CEC Africa (SL) Western Area Power Generation Project

CEC AFRICA (SIERRA LEONE)

Volume I: Environmental, Social and Health Impact Assessment Review and Update:

Project Report - Appendix

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Appendix A: Original ESIA

CEC Africa (SL) HFO Power Generation Project

CEC AFRICA (SIERRA LEONE)

Volume I: Environmental, Social and Health Impact Assessment: Project Report

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Acronyms

ADMS	Air Dispersion Modelling System
ARAP	Abbreviated Resettlement Action Plan
AfDB	African Development Bank
CECASL	CEC Africa (Sierra Leone) Ltd.
CO	Carbon Monoxide
CRCC	China Republic Construction Company
CTMP	Construction Traffic Management Plan
CWIQ	Core Welfare Indicator Questionnaire
dB	Decibels
DWS	Drinking Water Standards
EAP	Energy Access Project
EDSA	Electricity and Distribution Services Agency
EHS	Environmental, Health & Safety
EMS	Environmental Management Systems
EPC	Engineering, Procurement and Construction
EPA-SL	Environmental Protection Agency of Sierra Leone
EPH	Extractable Petroleum Hydrocarbons
ESHIA	Environmental, Social and Health Impact Assessment
ESMP	Environmental and Social Management Plan
EQS	Environmental Quality Standards
FCC	Freetown City Council
GAC	Guideline Assessment Criteria
GBV	Gender Based Violence
GDMA	Grid Development Management Agreement
GIS	Geographic Information Systems
GoSL	Government of Sierra Leone
GVWC	Guma Valley Water Company
H_2S	Hydrogen Sulphide
HAZOP	Hazard and Operability Study
HFO	Heavy Fuel Oil
HGV	Heavy Goods Vehicle
IBA	International Bird Area
INTEGEMS	Integrated GIS and Environmental Management Systems
IEEM	Institute of Ecology and Environmental Management
IFC	International Finance Corporation
IFI	International Financing Institutions
kV	Kilovolts
L_{Aeq}	Continuous equivalent sound level
L_{Amax}	Lamax Maximum sound level
LRP	Livelihood Restoration Plan

MDA	Ministries Departments and Agencies
MoE	Sierra Leone Ministry of Energy
MSU	Mechanical Service Unit
MW_e	Megawatts (electrical output)
MW_{th}	Megawatts (thermal input)
N_2	Nitrogen
NDA	Non-Degraded Airshed
NO_x	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
NP	National Petroleum
OSHMS	Occupational Safety and Health Management Systems
PAH	Polycyclic Aromatic Hydrocarbons
PC	Process Contribution
PHU	Peripheral Health Units
$PM_{2.5}$	Particulate matter under 2.5 microns in size
PM_{10}	Particulate matter under 10 microns in size
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
PPG	Pollution Prevention Guidelines
PS	Performance Standard
RAP	Resettlement Action Plan
RoW	Right of Way
SVOC	Semi-Volatile Organic Compounds
SLRA-WR	Sierra Leone Roads Authority- Western Region
SLRE	Sierra Leone River Estuary
SWSSF	Strategic Water Supply and Sanitation Framework
TA	Transport Assessment
TORs	Terms of Reference
IUCN	Union for Conservation of Nature
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WAPNP	Western Area Peninsular National Park
WMP	Waste Management Plan
WHO	World Health Organisation
WAFR	Western Area Forest Reserve
ZVI	Zone of Visual Impact

Part 1 – Non-technical Summary

1 The Project

1.1 Project Objectives

According to a 2006 report by the European Commission, Sierra Leone's energy production, supply and current utilization have serious implications for Sierra Leone's economy and environment. Bio-energy is the main source of fuel for approximately 75 per cent to 80 per cent of the country's population (both rural and urban). Petroleum, hydropower and coal are the major source of commercial energy in the country. The electricity sub sector contributes about 0.6 per cent of total energy consumption. Blackouts and power rationing, as a result of low water levels in the hydro dams are currently common. Power supply is restricted to mines or the major towns, where it is irregular and does not provide for minimum requirements. Hopes for improvement focus on the rehabilitation and expansion of the Bumbuna Hydro Power Plant.

According to the Ministry of Energy and Power in Sierra Leone, the following key goals have been identified for attainment by the year 2017:

- 75% of the population should have access to individual electricity supplies (access is currently around 6%[1]);
- 15% access to electricity in rural areas (in 2009 this was 1%);
- Integration of the electricity grid with neighbouring countries; and,
- Establishment of a framework for development and growth in the sector.

The primary objective of the project is to provide additional reliable and efficient electricity-generating capacity in Sierra Leone.

1.2 Project History

Blue Flare Power SL (BVI) Limited (Blue Flare) was founded to pursue opportunities for private sector investment in Freetown's electricity distribution network and power generation facilities. In July 2011, Blue Flare signed two foundational agreements with the GoSL: the Grid Development and Management Agreement (GDMA) and the PPA.

In 2012, TCQ entered into agreements with the founders of Blue Flare, and a Joint Development Agreement with CEC Africa Investments Ltd (CECA) was subsequently signed in April 2013. TCQ and CECA then formed a jointly owned company named CEC Africa (Sierra Leone) Limited (CECASL) based in Mauritius. The ownership of the firm is 49.9% TCQ and 50.1% CECA. In October 2013, it was agreed with GoSL/WB that the original agreements would be cancelled and that a new PPA would be signed that is limited to a generation project. A new Special Purpose Vehicle (SPV) wholly owned by CECASL was formed on the 13th of May that was signed with GoSL on the 15th of May 2014.

