gas" may result in loss of lives as has happened in the past. 30.7% of respondents did not anticipate an effect on their lives while 23.1% were uncertain about potential effects on their lives.

100% indicated that they did not depend on the lands for any business, farming or residence and did not know of anyone who depended on the proposed location for business, farming or residence.

30.8% of those interviewed indicated that they had a problem with domestic water supply, with all interviewees stating irregular water supply. 69.2% of respondents indicated that they did not have any problems with domestic water supply

100% of individuals stated that their community was not affected by flooding. Regarding whether the proposed site was affected by flooding. 100% indicated the proposed site was not. 100% of respondents indicated that the site was not affected by frequent fires.

100% of those interviewed indicated that they were not affected by storm surge or sea level rise. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

53.3% of respondents stated that the area had a recreational facility, with all respondents naming the Blackwood Gardens Community Centre. 23.1% of respondents indicated the presence of a historic or cultural site in or nearby the area. 66.7% the Church of England (Anglican Church) and the Old Harbour Bay Primary as historic or cultural sites as cannons are present at both these sites. 15.4% of interviewees indicated awareness of the presence of any nature reserves with 50% respectively naming the Salt Gully where crocodiles are present and the fish sanctuary.

CROSS ROADS

3.7% of respondents were interviewed in the Cross Roads Community. Of this, 66.7% were male and 33.3% were female. Respondents were of the age cohort under 20 years (0.0%), 20-29 (0.0%), 30-39 (0.0%), 40-49 (33.3%), 50-59 (66.7%) and >65 years (0.0%). 100% of interviewees stated that they were not fishers or fish vendors. 33.3% of respondents indicated that another person in the household was a fisher while 66.7% indicated that no other person was a fisher. 100% of respondents indicated that no other person in their household was a fish vendor.

100% of respondents knew that the JPS owns and operates the Old Harbour Power Station in Old Harbour Bay. 66.7% were aware that JPS uses fuel oil to generate electricity and 33.3% were not aware. Regarding awareness of the Office of Utilities Regulation's revocation of Energy World International's license to construct a 360MW Power Plant, 33.3% of respondents were aware of the revocation while 66.7% indicated they were not aware. 33.3% of respondents interviewed were aware that the Jamaica Public Service Company proposed to construct a 180-200 Megawatt combined cycle power plant on the existing JPS plant. Although, it could not be statistically presented, it was observed that some respondents mistook this current project proposal with that proposed previously. 66.7% of interviewees were not aware of the new proposal to construct the 180 - 200 MW plant.

On the issue of project concerns 33.3% of respondents indicated that they had concerns about the project and 66% indicated that were not certain. Those respondents indicating concern were specifically concerned about the possibility of employment in the area.

0.0% of interviewees indicated that they expected a positive effect on their lives as a result of the project. 33.3% of respondents indicated that they expected negative impact on their lives with all respondents indicating that the proposed project may prove to be harmful. 0.0% of respondents did not anticipate an effect on their lives while 66.7% were uncertain about potential effects on their lives.

100% indicated that they did not depend on the lands for any business, farming or residence and further indicated that they did not know of anyone who depended on the proposed location for business, farming or residence.

66.7% of those interviewed indicated that they had a problem with domestic water supply, with 50% of these interviewees stating the problem as low water pressure. 33.3% of respondents indicated that they did not have any problems with domestic water supply

100% of individuals stated that their community was not affected by flooding. Regarding whether the proposed site was affected by flooding, 100% indicated the proposed site was not. 100% of respondents indicated that the site was not affected by frequent fires.

100% of those interviewed indicated that they were not affected by storm surge or sea level rise. When asked if the proposed site was affected by storm surge or sea level rise, 100% of interviewees indicated that the proposed site was not affected by storm surge or sea level rise.

100% of respondents stated that the area had a recreational facility with 66.7% of persons naming the Blackwood Gardens Community Centre. 100% of respondents indicated that they were not aware of the presence of a historic or cultural site in or nearby the area. 100% of interviewees indicated that they were not aware of the presence of any nature reserves within or nearby their community.

Appendix 10 – Air Dispersion Modelling Met Data

Surface & Upper Air Met Data
AERMET/AERMOD
Preprocessed from MM5 Data

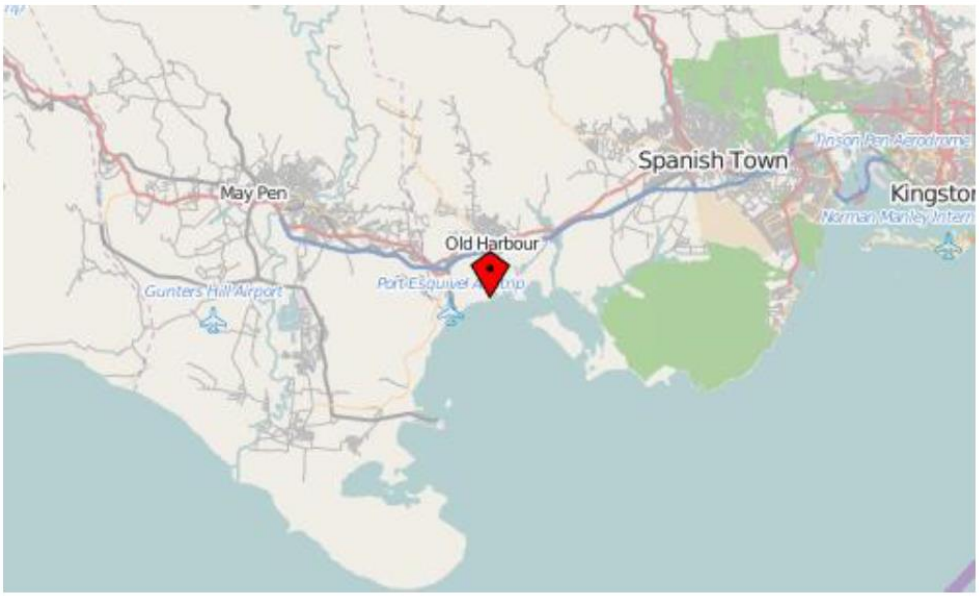
Sep 25, 2014

Met Data Order Information:

Order #:	MET145807
Ordered by:	Stephen Haughton
Company:	Air Quality Consultants Ltd.
Met Data Type:	AERMET-Ready (Surface & Upper Air Data)
Start-End Date:	Jan 01, 2009 - Dec 31, 2013
Latitude:	17.899797 N
Longitude:	77.108269 W
Datum:	WGS 84
Site Time Zone:	UTC/GMT UTC - 5 hour(s)
Closest City & Country:	Spanish Town - Jamaica

Calculated Pseudo Met Station Parameters:

Anemometer Height:	14 m
Station Base Elevation:	47 m
Upper Air Adjustment:	+5 hour(s)



MM5-Processed Grid Cell

- Grid cell centre (Lat, Lon): 17.899797 N, 77.108269 W
- Grid cell dimension: 12 km x 12 km
- Output period: Jan 01, 2009 to Dec 31, 2013
- For more information on MM5 Mesoscale Model, see link below:

  http://www.mmm.ucar.edu/mm5/mm5-home.html

Hourly Surface Met Data (*.sam)

- Format: SAMSON (surface met data for preprocessing by AERMET)
- Anemometer height: 14 meters
- Base elevation above MSL = 47 meters
- Time Zone: UTC/GMT UTC - 5 hour(s) (data reported in local time)
- Output interval: hourly
- File format description: http://www.webmet.com/MetGuide/Samson.html

Column	Parameter	Unit
6	Total cloud cover	tenths
7	Opaque cloud cover	tenths
8	Dry bulb temperature	degrees Celsius (°C)
9	Dew point temperature	degrees Celsius (°C)
10	Relative humidity	Percentage (%)
11	Station pressure	millibars (mb)
12	Wind direction	degrees (deg)
13	Wind speed	meters/second (m/s)
15	Ceiling height	meters (m) 77777 = unlimited ceiling height
21	Hourly precipitation amount	hundredths of inches

Note:

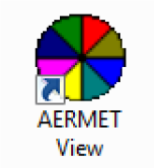
Although not necessary, if the surface file (*.SAM) is opened in a text editor (e.g., Windows NotePad), it may become apparent the file contains numerous 99999 entries in several columns. This is expected as the SAMSON format contains numerous columns which corresponds to parameters that are not used by the current version of the US EPA AERMET model. This does not affect the met data quality and is an artifact generated during MM5 processing to ensure the file is in the correct format for use in AERMET. Rest assured the data needed to support modeling in AERMET is included and not affected by the presence of columns with 99999 data flags.