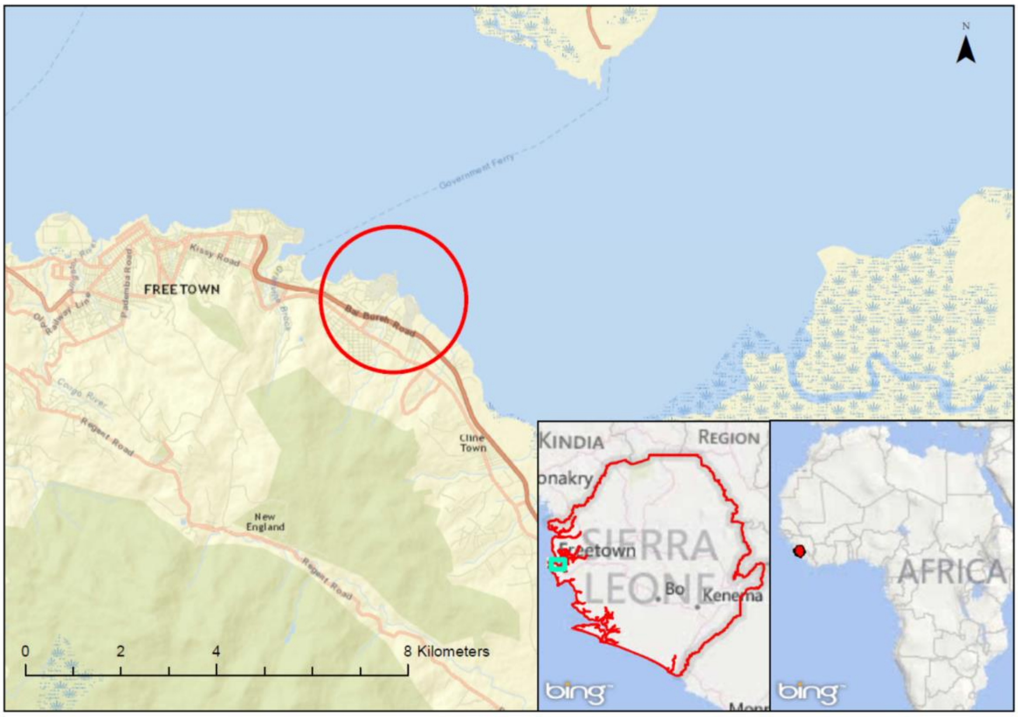
1.3 Project Overview

The proposed heavy fuel oil (HFO) power plant (hereafter referred to as the project) is located on a site in the Kissy Dock area, approximately 4 km east of the centre of Freetown, Sierra Leone as shown on Figure 1.1. The power plant will be developed first as a 50 megawatts electrical (MWe) installation and then an

[1] http://archive.crossborderinformation.com/Article/%EF%BB%BFNew+schemes+line+up+as+Sierra+Leone+promotes+baseload%2c+off-grid+options.aspx?date=20130627# (last accessed 15th April 2014)

additional two phases of 39MWe, resulting in a potential total output of 128 MWe to the transmission network.

Figure 1.1: Regional Location



The 50MWe and 128MWe installations would require 112MW thermal (MWth) and approximately 310MWth input from the combustion of HFO, respectively.

The Environmental, Social and Health Impact Assessment (ESHIA) currently covers the first 50MWe capacity only, as little detail is known about the design, timing and actual feasibility (with regards to transmission rehabilitation outside of CECASL control) of Phases 2 and 3. The future phases will each require the development of a ESHIA prior to construction. It is also acknowledged that the Power Purchase Agreement (PPA) with the Government of Sierra Leone (GoSL) will allow for the possibility of developing the final phase of the project offsite.

The HFO is planned to be imported via the Addax project jetty, construction of which is nearly complete, to the north of the site and will be transported from the jetty to the site via an approximately 1300 metre (m) pipeline. Jetty construction is progressing according to schedule and should be completed by October 2015, which will be well in advance of project operation. A new pipeline will be constructed along the same route of the existing redundant HFO supply line within the National Petroleum (NP) facility and disused refinery to the north of the site. The pipeline will be constructed on an elevated base or pipe rack within the existing right of way (RoW) and within the secured areas of the NP compound disused refinery. Additional sections will be required to connect into the manifold at the Addax jetty and from the refinery into the project site. The last short section of the route, between the disused refinery and the site, close to the site entrance, will be buried. All of the required infrastructure will either already be developed or will be directly funded and developed as part of the project.

A pump station and buffer tank will also be constructed along the pipeline route as shown on Figure 2.2. The on-site tank would be approximately 36m in diameter and 16m in elevation, with a volume of approximately 16,000m^3.

The power will be exported to the national transmission and distribution network, which is owned and operated by the Electricity Distribution and Services Agency (EDSA). It is intended that building the power plant capacity in stages will allow for the concurrent development of evacuation capacity within the grid through projects such as the World Bank-funded, Energy Access Project (EAP), which aims to rehabilitate the grid.

The EDSA and GoSL will jointly purchase the power produced by the plant on the basis of the PPA signed on 15th May 2014. As the new EDSA double circuit line will generally follow the route of the existing line that crosses the proposed CECASL site, the evacuation work will comprise an approximately 20m 33kV cable 'tee' into the existing and ultimately rehabilitated overhead lines.

Although CECASL is not constructing a new transmission line as part of the project, it is currently anticipated that CECASL will be responsible for the addition of the second circuit on the double circuit line that will be constructed as part of the rehabilitation works undertaken by the GoSL / World Bank funded EAP or its successors.

1.4 The Project Proponent

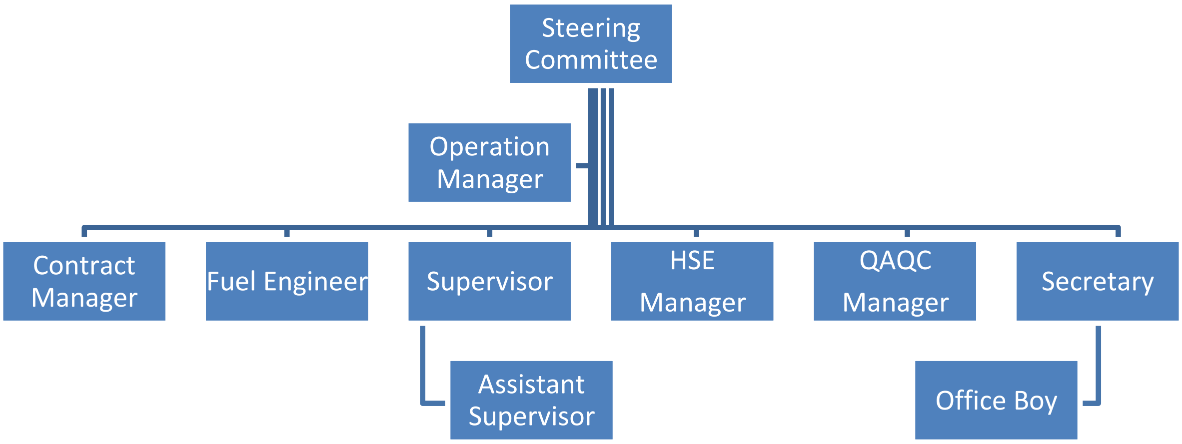
As stated above, the project is sponsored by a consortium of two firms, each with an approximate 50% shareholding: CEC Africa Investments Limited (a subsidiary of Copperbelt Energy Corporation plc [CEC]) and TCQ Power Limited (TCQ). The consortium has formed the CECASL joint venture to develop the project. The proposed organisational chart that will be implemented during the operation of the HFO power plant is outlined on Figure 1.2.

CEC is a Lusaka Stock Exchange Listed Zambian Energy Company involved in power generation, transmission and distribution. It has been in existence for over 60 years and owns approximately 900 km of 220 kV and 66 kV transmission lines; 38 major substations; and 80 MW of embedded gas turbine generation.

TCQ was established in January 2012 to acquire, build, develop and operate power projects in Africa. It was set up by the Nasser family, who have experience in construction through their firm Target Engineering Construction Co. that is based in the United Arab Emirates. In December 2008, Target Engineering was sold to Arabtec Holding PJSC for more than US$ 200M to form TCQ.

The project will be designed to meet the requirements of International Financing Institutions (IFIs) as generally defined in the International Financing Corporation (IFC) Performance Standards for Environmental and Social Sustainability ('IFC Standards' or 'the Performance Standards') and the Environmental, Health and Safety (EHS) Guidelines of the World Bank Group (WBG).

Figure 1.2: CECASL, HFO Power Plant Operation Organisation Chart



1.5 Need for the Project

A history of lack of investment in generation, transmission and distribution of electricity has left a significant capacity deficit in Sierra Leone, with estimates that the 92MW current installed capacity was approximately 200 MW short of demand in 2008. In November 2008, the Sierra Leone Ministry of Energy and Power formulated the "statement of energy sector policy and strategic action plan," which contained a number of short, medium and long-term goals for the development of electricity capacity in Sierra Leone. In addition to the need for new generation, significant replacement/rehabilitation work to Sierra Leone's high voltage electrical distribution system is needed.

The project has been in development since early 2013 and the ESHIA was initially commenced in December 2013. However, since June 2014 the ongoing Ebola crisis in West Africa has significantly impacted Sierra Leone and has prevented continued survey work.

As part of ongoing discussions with the IFC/WBG, it has been indicated that the project is critical to the post-Ebola rebuilding of Sierra Leone's economy. Therefore, CECASL has proceeded with this preliminary ESHIA in order to support ongoing project financing and technical design discussions.

The current approach under Ebola conditions is to focus the preliminary ESHIA on the key project issues required in order to progress the design. Further detailed mitigation will be developed and included as part of the detailed design phase, and the ESMP will be reviewed and updated accordingly in future. This approach has been agreed to by the IFC, World Bank and the EPA-SL.

1.6 Project Features

The power plant is planned to be developed in three Phases with an ultimate output of 128MWe, details of design and timing of Phases 2 and 3 have not been confirmed at this time, on that basis the scope of the assessments included in the ESHIA are limited to Phase 1 only. This section summarises key elements of the development.

1.7 Site Layout

The plant configuration and layout shown on Figure 2.1 was developed on the basis of a staged development and construction programme.

Key determinants of the layout and plant facilities have been:

- The limited area;
- The irregular plot shape;
- The need to achieve adequate road access into and around the power plant; and,
- Consideration of potential environmental and social impacts, such as waste, pollution control and noise levels at nearby sensitive receptors (principally adjacent residences, the school-hospital-mosque complex and the Sir Winston Churchill International Secondary School [Winston Churchill Secondary School]).

The current design comprises a single engine house in the centre of the site that can be extended as each phase is developed. A single tank for untreated HFO, two treated HFO storage tanks together with a service tank and a smaller light fuel oil storage tank are planned. In the final configuration, diesel generators are connected to six generator transformers that are connected by cables to the indoor 33kV substation. A central control room will be provided, along with workshops, water treatment and effluent facilities, fuel oil treatment and other normal services. Exhaust from the Phase 1 stacks will be grouped into a shared enclosure, which will appear as a single stack from surrounding views and will assist with stack emissions dispersion.

1.7.1 Power Station

As previously detailed the power plant is planned to be developed in a number of stages, beginning with 50MWe and with a potential ultimate output of 128MWe to the transmission network. However, Phases 2 and 3 are likely to be developed in the future, and any plans associated with these are considered preliminary and could change in the future. It is also important to note that EPC contractors for the project are currently being procured, so some of the detailed design regarding Phase 1 will require review and refinement once the appropriate contractor is secured. At present, design information for the project indicates that the power station will be constructed in phases likely to consist of the following engine configuration:

- Phase 1: 6 x 20v32 engines, each 8.9MW; and,
- Phases 2 and 3: 4 x 18v46 engine, each 17MW.

As indicated on Figure C, permanent plant buildings will consist of:

- A totally enclosed, fan ventilated engine hall;
- A control building;
- A combined administration and workshop building (reuse of existing building on site);
- A security (gatehouse) building;
- A fuel oil pump house; and,
- A substation building.

Other elements of the power plant will include:

- Perimeter site fencing and gates;

- A road way connection to the public highway, plus on-site roads, parking with sunshades and sealed areas;
- The refurbishment and reuse of buildings on the site to create administration offices and workshop facilities;
- A heavy oil filtration and treatment plant;
- Bunded storage for treated heavy oil and diesel oil;
- 11kV to 33kV step-up transformers;
- An indoor 33kV substation and overhead lines to connect from the generator step-up transformers to allow connection, at choice, with the existing 33kV line running to the west;
- Water supply and associated borehole;
- Tanks for filtered raw water (including fire water) and potable water;
- A sewage and effluent treatment plant;
- An observation pond for treated effluent prior to discharge to the environment, to allow inspection to confirm that no visible potential contaminants (such as fuel oil or diesel) are present in the discharged effluent;
- Waste incinerator;
- Messing, toilet and first-aid facilities; and,
- Civil works including roads, fencing and lighting.