Upper Air Data (*.ua)

- Format: TD-6201 – Fixed Length (upper air met data for preprocessing by AERMET)
- Data reported in Universal Time Coordinate (UTC) / GMT
- Output interval: 00Z and 12Z
- File format description: http://www.webmet.com/MetGuide/TD6200.html

AERMET View Instructions

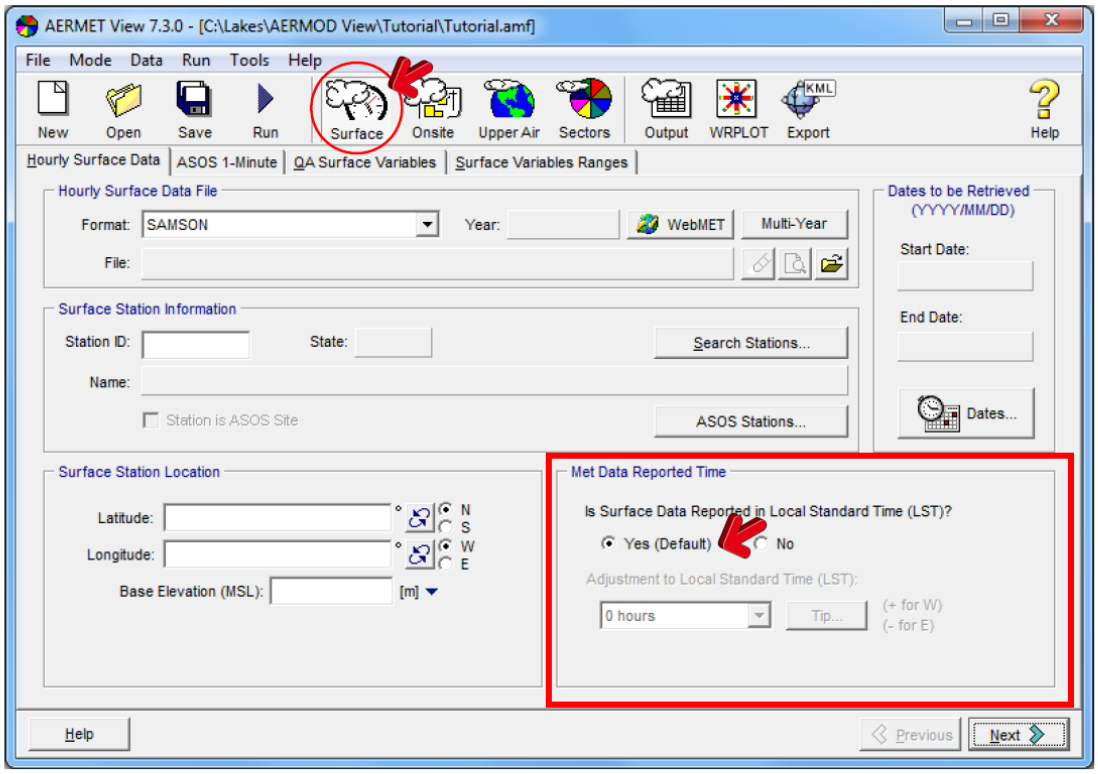
See below some tips on processing your surface (*.sam) and upper air (*.ua) met data files using **AERMET View**.



Hourly Surface Met Data

Since the surface data in SAMSON format (*.sam) is provided in local time, you must specify in AERMET View that the surface data does not need to be adjusted to local time by specifying the following:

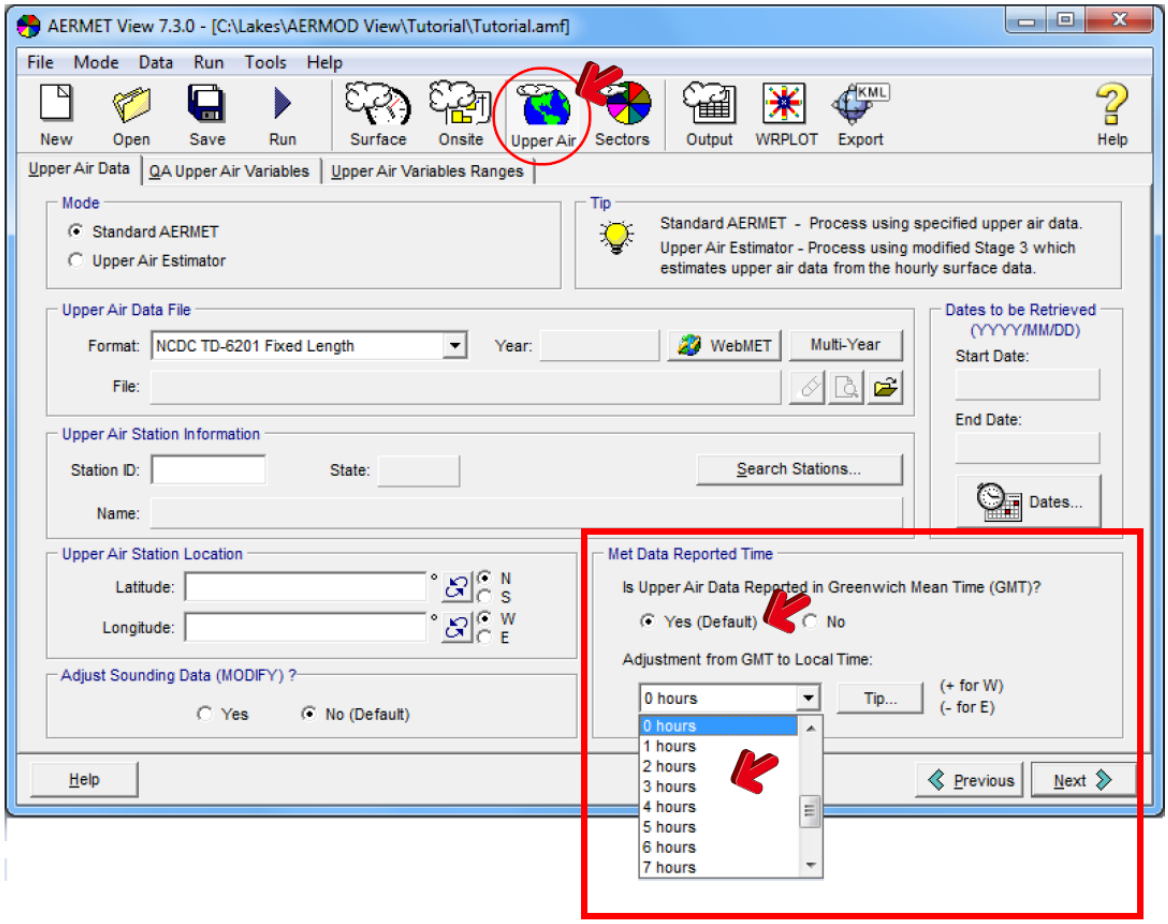
Is Surface Data Reported in Local Standard Time (LST)? Yes (Default)
Adjustment to Local Standard Time (LST): 0 hours



Upper Air Met Data

Since the Upper Air data (*.ua) is provided in UTC/GMT time then you must specify in AERMET View that the data must be adjusted to local time by specifying the following:

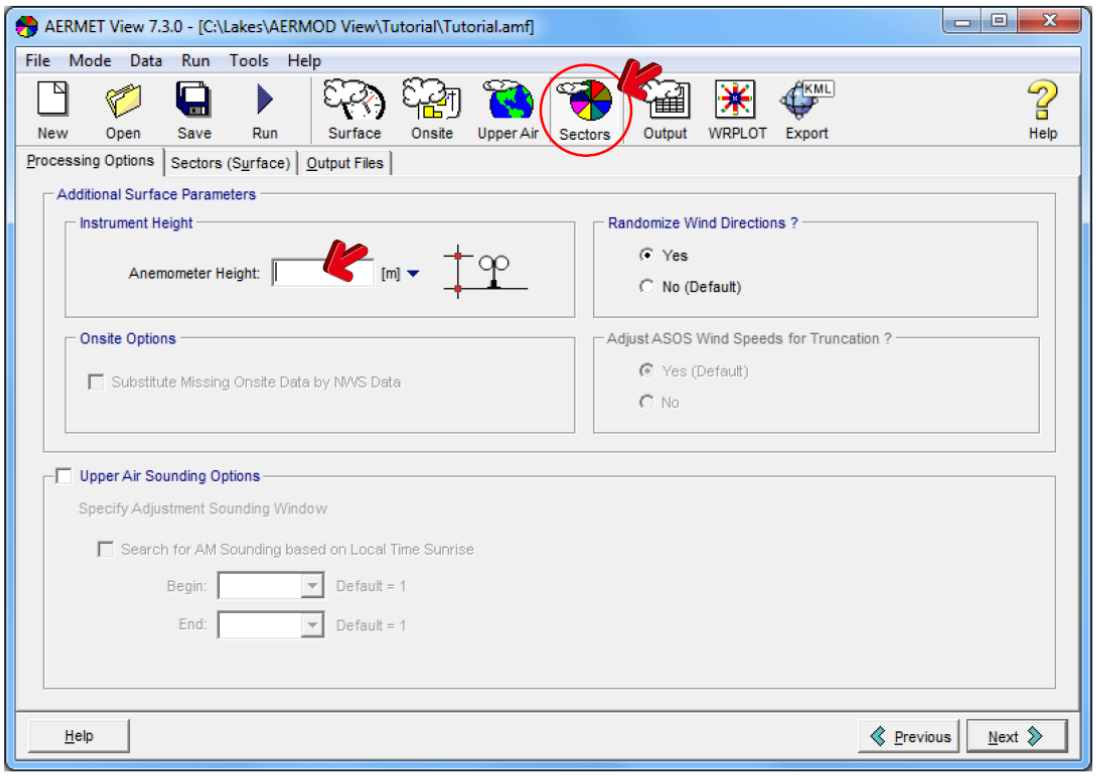
Format: NCDC TD-6201 – Fixed Length
Is Upper Air Reported in Greenwich Mean Time (GMT)? Yes
Adjustment from GMT to Local Time: +5 hour(s)



Application Site Parameters

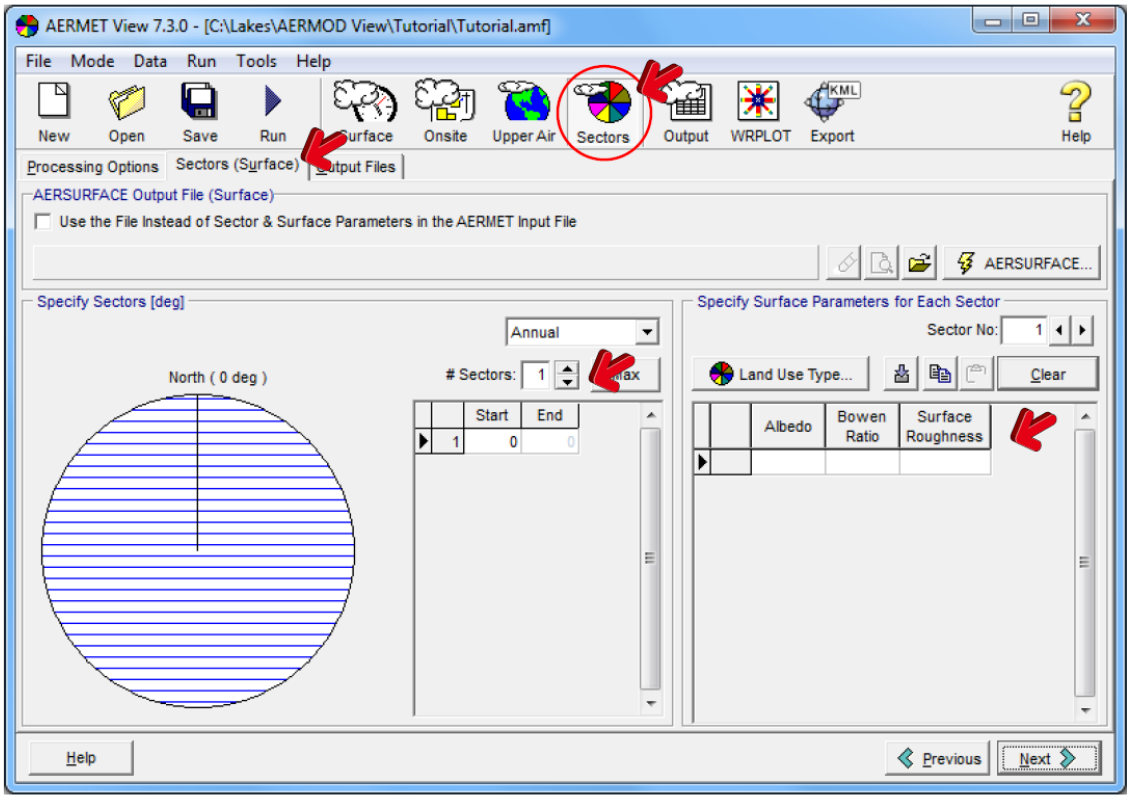
In **AERMET View**, press the **Sectors** menu toolbar button and then under the **Processing Options** tab, specify the following parameter:

Anemometer Height = 14 [m]



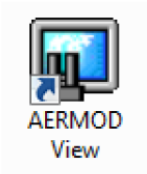
Sectors & Surface Parameters

Under the **Sectors (Surface)** tab, specify the number of sectors and the corresponding surface parameters around the facility you are modeling for.



AERMOD View Instructions

Start your **AERMOD View** project and go to the **Meteorology Pathway – Met Input Data** window.



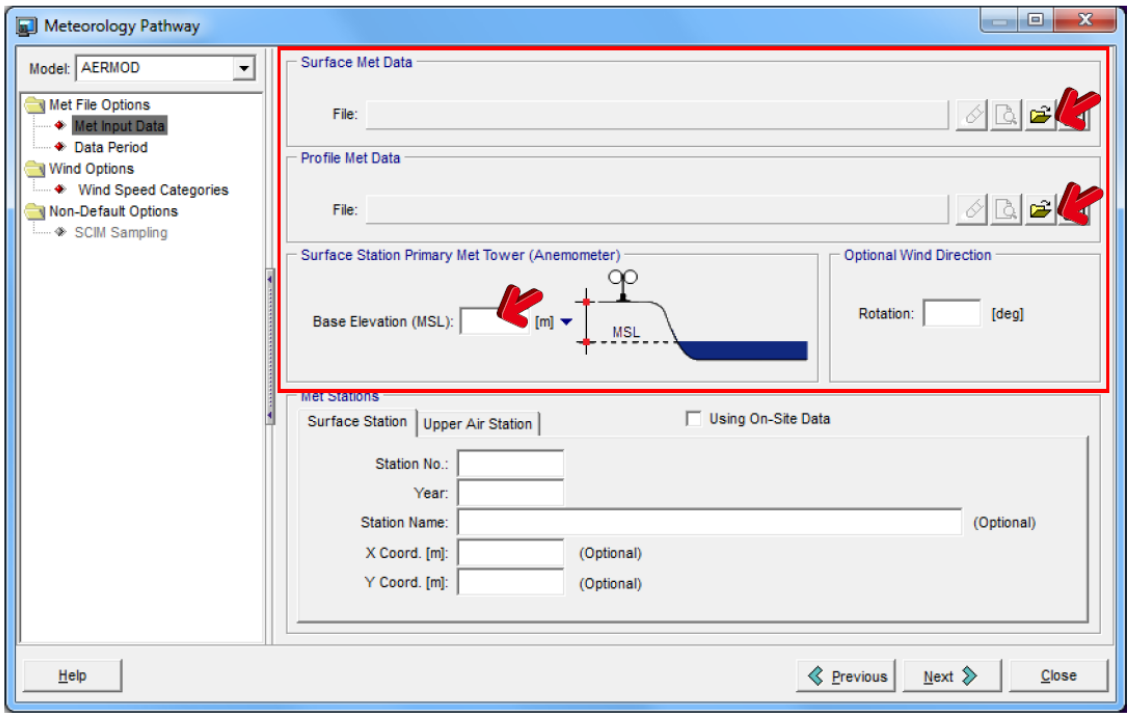
After you preprocess your surface (*.SAM) and upper air (*.UA) met data using **AERMET View**, two (2) meteorological output files will be generated:

1. Surface Met Data (*.SFC)
2. Profile Met Data (*.PFL)

Under the **Meteorology Pathway – Met Input Data** window, specify the Surface Met Data file (*.SFC) and the Profile Met Data file (*.PFL) generated by AERMET.

Under the same window, specify the base elevation for the surface station as:

Base Elevation (MSL) = 47 [m]



Appendix 11 – Study Team

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Appendix 12 – Glossary of Technical Terms

A

ACCRETION
May be either natural or artificial. Natural accretion is the buildup of land, solely by the action of the forces of nature, on a beach by deposition of water – or airborne material. Artificial accretion is a similar buildup of land by reason of an act of man, such as the accretion formed by a GROYNE or BREAKWATER, or beach fill deposited by mechanical means.

ADVECTION
Changes in a sea water property (salinity, temperature, oxygen content, etc.) that takes place in the presence of currents. Also, changes in atmospheric properties in the earth's atmosphere.

ALLUVIAL DEPOSIT
Detrital material which is transported by a river and deposited – usually temporarily – at points along the flood plain of a river. Commonly composed of sands and gravels.

AMPLITUDE, WAVE
(1) The magnitude of the displacement of a wave from a mean value. An ocean wave has an amplitude equal to the vertical distance from still-water level to wave crest. For a sinusoidal wave, the amplitude is one-half the wave height. (2) The semi range of a constituent tide.

B

BACK REEF
Back reefs are shallow water areas that extend from shore to the reef crest, the highest part of the reef that separates the back reef from the fore reef.

BANK
(1) The rising ground bordering a lake, river, or sea; or of a river or channel, for which it is designated as right or left as the observer is facing downstream. (2) An elevation of the sea floor or large area, located on a continental (or island) shelf and over which the depth is relatively shallow but sufficient for safe surface navigation (e.g., Georges Bank); a group of shoals. (3) In its secondary sense, used only with a qualifying word such as "sandbank," "gravelbank," or "spoil bank," a shallow area consisting of shifting forms of silt, sand, mud, and gravel.

BARRIER REEF
A coral REEF parallel to and separated from the coast by a lagoon that is too deep for coral growth. Generally, barrier reefs follow the coasts for long distances and are cut through at irregular intervals by channels or passes. Example: Great Barrier Reef, Queensland, Australia.

BASIN
A depressed area with no surface outlet, such as a lake basin or an enclosed sea.

BATHYMETRY
The measurement of water depths in oceans, seas, and lakes; also information derived from such measurements.

BAY
A recess in the shore or an inlet of a sea between two capes or headlands, not as large as a gulf but larger than a cove. See also BIGHT, EMBAYMENT.

BEACH
The zone of unconsolidated material that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves). The seaward limit of a beach--unless otherwise specified--is the mean low water line. A beach includes foreshore and backshore.

BEACH ACCRETION
See ACCRETION.

BEACH EROSION
The carrying away of beach materials by wave action, tidal currents, littoral currents, or wind.

BEACH FACE
The section of the beach normally exposed to the action of the wave uprush. The FORESHORE of a BEACH. (Not synonymous with SHOREFACE)

BEACH PROFILE
A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or sea wall; extend over the backshore, across the foreshore, and seaward underwater into the NEARSHORE zone.

BED
The bottom of a watercourse, or any body of water.

BENEFITS
The asset value of a scheme, usually measured in terms of the cost of damages avoided by the scheme, or the valuation of perceived amenity or environmental improvements

BENTHIC
Pertaining to the sub-aquatic bottom.

BIGHT
A bend in a coastline forming an open BAY. A BAY formed by such a bend.

BIOLOGICAL OXYGEN DEMAND (BOD)
The amount of oxygen taken up by aerobic microbes that decompose organic matter in a unit volume of water over a given time. It is used as a measure of the degree of organic pollution of water. The more organic matter the water contains, the more oxygen is used by microorganisms.

BOTTOM (nature of)
The composition or character of the bed of an ocean or other body of water (e.g., clay, coral, gravel, mud, ooze, pebbles, rock, shell, shingle, hard, or soft).

BREAKING
Reduction in wave energy and height in the surf zone due to limited water depth

C

CALCAREOUS
Containing calcium carbonate ($CaCO_3$), chiefly as the minerals calcite and aragonite. When applied to rock, it implies that as much as 50 percent of the rock is carbonate (e.g., calcareous sand).

CHANNEL
(1) A natural or artificial waterway of perceptible extent which either periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. (2) The part of a body of water deep enough to be used for navigation through an area otherwise too shallow for navigation. (3) A large strait, as the English Channel. (4) The deepest part of a stream, bay, or strait through which the main volume or current of water flows.

CHART DATUM
The plane or level to which soundings (or elevations) or tide heights are referenced (usually LOW WATER DATUM). The surface is called a tidal datum when referred to a certain phase of tide. To provide a safety factor for navigation, some level lower than MEAN SEA LEVEL is generally selected for hydrographic charts, such as MEAN LOW WATER or MEAN LOWER LOW WATER. See DATUM PLANE.

CHLOROPHYLL A
A type of chlorophyll that is most common and predominant in all oxygen-evolving photosynthetic organisms such as higher plants, red and green algae. It is best at absorbing wavelength in the 400-450 nm and 650-700 nm of the electromagnetic spectrum.

CHOPPY SEA
Short, rough waves tumbling with a short and quick motion. Short-crested waves that may spring up quickly in a moderate breeze, and break easily at the crest.

CLAY
A fine grained, plastic, sediment with a typical grain size less than 0.004 mm. Possesses electromagnetic properties which bind the grains together to give a bulk strength or cohesion. See SOIL CLASSIFICATION.

CLIMATE
The characteristic weather of a region, particularly regarding temperature and precipitation, averaged over some significant internal of time (years).

CLOSURE DEPTH
The water depth beyond which repetitive profile or topographic surveys (collected over several years) do not detect vertical sea bed changes, generally considered the seaward limit of littoral transport. The depth can be determined from repeated cross-shore profile surveys or estimated using formulas based on wave statistics. Note that this does not imply the lack of sediment motion beyond this depth.

COAST
(1) A strip of land of indefinite width (may be several kilometres) that extends from the SHORELINE inland to the first major change in terrain features. (2) The part of a country regarded as near the coast.

COASTAL AREA
The land and sea area bordering the SHORELINE.

COASTAL ZONE
The coastal zone may be simply defined as that transitional area between the land and sea. The coastal zone includes beaches and wetlands. Jamaica's coastal zone has important infrastructure including our ports, airports, oil refinery, road and electricity networks, and many towns and cities. It also includes important tourism related infrastructure (hotels and attractions). Coastal wetlands are valuable habitats for fish and other marine life. Coastal zones provide a buffer from flooding due to storm surges due to hurricanes.[34]

COASTLINE
(1) Technically, the line that forms the boundary between the coast and the shore. (2) Commonly, the line that forms the boundary between the land and the water, esp. the water of a sea or ocean. The SHORELINE.