A contract for operations and maintenance services for the debt repayment period of 10 years is expected to be in place from the date of commercial operation. During operations, the power plant is expected to employ approximately 45 permanent employees.

Figure 2.1: Project Site Plan

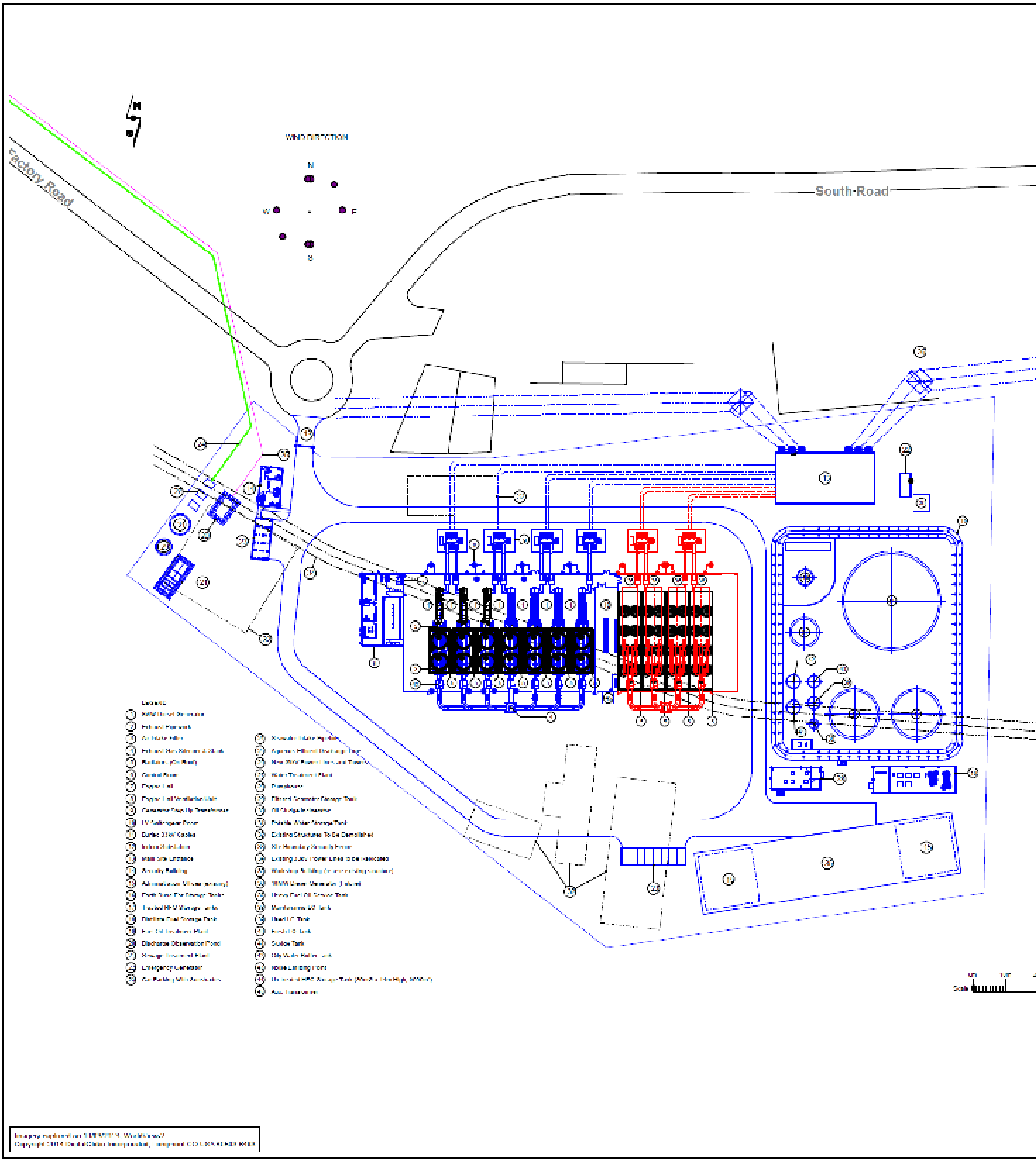

WIND DIRECTION
N
W
E
S
South-Road
Factory Road
Control Room
Existing Structures To Be Demolished
Discharge Observation Pond
Emergency Generator

Figure 2.2: Associated Development


National Petroleum Jetty
NP Facility
Disused Refinery
Welling Creek
South Road
Factory Road
CECA Project Site
Imagery captured on 10/03/2013, WorldView-2.
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1.8 Project Timescales

The proposed construction schedule for Phase 1 is anticipated to be completed 18 months from financial close, which is likely to be late 2015. At the peak of construction, the project is anticipated to employ up to 200 construction workers from the surrounding communities including Shell, Hotel 5-10, Kissy Thunderhill and Kissy Brook communities, where unemployment levels are currently high.

1.9 Consultation

During the period January 2014 to May 2014 a number of informal and formal meetings were held with a number of stakeholders including the following:

- Government (National, Regional and Local) Ministries, Departments and Agencies;
- Community Leaders (e.g. Religious, Educational);
- Local and International NGOs;
- International Financial Institutions;
- Vulnerable Groups (e.g., women, youth and elderly);
- Business Organisations; and
- Communities & Community-Based Organisations (CBO)

In addition to the various stakeholder meetings, a Public Community Consultation Workshop took place on the 15th May 2014.

To further inform the ESHIA, a second round of consultation was undertaken during February 2015 to March 2015.

The Freetown community including the Kissy Dockyard and its environs, were engaged in a series of media based activities to inform the community and the populace that the project work is ongoing and to provide them with an opportunity for exchange of views, for input to and review by the project team;

- Information was published via three local tabloid newspapers namely the Salone Times, Awoko and Standards Times.
- Information was broadcast across local radio stations (Radio Democracy, Radio Citizen and Tumac Radio). These broadcasts were in the local dialects (krio, mende and temne) and were aired in the morning, afternoon and evening.
- A follow on community specific broadcast was undertaken on the 9th-10th March 2015 using a public address system.
- Hand bills were handed out to interested individuals and posters put up at strategic points in the community.