COHESIVE SEDIMENT
Sediment containing significant proportion of clays, the electromagnetic properties of which cause the sediment to bind together.

CONSOLIDATION
The gradual, slow compression of a cohesive soil due to weight acting on it, which occurs as water is driven out of the voids in the soil. Consolidation only occurs in clays or other soils of low permeability.

CONTINENTAL SHELF
(1) The zone bordering a continent extending from the line of permanent immersion to the depth, usually about 100 m to 200 m, where there is a marked or rather steep descent toward the great depths of the ocean. (2) The area under active littoral processes during the HOLOCENE period. (3) The

[34] http://myspot.mona.uwi.edu/physics/sites/default/files/physics/uploads/02_CCAndCoastal%20Zones2.pdf

region of the oceanic bottom that extends outward from the shoreline with an average slope of less than 1:100, to a line where the gradient begins to exceed 1:40 (the CONTINENTAL SLOPE).

CONTOUR
A line on a map or chart representing points of equal elevation with relation to a DATUM. It is called an ISOBATH when connecting points of equal depth below a datum. Also called DEPTH CONTOUR.

CORAL
Corals are marine invertebrates in class Anthozoa of phylum Cnidaria typically living in compact colonies of many identical individual "polyps". The group includes the important reef builders that inhabit tropical oceans and secrete calcium carbonate to form a hard skeleton.

CORAL REEF
A coral-algal mound or ridge of in-place coral colonies and skeletal fragments, carbonate sand, and organically-secreted calcium carbonate. A coral reef is built up around a wave-resistant framework, usually of older coral colonies.

CORIOLIS EFFECT
Force due to the Earth's rotation, capable of generating currents. It causes moving bodies to be deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The "force" is proportional to the speed and latitude of the moving object. It is zero at the equator and maximum at the poles.

CPCe (Coral Point Count with Excel extensions)
A visual basic software program for the determination of coral and substrate coverage using random point counts.

CROSS-SHORE
Perpendicular to the SHORELINE

CURRENT
(1) The flowing of water, or other liquid or gas. (2) That portion of a stream of water which is moving with a velocity much greater than the average or in which the progress of the water is principally concentrated. (3) Ocean currents can be classified in a number of different ways. Some important types include the following: (1) Periodic - due to the effect of the tides; such Currents may be rotating rather than having a simple back and forth motion. The currents accompanying tides are known as tidal currents; (2) Temporary - due to seasonal winds; (3) Permanent or ocean - constitute a part of the general ocean circulation. The term DRIFT CURRENT is often applied to a slow broad movement of the oceanic water; (4) Nearshore - caused principally by waves breaking along a shore.

CYCLONE
A system of winds that rotates about a center of low atmospheric pressure. Rotation is clockwise in the Southern Hemisphere and anti-clockwise in the Northern Hemisphere. In the Indian Ocean, the term refers to the powerful storms called HURRICANES in the Atlantic.

D

DATUM
Any permanent line, plane or surface used as a reference datum to which elevations are referred.

DATUM, CHART
See CHART DATUM.

DECIBELS (dB)
Is a dimensionless unit used to report sound pressure level (SPL or Lp). Decibels are used to represent the wide pressure range a human ear can detect. It is a logarithmic scale is used to report sound pressures.

DEEP WATER
Water so deep that surface waves are little affected by the ocean bottom. Generally, water deeper than one-half the surface wavelength is considered deep water. Compare SHALLOW WATER.

DEEP WATER WAVES
A wave in water the depth of which is greater than one-half the WAVE LENGTH

DEGRADATION
The geologic process by means of which various parts of the surface of the earth are worn away and their general level lowered, by the action of wind and water.

DELTA
(1) An ALLUVIAL DEPOSIT, usually triangular or semi-circular, at the mouth of a river or stream. The delta is normally built up only where there is no tidal or current action capable of removing the sediment at the same rate as it is deposited, and hence the delta builds forward from the coastline. (2) A TIDAL DELTA is a similar deposit at the mouth of a tidal INLET, the result of TIDAL CURRENTS that flow in and out of the inlet.

DENSITY
Mass (in kg) per unit of volume of a substance; kg/m3. For pure water, the density is 1000 kg/m3, for seawater the density is usually more. Density increases with increasing salinity, and decreases with increasing temperature. More information can be found in "properties of seawater". For stone and sand, usually a density of 2600 kg/m3 is assumed. Concrete is less dense, in the order of 2400 kg/m3. Some types of basalt may reach 2800 kg/m3. For sand, including the voids, one may use 1600 kg/m3, while mud often has a density of 1100 - 1200 kg/m3.

DEPENDENCY RATIOS
It is the portion of a population which is composed of dependents (people who are too young or too old to work). The dependency ratio is equal to the number of individuals aged below 15 or above 64 divided by the number of individuals aged 15 to 64, expressed as a percentage.

DEPRESSION
A general term signifying any depressed or lower area in the ocean floor.

DEPTH
The vertical distance from a specified datum to the sea floor.

DISCHARGE
The volume of water per unit of time flowing along a pipe or channel.

DISPERSION
Pattern of geographic distribution of individuals within a species. (2) Distortion of the shape of a seismic wave train or ocean wave train because of variations of velocity with frequency.

DIURNAL
Having a period or cycle of approximately one TIDAL DAY

DREDGING
The practice of excavating or displacing the bottom or shoreline of a water body. Dredging can be accomplished with mechanical or hydraulic machines. Most is done to maintain channel depths or berths for navigational purposes; other dredging is for shellfish harvesting, for cleanup of polluted sediments, and for placement of sand on beaches.

DUNES
(1) Ridges or mounds of loose, wind-blown material, usually sand. (2) Bed forms smaller than bars but larger than ripples that are out of phase with any water-surface gravity waves associated with them.

DURATION
In wave forecasting, the length of time the wind blows in nearly the same direction over the FETCH (generating area).

DURATION, MINIMUM
The time necessary for steady-state wave conditions to develop for a given wind velocity over a given fetch length.

E

ECHO SOUNDER
An electronic instrument used to determine the depth of water by measuring the time interval between the emission of a sonic or ultrasonic signal and the return of its echo from the bottom.

ECOSYSTEM
The living organisms and the nonliving environment interacting in a given area, encompassing the relationships between biological, geochemical, and geophysical systems.

ELEVATION
The vertical distance from mean sea level or other established datum plane to a point on the earth's surface; height above sea level. Although sea floor elevation below msl should be marked as a negative value, many charts show positive numerals for water depth.

ENTRANCE
The avenue of access or opening to a navigable channel or inlet.

EROSION
The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation.

F

FAECAL COLIFORM
A group of bacteria normally present in large numbers in the intestinal tracts of humans and other warm-blooded animals. Frequently used as an indicator of sewage pollution.

FAUNA
The entire group of animals found in an area.

FETCH
The area in which SEAS are generated by a wind having a fairly constant direction and speed. Sometimes used synonymously with FETCH LENGTH.

FETCH LENGTH
The horizontal distance (in the direction of the wind) over which a wind generates seas or creates a WIND SETUP.

FETCH-LIMITED
Situation in which wave energy (or wave height) is limited by the size of the wave generation area (fetch).

FILTER
Intermediate layer, preventing fine materials of an underlayer from being washed through the voids of an upper layer.

FLOOD
(1) Period when tide level is rising; often taken to mean the flood current which occurs during this period (2) A flow beyond the carrying capacity of a channel.

FLORA
The entire group of plants found in an area.

FLUVIAL
Of or pertaining to rivers; produced by the action of a river or stream (e.g.,fluvial sediment).

FORESHORE
The part of the shore, lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the ordinary low-water mark, that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall. See BEACH FACE.

FORE REEF
The fore-reef is found on the oceanic side of the reef crest. It slopes downwards, sometimes to great depths. This is where coral diversity of highest.

FRINGING REEF
A coral REEF attached directly to an insular or continental shore. There may be a shallow channel or lagoon between the reef and the adjacent mainland.

G

GAUGE (GAGE)
Instrument for measuring the water level relative to a datum or for measuring other parameters

GEOGRAPHICAL INFORMATION SYSTEM (GIS)
Database of information which is geographically referenced, usually with an associated visualization system.

GEOMORPHOLOGY
(1) That branch of physical geography which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc. (2) The investigation of the history of geologic changes through the interpretation of topographic forms.

GDP
Gross domestic product is the market value of all officially recognized final goods and services produced within a country in a given period of time (normally a year).

GLOBAL POSITIONING SYSTEM (GPS)
A navigational and positioning system developed by the U.S. Department of Defense, by which the location of a position on or above the Earth can be determined by a special receiver at that point interpreting signals received simultaneously from several of a constellation of special satellites.

GRADIENT
(1) A measure of slope (soil- or water-surface) in meters of rise or fall per meter of horizontal distance. (2) More general, a change of a value per unit of distance, e.g. the gradient in longshore transport causes erosion or accretion. (3) With reference to winds or currents, the rate of increase or decrease in speed, usually in the vertical; or the curve that represents this rate.

GRADING
Distribution, with regard to size or weight, of individual stones within a bulk volume; heavy, light and fine grading are distinguished.

GRAVEL
Unconsolidated natural accumulation of rounded rock fragments coarser than sand but finer than pebbles (2-4 mm diameter).

H

HACH HYDROLAB DATASONDE-5
A tethered device used to measure various water quality parameters.

HARBOUR
Any protected water area affording a place of safety for vessels. See also PORT. A harbor may be natural or man-made.

HERTZ (Hz)
The time that it takes for a vibrating particle to complete one vibration is known as the time period. The number of vibrations (pressure variations) per second is called the frequency of the sound, and is measured in Hertz (Hz). The frequency of a sound produces its distinctive tone. Thus, the rumble of distant thunder has a low frequency, while a whistle has a high frequency.

HIGH TIDE, HIGH WATER (HW)
The maximum elevation reached by each rising tide. See TIDE.

HIGH WATER (HW)
Maximum height reached by a rising tide. The height may be solely due to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. Nontechnically, also called the HIGH TIDE.

HIGH WATER LINE
In strictness, the intersection of the plane of mean high water with the shore. The shoreline delineated on the nautical charts of the National Ocean Service is an approximation of the high water line. For specific occurrences, the highest elevation on the shore reached during a storm or rising tide, including meteorological effects.

HIGH WATER MARK
A reference mark on a structure or natural object, indicating the maximum stage of tide or flood.

HINDCASTING
In wave prediction, the retrospective forecasting of waves using measured wind information.

HISTORIC EVENT ANALYSIS

Extreme analysis based on hindcasting typically ten events over a period of 100 years.

HURRICANE
An intense tropical cyclone in which winds tend to spiral inward toward a core of low pressure, with maximum surface wind velocities that equal or exceed 33.5 m/sec (75 mph or 65 knots) for several minutes or longer at some points. TROPICAL STORM is the term applied if maximum winds are less than 33.5 m/sec but greater than a whole gale (63 mph or 55 knots). Term is used in the Atlantic, Gulf of Mexico, and eastern Pacific.

HURRICANE PATH or TRACK
Line of movement (propagation) of the eye through an area.

HYDROGRAPHY
(1) The description and study of seas, lakes, rivers and other waters. (2) The science of locating aids and dangers to navigation. (3) The description of physical properties of the waters of a region.

I

INCIDENT WAVE
Wave moving landward.

INLET
(1) A short, narrow waterway connecting a bay, lagoon, or similar body of water with a large parent body of water.

(2) An arm of the sea (or other body of water) that is long compared to its width and may extend a considerable distance inland.

IRREGULAR WAVES
Waves with random wave periods (and in practice, also heights), which are typical for natural wind-induced waves.

J

JONSWAP SPECTRUM
Wave spectrum typical of growing deep water waves developed from field experiments and measurements of waves and wave spectra in the Joint North Sea Wave Project.

K

KNOT
The unit of speed used in navigation equal to 1 nautical mile (6,076.115 ft or 1,852 m) per hour.

L

LANDMARK
A conspicuous object, natural or artificial, located near or on land, which aids in fixing the position of an observer.

LEEWARD
The direction toward which the wind is blowing; the direction toward which waves are traveling.

LENGTH OF WAVE
The horizontal distance between similar points on two successive waves measured perpendicularly to the crest.

LITTORAL
Of or pertaining to a shore, especially of the sea. Often used as a general term for the coastal zone influenced by wave action, or, more specifically, the shore zone between the high and low water marks.

LITTORAL DRIFT, LITTORAL TRANSPORT
The movement of beach material in the littoral zone by waves and currents. Includes movement parallel (long shore drift) and sometimes also perpendicular (cross-shore transport) to the shore

LOAD
The quantity of sediment transported by a current. It includes the suspended load of small particles and the BED LOAD of large particles that move along the bottom.

LONGSHORE
Parallel to and near the shoreline; ALONGSHORE.

LOW TIDE (LOW WATER, LW)
The minimum elevation reached by each falling tide. See TIDE.

LOW WATER (LW)
The minimum height reached by each falling tide. Nontechnically, also called LOW TIDE.

LOW WATER LINE
The line where the established LOW WATER DATUM intersects the shore. The plane of reference that constitutes the LOW WATER DATUM differs in different regions.

LUGOL'S PRESERVE
A solution of elemental iodine and potassium iodide in water.

M

MANGROVE
A tree or shrub which grows in tidal, chiefly tropical, coastal swamps, having numerous tangled roots that grow above ground and form dense thickets.

MARKER, REFERENCE
A mark of permanent character close to a survey station, to which it is related by an accurately measured distance and azimuth (or bearing).

MARKER, SURVEY
An object placed at the site of a station to identify the surveyed location of that station.

MEAN DEPTH
The average DEPTH of the water area between the still water level and the SHOREFACE profile from the waterline to any chosen distance seaward.

MEAN HIGH WATER (MHW)
The average height of the high waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value. All high water heights are included in the average where the type of tide is either semidiurnal or mixed. Only the higher high water heights are included in the average where the type of tide is diurnal. So determined, mean high water in the latter case is the same as mean higher high water.

MEAN SEA LEVEL
The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings. Not necessarily equal to MEAN TIDE LEVEL. It is also the average water level that would exist in the absence of tides.

MEAN TIDE LEVEL
A plane midway between MEAN HIGH WATER and MEAN LOW WATER. Not necessarily equal to MEAN SEA LEVEL.

MEAN WAVE HEIGHT
The mean of all individual waves in an observation interval of approximately half an hour. In case of a Rayleigh-distribution 63% of the significant wave height.

MEDIAN DIAMETER
The diameter which marks the division of a given sand sample into two equal parts by weight, one part containing all grains larger than that diameter and the other part containing all grains smaller.

MINIMUM DURATION
See DURATION, MINIMUM.

MINIMUM FETCH
The least distance in which steady-state wave conditions will develop for a wind of given speed blowing a given duration of time.

MORPHOLOGY
River/estuary/lake/seabed form and its change with time.

MOUTH
Entrance to an inland water body (e.g., river).

MUD
A fluid-to-plastic mixture of finely divided particles of solid material and water.

N

NEARSHORE
(1) In beach terminology an indefinite zone extending seaward from the SHORELINE well beyond the BREAKER ZONE. (2) The zone which extends from the swash zone to the position marking the start of the offshore zone, typically at water depths of the order of 20 m.

NISKIN
Device used to collect water samples at discrete depths in the water column.

NOISE
Noise is unwanted sound without agreeable musical quality. It is unwanted /undesired sound or sound in the wrong place at the wrong time. It is considered a pollutant and can be measured.

NUMERICAL MODELLING
Refers to analysis of coastal processes using computational models.

O

OCEANOGRAPHY
The study of the sea, embracing and indicating all knowledge pertaining to the sea's physical boundaries, the chemistry and physics of seawater, marine biology, and marine geology.