In addition a number of face-to-face meetings were held with the following key stakeholders in the project area:

- The Deputy Director of the Environmental Protection Agency;
- A group of garden farmers cultivating at the site; and

- The Energy Distribution and Supply Agency and the Energy Generation and Transmission Corporation.

Further consultation reports will be prepared as the project develops. Pre-construction phase consultation requirements will include the following;

- Two public consultation workshops will be held prior to construction (one close to the project site and a second in central Freetown).
- The Stakeholder Engagement Plan (SEP) will be developed and implemented by CECA SL so that all concerns identified to date are managed and factored into the design phase of the project. This will be undertaken prior to construction.

Additional consultation was also conducted with the artisanal farmers in September 2015.

1.10 Legal Requirements

The project is required to comply with the relevant Sierra Leone laws and regulations. The project must also meet the requirements of the World Bank Group and the International Finance Corporation (IFC) Performance Standards and relevant Environmental Health and Safety Guidelines. The following provides a brief overview of the key applicable environmental legislation.

1.10.1 National Legislation

The National Environmental Policy (1994) seeks to achieve sustainable development in Sierra Leone through the implementation of sound environmental management. It also promotes efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of nationals, and serves to enrich the understanding of ecological systems and natural resources import ant to the Nation. Other relevant national legislation includes:

- National Energy Policy;
- National Land Policy (2005);
- National Water and Sanitation Policy (Draft);
- Environment Protection Agency Act, 2008 (No. 11 of 2008) as amended in 2010;
- National Electricity Act, 2011.
- Fisheries Management and Development Act, 1988 (Act No. 4).
- Factories Act, 1974

1.10.2 International Regulations

This ESHIA considers the policies, guidelines and standards of the WBG's IFC. The requirements of the WB Multilateral Investment Guarantee Agency essentially reflect those of the IFC Standards for private sector projects. The following international conventions would also apply to the project:

- Abidjan Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the West and Central African Region;
- Convention on Migratory Species (CMS);

- Ramsar Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention);
- Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972;
- United Nations Framework Convention on Climate Change;
- Vienna Convention for the Protection of the Ozone Layer;
- Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol);
- The Stockholm Convention on Persistent Organic Pollutants; and
- Aarhus Convention

This ESHIA has also been undertaken with reference to African Development Bank's (AfDB) 'Environmental and Social Assessment Procedures' (AfDB, 2001), and the associated 'Integrated Environmental and Social Impact Assessment Guidelines' (AfDB, 2003).

2 Environmental and Social Effects

2.1 Summary

The following are the key ESIA findings:

- **Air:** Potential air quality from the project during the construction and operations would not be considered to be significant. This ESHIA has identified that stack height for the plant will need to be 65m in order to appropriately manage the project's potential impacts on ambient air quality. All pollutants would be within acceptable WBG standards except PM emissions as the background concentrations measured as being high. Project emissions will be monitored to ensure that the particulate emissions levels from the project do not substantially increase. Continuous Emissions Monitoring Systems (CEMS) will be installed on the engine exhaust stacks to monitor the emissions of the relevant pollutants and associated emissions parameters in accordance with the appropriate monitoring and reporting requirements of the EPA-SL and WBG.

  An ambient air quality monitoring program (AAQMP) will also be developed in consultation with the WBG and EPA-SL to monitor concentrations of NO_2, SO_2 and particulates (PM_{10} and $PM_{2.5}$) in the project vicinity during the operational phase of the project.

- **Noise:** Noise levels in the project vicinity are currently high based upon monitoring conducted for the project. There is the potential for significant construction noise impacts, which will require the contractor(s) to implement noise control measures during the construction works. The construction noise impacts will be temporary in nature and will be addressed in the Noise Management Plan.

  There are no predicted noise impacts from operation of the plant, however, a Noise Management Plan with measures such as a noise insulation scheme will be developed in consultation with the nearest households that are affected by the already high night time noise levels.

- **Access Road and Traffic Safety:** Due to the presence of two schools and the Islamic compound (whose entrance is directly on the access road) and the shanty houses located in close proximity to the project entrance, the community safety risks associated with the project would be considered significant.

  Therefore, a Transportation Management Plan will be developed for the project including that will include limited road grading and maintenance to reduce safety risks.

- **Socio-economics and Economic Displacement:** The 16 farmers currently utilising the site for subsistence farming would be displaced by the project and a Livelihood Restoration Plan/Abbreviated Resettlement Plan would be developed to ensure adequate compensation and resettlement including support measures would be implemented. This would include taking steps to assess the livelihood impact and to improve or restore income-earning capacity such as identifying and providing relocating the farmers to land of comparable productive value to the 16 farmers, providing alternative sources of income as necessary, and providing transitional support and compensation. This process will be completed prior to project construction.

2.2 Site Surrounds

Land uses surrounding the site include the following:

- **North:** The disused refinery and other primarily commercial and industrial properties, reflecting the industrial zoning of the project site and local area. There is a polio treatment compound on the northern side of South Road and some residential dwellings on the southern side of South Road. There are also some shanty housing and stores located directly adjacent to the site entrance.

- **East:** A school/mosque/health clinic is located directly to the southern end of the eastern boundary. Commercial properties are located adjacent to the remainder of the eastern boundary.
- **West:** The German Academy and the Winston Churchill Secondary School are located along Factory Road. There are some artisanal farming areas within the storm drain overflows along South Road.
- **South:** There are residential buildings along the length of the western portion of the southern boundary, with commercial uses to the southeast. Some shanty developments are present behind shops to the southeast.

In general, the area is characterised by industrial and commercial uses with some formal and informal shanty dwellings and school dispersed between.

2.3 Noise

A noise assessment was carried out in order to determine the potential noise impacts of construction and operation of the project. Baseline noise data was collected as part of the ESHIA. Noise modelling was undertaken and impacts assessed in consideration of baseline noise levels. Due to the nature of the construction process, noise levels will fluctuate with the combination of machinery being used at any one time. Noise levels will also vary depending on time, and distance as the construction progresses, particularly along linear infrastructure i.e. the pipeline. Construction works may generate high noise levels i.e. above 70 dB LAeq.

Based on the findings of the operational modelling and construction assessment, there is the potential for significant construction and operational noise impacts. However, mitigation will be developed as part of the Noise Management Plan to reduce these impacts.

During operations, no significant noise increases are predicted to result from the project. However, as existing night time noise levels are already high and this could result in certain health effects associated with sleep disturbance, a Noise Management Plan will be developed that will include additional measures such as a noise insulation scheme to reduce night time noise levels.

2.4 Air Quality

An air quality assessment was carried out to determine the potential impacts on air quality resulting from the construction and operation of the power plant on sensitive human and ecological receptors. To assess the likely air quality impact from the proposed project, air dispersion modelling was conducted.

The assessment of construction impacts considered the effect of dust and emissions generated through activities such as vehicle movements and general construction activities, as well as the impacts of construction traffic on local road receptors such as local residents.

For the operation of Phase 1 of the power plant, the predicted impact on air quality in the area was assessed against the relevant WHO ambient air quality guidelines (AAQG). The results presented for Phase 1 show that the relevant ambient air quality guidelines are predicted to be complied with for Nitrogen dioxide, Carbon Monoxide and Sulphur Dioxide. However, there are predicted exceedances of both the annual mean and 24 hour mean WHO AAQG values for small particulates (PM_{10} and $PM_{2.5}$) due to the high background concentration of particulates already present in the area. Additional ambient air quality monitoring will be conducted to ensure that the project is in compliance with the WBG requirements

The potential impact due to emissions from road traffic or dust generated during the construction is considered to be insignificant. However, given the close proximity of sensitive areas adjacent to the project site, a high level of management will need to be employed to ensure best practice is continually adopted throughout the construction phase.

The stack height modelling assessment indicated that a height of 65 meters would be required to meet WBG/WHO Air Quality Guidelines for emissions. A continuous emissions monitoring system (CEMS) will be installed on the stack to confirm the amount of particulates and other emissions coming from the plant and ambient air quality monitoring is proposed to ensure that project contributions to local air quality are consistent with international guidelines and EPA permit requirements for the plant.

2.5 Soils, Geology, Hydrogeology and Hydrology

The potential for project impacts on soils, rivers, streams and groundwater and the flood risk implications of the proposed project during the construction operational and decommissioning phases was assessed. Findings showed that the storage and handling of hazardous materials, including fuel and oils, in both construction and operational phases may pose a risk of land contamination through accidental release. There is also the potential for contamination of soil to be uncovered during construction activities, in particular in the area of the old fuel pump. The abstraction of large quantities of groundwater from both the existing onsite borehole and additional borehole (to be drilled) also has the potential to reduce groundwater resources available in the aquifer underlying the site. There is the potential for pollution of groundwater and soils in the event of a spill or other type of accident from hazardous materials stored on site during construction and operation. Contaminated groundwater also has the potential to impact the quality of surface waters. If contamination is present beneath the site, groundwater flowing beneath the site can pick up the contamination and then carry it to the nearest river or stream (i.e., the Sierra Leone River Estuary [SLRE] or Wellington Creek).

Contamination of surface water features could also result from sediment loading as a result of surface water runoff. In addition a variety of materials and chemicals are likely to be used during construction and operation works, which could have varying polluting potential if spilled adjacent to or within the Old Railway Road Stream. No construction works will be undertaken within or adjacent to the SLRE or the Wellington Stream; however, there is the potential for works to be undertaken within and adjacent to streams and/or drainage channels that are hydraulically connected to these watercourses.

2.6 Socio Economics

A desktop study and a household survey were conducted to assess the potential for socio-economic impacts on the community. The study showed that existing infrastructure, including water conveyance, waste management and health, and other social services are currently considered to be in poor condition in the project area.

Predicted project impacts include employment opportunities during construction for approximately 200 people anticipated to be primarily local workers, which would create an additional demand for services at the site on a daily basis. Operational jobs associated with the project would include 45 positions. It is not clear whether or not these jobs will be able to be sourced from the local community as this would largely depend upon skill levels and training in the local and regional community.

The project site has no inhabitants (legal residents or squatters). However, a number of residential properties and shanties are located adjacent to the site, with the potential for noise impacts. Development of the project site would also result in the economic displacement and livelihood impacts on 16 farmers currently farming small areas within the site, which will be addressed by a Livelihood Restoration Plan/Abbreviated Resettlement Action Plan to be completed prior to project construction and in accordance with IFC Performance Standards.

The operational phase of the project will result in increased power generation capacity and supply for the Freetown economy.

2.7 Health and Safety

An assessment of health and safety impacts was conducted to ensure that the project would meet international safety standards. Specific occupational health and safety issues associated with power projects include the potential for exposure to confined spaces, heat, air quality and noise impacts. The construction, operations and decommissioning of the project have the potential to impact the local communities' health and safety as a result of increased traffic movement and project-related hazards.

A significant influx of workers from outside the area is not anticipated to result from project construction, as ample labour already exists in the project area. However, increased daily activity at the site would put pressure on already poor local infrastructure.

2.8 Ecology

The project site is a brownfield site entirely comprised of modified habitat and mainly characterised by warehouses, garages, office buildings, truck parking and workshops. The area is highly disturbed and features considerable areas of bare ground and hardstanding. The local area is drained by watercourses which flow northwards from the hills south of Freetown. They include a watercourse located 200 m west of the project site that crosses Factory Road and flows through disused industrial land to the bay west of the NP Facility. A tributary of this stream passes close to the southern boundary of the site. The most significant surface water feature in the area is Wellington Creek, located 250 m east of the project site and 75 m east of the proposed HFO pipeline route at its closest point.

An assessment of the potential effects on ecological features arising from the construction and operation phases of the project was undertaken. The construction of the project has the potential to result in indirect negative impacts on the Sierra Leone River Estuary (a RAMSAR Wetland and International Bird Area) as a result of surface run-off and accidental spills. During operation, potential impacts could include accidental HFO spills on the estuary as well as air pollution effects on habitats and species.

2.9 Solid Waste

Solid wastes will be generated both during construction and operation of the project. These wastes will range from excavated materials during construction to a range of operational wastes. Construction activities will temporarily increase waste requiring disposal. A major component of construction wastes will be the generation of soil which may require disposal.