OFFSHORE
(1) In beach terminology, the comparatively flat zone of variable width, extending from the SHOREFACE to the edge of the CONTINENTAL SHELF. It is continually submerged. (2) The direction seaward from the shore. (3) The zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the sea bed on wave action is small in comparison with the effect of wind. (4) The breaker zone directly seaward of the low tide line.

OFFSHORE CURRENT
(1) Any current in the offshore zone. (2) Any current flowing away from shore.

ONSHORE
A direction landward from the sea.

OSCILLATION
(1) A periodic motion backward and forward. (2) Vibration or variance above and below a mean value.

OUTCROP
A surface exposure of bare rock, not covered by soil or vegetation.

OUTFALL
A structure extending into a body of water for the purpose of discharging sewage, storm runoff, or cooling water.

P

PARTICLE VELOCITY
The velocity induced by wave motion with which a specific particle moves within a wave.

PEAK PERIOD
The wave period determined by the inverse of the frequency at which the wave energy spectrum reaches its maximum.

PERCOLATION
The process by which water flows through the interstices of a sediment. Specifically, in wave phenomena, the process by which wave action forces water through the interstices of the bottom sediment and which tends to reduce wave heights.

PHASE
In surface wave motion, a point in the period to which the wave motion has advanced with respect to a given initial reference point.

PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR)
The amount of light available for photosynthesis, which is light in the 400 to 700 nanometer wavelength range.

PHYTOPLANKTON
Microscopic plant-like organisms that inhabit oceans and bodies of freshwater requiring sunlight in order to live and grow.

PIER
A structure, usually of open construction, extending out into the water from the shore, to serve as a landing place, recreational facility, etc., rather than to afford coastal protection or affect the movement of water. In the Great Lakes, a term sometimes improperly applied to jetties.

PM 10
These are airborne particles that fall between 2.5 and 10 micrometers in diameter. They are considered coarse particles which are generated from sources such as crushing or grinding operations, and dust stirred up by vehicles traveling on roads.

PM 2.5
These are airborne particles that have diameters below 2.5 micrometres. Sources of these fine particles include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

POPULATION DENSITY
The number of persons per square kilometre or acre of land area.

PROBABILITY
The chance that a prescribed event will occur, represented by a number (p) in the range 0 - 1. It can be estimated empirically from the relative frequency (i.e. the number of times the particular event occurs, divided by the total count of all events in the class considered).

PROPAGATION OF WAVES
The transmission of waves through water.

PROPAGULE
A vegetative structure that can become detached from a plant and give rise to a new plant, e.g. a bud, sucker, or spore.

R

REEF
An offshore consolidated rock hazard to navigation, with a least depth of about 20 meters (10 fathoms) or less. Often refers to coral FRINGING REEFS in tropical waters

REEF, BARRIER
See BARRIER REEF.

REEF BREAKWATER
Rubble mound of single-sized stones with a crest at or below sea level which is allowed to be (re)shaped by the waves.

REEF CREST
The reef crest is found between the back reef and the fore-reef, and ths is the area of the reef with the highest wave action.

REFRACTION (of water waves)
(1) The process by which the direction of a wave moving in shallow water at an angle to the contours is changed: the part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours. (2) The bending of wave crests by currents.

REGULAR WAVES
Waves with a single height, period, and direction.

RETURN PERIOD
Average period of time between occurrences of a given event.

ROCK
(1) An aggregate of one or more minerals; or a body of undifferentiated mineral matter (e.g., obsidian). The three classes of rocks are: (a) Igneous – crystalline rocks formed from molten material. Examples are granite and basalt. (b) Sedimentary – resulting from the consolidation of loose sediment that has accumulated in layers. Examples are sandstone, shale and limestone. (c) Metamorphic – formed from preexisting rock as a result of burial, heat, and pressure. (2) A rocky mass lying at or near the surface of the water or along a jagged coastline, especially where dangerous to shipping.

S

SALINITY
Number of grams of salt per thousand grams of sea water, usually expressed in parts per thousand (symbol: ‰).

SAND
Sediment particles, often largely composed of quartz, with a diameter of between 0.062 mm and 2 mm, generally classified as fine, medium, coarse or very coarse. Beach sand may sometimes be composed of organic sediments such as calcareous reef debris or shell fragments.

SEA
(1) A large body of salt water, second in rank to an ocean, more or less landlocked and generally part of, or connected with, an ocean or a larger sea. Examples: Mediterranean Sea; South China Sea. (2) Waves caused by wind at the place and time of observation. (3) State of the ocean or lake surface, in regard to waves.

SEA GRASS
Members of marine seed plants that grow chiefly on sand or sand-mud bottom. They are most abundant in water less than 9 m deep. The common types are: Turtle grass (Thallasia), Manatee grass (Syringodium) and Eel grass (Zostera).

SEA LEVEL
See MEAN SEA LEVEL.

SEA LEVEL RISE
The long-term trend in MEAN SEA LEVEL.

SEDIMENT
(1) Loose, fragments of rocks, minerals or organic material which are transported from their source for varying distances and deposited by air, wind, ice and water. Other sediments are precipitated from the overlying water or form chemically, in place. Sediment includes all the unconsolidated materials on the sea floor. (2) The fine grained material deposited by water or wind.

SETBACK
A required open space, specified in shoreline master programs, measured horizontally upland from a perpendicular to the ordinary high water mark.

SETUP, WAVE
Super elevation of the water surface over normal surge elevation due to onshore mass transport of the water by wave action alone.

SETUP, WIND
See WIND SETUP.

SHALLOW WATER
(1) Commonly, water of such a depth that surface waves are noticeably affected by bottom topography. It is customary to consider water of depths less than one-half the surface wavelength as shallow water. See TRANSITIONAL ZONE and DEEP WATER. (2) More strictly, in hydrodynamics with regard to progressive gravity waves, water in which the depth is less than 1/25 the wavelength.

SHOALING
Decrease in water depth. The transformation of wave profile as they propagate inshore.

SHORE
The narrow strip of land in immediate contact with the sea, including the zone between high and low water lines. A shore of unconsolidated material is usually called a BEACH. Also used in a general sense to mean the coastal area (e.g., to live at the shore). Also sometimes known as the LITTORAL.

SHOREFACE
The narrow zone seaward from the low tide SHORELINE, covered by water, over which the beach sands and gravels actively oscillate with changing wave conditions.

SHORELINE
The intersection of a specified plane of water with the shore or beach (e.g., the high water shoreline would be the intersection of the plane of mean high water with the shore or beach). The line delineating the shoreline on National Ocean Service nautical charts and surveys approximates the mean high water line (United States).

SIGNIFICANT WAVE
A statistical term relating to the one-third highest waves of a given wave group and defined by the average of their heights and periods. The composition of the higher waves depends upon the extent to which the lower waves are considered. Experience indicates that a careful observer who attempts to establish the character of the higher waves will record values which approximately fit the definition of the significant wave.

SIGNIFICANT WAVE HEIGHT
The average height of the one-third highest waves of a given wave group. Note that the composition of the highest waves depends upon the extent to which the lower waves are considered. In wave record analysis, the average height of the highest one-third of a selected number of waves, this number being determined by dividing the time of record by the significant period.

SIGNIFICANT WAVE PERIOD
An arbitrary period generally taken as the period of the one-third highest waves within a given group. Note that the composition of the highest waves depends upon the extent to which the lower waves are considered. In wave record analysis, this is determined as the average period of the most frequently recurring of the larger well-defined waves in the record under study.

SILT
Sediment particles with a grain size between 0.004 mm and 0.062 mm, i.e. coarser than clay particles but finer than sand. See SOIL CLASSIFICATION.

SINUSOIDAL WAVE
An oscillatory wave having the form of a sinusoid.

SLOPE
The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25, indicating one unit rise in 25 units of horizontal distance; or in a decimal fraction (0.04). Also called GRADIENT.