Once operational, there will be few significant sources of solid waste generated, and the additional burden placed on the existing waste management infrastructure in the project area should be low. The principal solid wastes will be sludge from the treatment of HFO and the effluent treatment plant. HFO sludge waste will be burned in a small on-site incinerator designed to meet SL-EPA and international standards, with the resulting ash disposed of in the Central Dump in Freetown. Because this dump is not an engineered landfill and is not appropriate to accept hazardous waste, ashes will be analysed to confirm content is non-hazardous.

2.10 Traffic and Transport

Transport and transportation impacts that will result from the proposed project have been assessed and their significance in terms of the general effect on the road network, existing marine vessel movements and sensitive local receptors considered. Construction and operation activities will generate a small increase in the volume of heavy goods vehicles (HGVs) on the local roads, approximately 55 vehicles at the peak of construction, and could increase the potential impacts to involve highway user safety, pedestrian delay, dust and dirt and movement hazardous loads. Although this number is considered to be relatively low, due to the presence of many school children in the area and the fact that there are shanties located along the roadway and near the site entrance, community health and safety impacts are considered moderately significant.

Therefore, a Transportation Management Plan will be developed for the project including that will include limited road grading and some minor improvements to local access roadways.

2.11 Trans-boundary Impacts

The project is not located near the national borders and is not of a scale that is likely to result in trans-boundary impacts.

2.12 Cumulative Impact Assessment

Cumulative impacts may potentially result from implementation of the project at the same time as other identified proposed developments in the area.

Under Ebola conditions, development is currently limited and it is understood from information provided by Sierra Leone consultant INTEGEMS that no significant relevant new projects have been commenced or have received planning permission during the Ebola period.

Prior to the Ebola period, the following significant developments were identified:

- The proposed Addax Petrojetty New Oil Jetty Project;
- A number of roadway projects currently underway in Freetown; and,
- The World Bank-funded NPA transmission line rehabilitation project (the EAP).

These projects are anticipated to have minimal impact on the resources being utilised for this development. Combined construction related transportation, noise, air quality, and employment increases if projects progress simultaneously could increase nuisance and health and safety impacts. However, given the small scale of all of these projects, the risk is still considered low.

Part 2 – Main report text

1. Introduction and Overview

1.1 Introduction

CEC Africa (Sierra Leone) Limited (CECASL) is a joint venture established to develop an electricity-generating, heavy fuel oil (HFO) power plant (hereafter referred to as the project) on a site approximately 4 kilometres (km) east of the centre of Freetown, Sierra Leone. CECASL has retained Jacobs to undertake and Environmental, Social and Health Impact assessment (ESHIA) of the project in order to comply with the environmental regulations of Sierra Leone as required by the Environmental Protection Agency of Sierra Leone (EPA-SL). The ESHIA will also meet the requirements of International Financing Institutions (IFIs) as generally defined in the International Financing Corporation (IFC) Performance Standards for Environmental and Social Sustainability ('IFC Standards' or 'the Performance Standards') and the Environmental, Health and Safety (EHS) Guidelines of the World Bank Group (WBG).

This ESHIA presents a statement of the likely social, environmental and health effects of the project and includes a description of the measures that are required to be implemented in order to avoid, reduce and where possible, remedy any identified significant adverse effects.

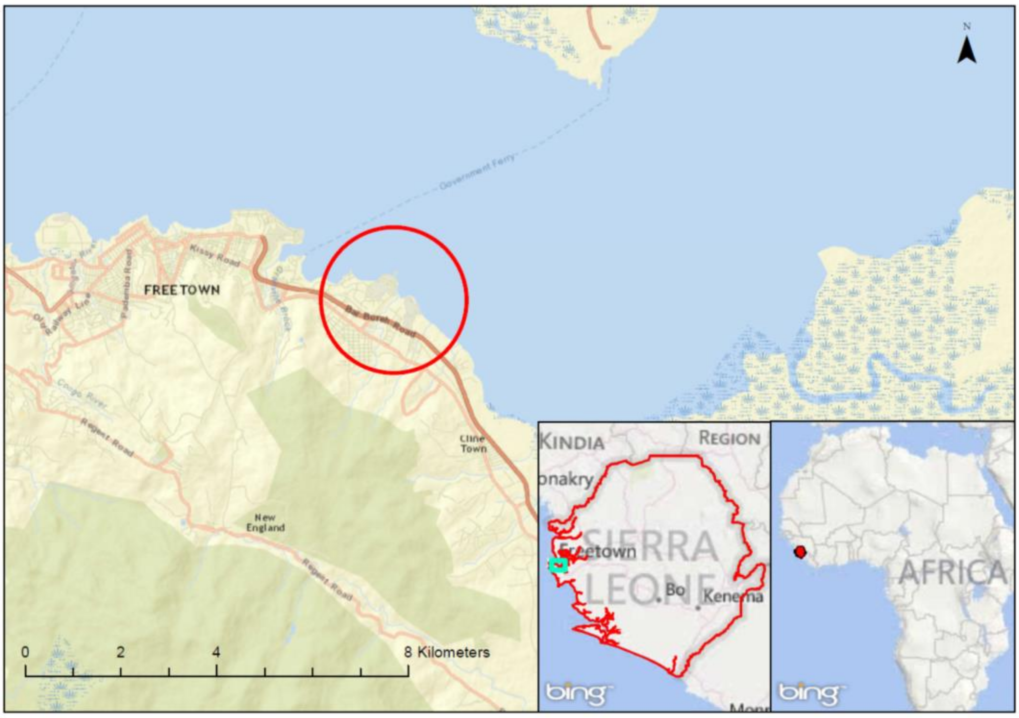
This submission comprises three parts, as follows:

- Volume I – Non-technical summary (NTS) and ESHIA main report text (this document)
- Volume II – Environmental and Social Management Plan (ESMP)
- Volume III - Appendices

1.2 Project Overview

The project is located on a site in the Kissy Dock area, approximately 4 km east of the centre of Freetown, Sierra Leone as shown on Figure 1.1. The power plant will be developed first as a 50 megawatts electrical (MWe) installation and then an additional two phases of 39MWe, resulting in a potential total output of 128 MWe to the transmission network.

Figure 1.1: Regional Location



The 50MWe and 128MWe installations would require 112MW thermal (MWth) and approximately 310MWth input from the combustion of HFO, respectively.