SOCIAL IMPACT AREA (SIA)
Estimated spatial extent of the proposed project's effect on surrounding communities, demarcated as a buffer of specified distance, e.g. 2 km from the proposed project.

SOIL

A layer of weathered, unconsolidated material on top of bed rock; in geologic usage, usually defined as containing organic matter and being capable of supporting plant growth.

SOIL CLASSIFICATION (size)
An arbitrary division of a continuous scale of grain sizes such that each scale unit or grade may serve as a convenient class interval for conducting the analysis or for expressing the results of an analysis. There are many classifications used.

SORTING
Process of selection and separation of sediment grains according to their grain size (or grain shape or specific gravity).

SOUND
(1) (noun) a relatively long arm of the sea or ocean forming a channel between an island and a mainland or connecting two larger bodies, as a sea and the ocean, or two parts of the same body; usually wider and more extensive than a STRAIT (e.g., Long Island Sound). (2) (verb) To measure the depth of the water.

SOUNDING
A measured depth of water. On hydrographic CHARTS the soundings are adjusted to a specific plane of reference (SOUNDING DATUM).

SOUNDING DATUM
The plane to which soundings are referred. See also CHART DATUM.

SPECIFIC GRAVITY
The ratio of the weight of unit volume of any material to the weight of unit volume of water at 4 deg C, Gs = γs/γw. Typical values of Gs for soil solids are 2.65 to 2.72.

SPL (Sound Pressure Level)
A ratio of one sound pressure to a reference pressure.

SPL = 20 log (L/Lr) dB where Lr is the reference pressure

SPIT

See TOMBOLO.

SPRING TIDE
A tide that occurs at or near the time of new or full moon (SYZYGY) and which rises highest and falls lowest from the mean sea level.

STILL-WATER LEVEL (SWL)

The surface of the water if all wave and wind action were to cease. In deep water this level approximates the midpoint of the wave height. In shallow water it is nearer to the trough than the crest. Also called the UNDISTURBED WATER LEVEL.

STONE
Quarried or artificially-broken rock for use in construction, either as aggregate or cut into shaped blocks as dimension stone.

STORM SURGE
A rise above normal water level on the open coast due to the action of wind stress on the water surface. Storm surge resulting from a hurricane also includes that rise in level due to atmospheric pressure reduction as well as that due to wind stress.

SURGE
(1) The name applied to wave motion with a period intermediate between that of the ordinary wind wave and that of the tide, say from ½ to 60 min. It is low height, usually less than 0.9 m (3 ft). (2) In fluid flow, long interval variations in velocity and pressure, not necessarily periodic, perhaps even transient in nature. (3) see STORM SURGE.

SURVEY, CONTROL
A survey that provides coordinates (horizontal or vertical) of points to which supplementary surveys are adjusted.

SURVEY, HYDROGRAPHIC
A survey that has as its principal purpose the determination of geometric and dynamic characteristics of bodies of water.

SURVEY, TOPOGRAPHIC
A survey which has, for its major purpose, the determination of the configuration (relief) of the surface of the land and the location of natural and artificial objects thereon.

SUSPENDED LOAD
(1) The material moving in suspension in a fluid, kept up by the upward components of the turbulent currents or by colloidal suspension. (2) The material collected in or computed from samples collected with a SUSPENDED LOAD SAMPLER. Where it is necessary to distinguish between the two meanings given above, the first one may be called the "true

SWELL
Wind-generated waves that have traveled out of their generating area. Swell characteristically exhibits a more regular and longer period and has flatter crests than waves within their fetch (SEAS).

T

TIDAL PERIOD
The interval of time between two consecutive, like phases of the TIDE.

TIDAL RANGE
The difference in height between consecutive high and low (or HIGHER HIGH and LOWER LOW) waters.

TIDE
The periodic rising and falling of the water that results from gravitational attraction of the Moon and Sun and other astronomical bodies acting upon the rotating Earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as TIDAL CURRENT, reserving the name TIDE for the vertical movement.

TOPOGRAPHIC MAP
A map on which elevations are shown by means of contour lines.

TOPOGRAPHY
The configuration of a surface, including its relief and the positions of its streams, roads, building, etc.

TOTAL DISSOLVED SOLIDS (TDS)
Compounds in the water that cannot be removed by a traditional filter and are made up of salts or compounds which dissociate in water to form ions.

TOTAL PETROLEUM HYDROCARBON (TPH)
A mixture of chemicals made mainly from hydrogen and carbon.

TOTAL SUSPENDED SOLIDS (TSS)
Solid materials, including organic and inorganic, that are suspended in the water.

TROPICAL CYCLONE
See HURRICANE

TROPICAL STORM
A tropical cyclone with maximum winds less than 34 m/sec (75 mile per hour). Compare with HURRICANE (winds greater than 34 m/sec).

TROUGH
A long and broad submarine DEPRESSION with gently sloping sides.

TROUGH OF WAVE
The lowest part of a waveform between successive crests. Also, that part of a wave below still-water level.

TSUNAMI
A long-period water wave caused by an underwater disturbance such as a volcanic eruption or earthquake. Also SEISMIC SEA WAVE. Commonly miscalled "tidal wave."

TURBIDITY
(1) A condition of a liquid due to fine visible material in suspension, which may not be of sufficient size to be seen as individual particles by the naked eye but which prevents the passage of light through the liquid. (2) A measure of fine suspended matter in liquids.

TURBULENT FLOW
Any flow which is not LAMINAR, i.e., the stream lines of the fluid, instead of remaining parallel, become confused and intermingled.

V

VISCOSITY (or internal friction)
That molecular property of a fluid that enables it to support tangential stresses for a finite time and thus to resist deformation. Resistance to flow.

W

WATER DEPTH
Distance between the seabed and the still water level.

WATER LEVEL
Elevation of still water level relative to some datum.

WATERLINE
A juncture of land and sea. This line migrates, changing with the tide or other fluctuation in the water level. Where waves are present on the beach, this line is also known as the limit of backrush (approximately, the intersection of the land with the still-water level.)

WAVE
A ridge, deformation, or undulation of the surface of a liquid.

WAVE CLIMATE
The seasonal and annual distribution of wave height, period and direction.

WAVE DIRECTION
The direction from which a wave approaches.

WAVE DIRECTIONAL SPECTRUM
Distribution of wave energy as a function of wave frequency and direction.

WAVE FORECASTING
The theoretical determination of future wave characteristics, usually from observed or predicted meteorological phenomena.

WAVE FREQUENCY
The inverse of wave period.

WAVE FREQUENCY SPECTRUM
Distribution of wave energy as a function of frequency.

WAVE HEIGHT
The vertical distance between a crest and the preceding trough. See also SIGNIFICANT WAVE HEIGHT.

WAVE PERIOD
The time for a wave crest to traverse a distance equal to one wavelength. The time for two successive wave crests to pass a fixed point. See also SIGNIFICANT WAVE PERIOD.

WAVE PROPAGATION
The transmission of waves through water.

WAVE SPECTRUM
In ocean wave studies, a graph, table, or mathematical equation showing the distribution of wave energy as a function of wave frequency. The spectrum may be based on observations or theoretical considerations. Several forms of graphical display are widely used.

WAVE TRANSFORMATION
Change in wave energy due to the action of physical processes.

WAVELENGTH
The horizontal distance between similar points on two successive waves measured perpendicular to the crest.

WEIBULL DISTRIBUTION
A model probability distribution, commonly used in wave analysis.

WETLANDS
Lands whose saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities that live in the soil and on its surface (e.g. Mangrove forests).

WELL-SORTED
Clastic sediment or rock that consists of particles all having approximately the same size. Example: sand dunes.

WIND SETUP
On reservoirs and smaller bodies of water (1) the vertical rise in the still-water level on the leeward side of a body of water caused by wind stresses on the surface of the water; (2) the difference in still-water levels on the windward and the leeward sides of a body of water caused by wind stresses on the surface of the water. STORM SURGE (usually reserved for use on the ocean and large bodies of water).