This ESHIA currently covers the first 50MWe capacity only, as little detail is known about the design, timing and actual feasibility (with regards to transmission rehabilitation outside of CECASL control) of Phases 2 and 3. The future phases will each require the development of a separate ESHIA prior to construction. It is also acknowledged that the Power Purchase Agreement (PPA) with the Government of Sierra Leone (GoSL) will allow for the possibility of developing the final phase of the project offsite.

The HFO is planned to be imported via the Addax project jetty, construction of which is nearly complete, to the north of the site, and will be transported from the jetty to the site via an approximately 1300 metre (m) pipeline. Jetty construction is progressing according to schedule and should be completed by October 2015, which will be well in advance of project operation. A new pipeline will be constructed along the same route of the existing redundant HFO supply line within the National Petroleum (NP) facility and disused refinery to the north of the site. The pipeline will be constructed on an elevated base or pipe rack within the existing right of way (RoW) and within the secured areas of the NP compound disused refinery. Additional sections will be required to connect into the manifold at the Addax jetty and from the refinery into the project site. A short section (less than 100m from the NP gate to the refinery) may require re-routing to reduce community health and safety risks. All of the required infrastructure will either already be developed or will be directly funded and developed as part of the project.

The majority of the pipeline route will be above ground, and located within the secured areas near the jetty and within the disused refinery. The last short section of the route, between the disused refinery and the site, close to the site entrance, will be buried. A pump station and buffer tank will also be constructed along the pipeline route as shown on Figure 2.2 (see Section 2). The on-site tank would be approximately 36m in diameter and 16m in elevation, with a volume of approximately 16,000m^3.

The power will be exported to the national transmission and distribution network, which is owned and operated by the Electricity Distribution and Services Agency (EDSA). It is intended that building the power plant capacity in stages will allow for the concurrent development of evacuation capacity within the grid through projects such as the World Bank-funded, Energy Access Project (EAP), which aims to rehabilitate the grid.

The EDSA and GoSL will jointly purchase the power produced by the plant on the basis of the PPA signed on 15th May 2014. As the new EDSA double circuit line will generally follow the route of the existing line that crosses the proposed CECASL site, the evacuation work will comprise an approximately 20m 33kV cable 'tee' into the existing and ultimately rehabilitated overhead lines.

Although CECASL is not constructing a new transmission line as part of the project, it is currently anticipated that CECASL will be responsible for the addition of the second circuit on the double circuit line that will be constructed as part of the rehabilitation works undertaken by the GoSL / World Bank funded EAP or its successors.

1.3 The Project Proponent

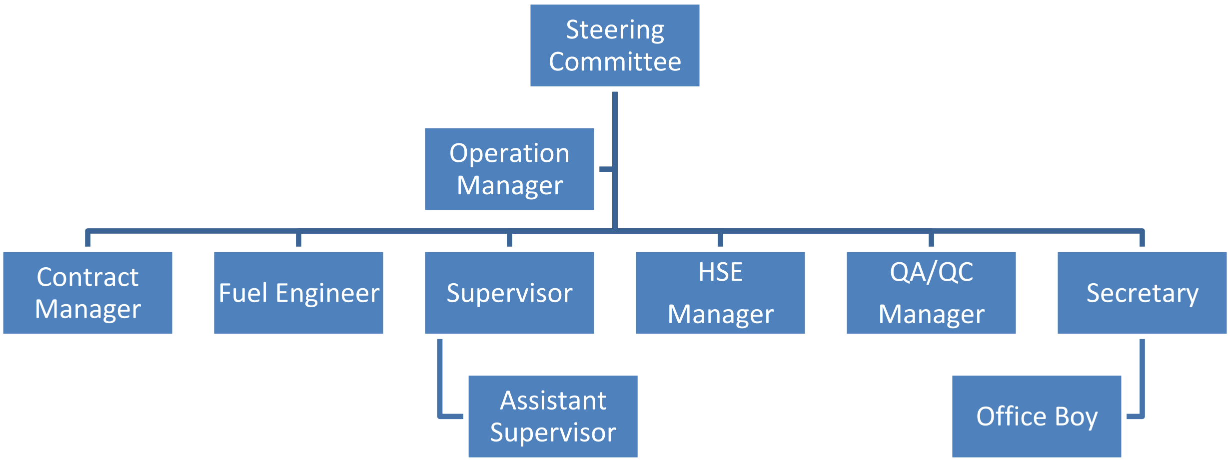
The project is sponsored by a consortium of two firms, each with a 50% shareholding: CEC Africa Investments Limited (a subsidiary of Copperbelt Energy Corporation plc [CEC]) and TCQ Power Limited (TCQ). The consortium has formed the CECASL joint venture to develop the project. The proposed supervision organisational chart that will be implemented during the operation of the HFO power plant is outlined on Figure 1.2.

CEC is a Lusaka Stock Exchange Listed Zambian Energy Company involved in power generation, transmission and distribution. It has been in existence for over 60 years and owns around 900 km of 220 kV and 66 kV transmission lines; 38 major substations; and 80 MW of embedded gas turbine generation.

TCQ was established in January 2012 to acquire, build, develop and operate power projects in Africa. It was set up by the Nasser family, who have experience in construction through their firm Target Engineering Construction Co. that is based in the United Arab Emirates. In December 2008, Target Engineering was sold to Arabtec Holding PJSC for more than US$ 200M to form TCQ.

In anticipation of future international funding, the project will be designed to meet the requirements of the IFC Standards and WBG EHS Guidelines.

Figure 1.2: CECASL, HFO Power Plant Operation Organisation Chart



1.4 Project Context

A history of lack of investment in generation, transmission and distribution of electricity has left a significant capacity deficit in Sierra Leone, with estimates that the 92MW current installed capacity was approximately 200 MW short of demand in 2008. In November 2008, the Sierra Leone Ministry of Energy and Power formulated the "statement of energy sector policy and strategic action plan," which contained a number of short, medium and long-term goals for the development of electricity capacity in Sierra Leone.

In addition to the need for new generation, significant replacement/rehabilitation work to Sierra Leone's high voltage electrical distribution system is needed. The presentation "CEC Africa SL Emergency Scope Overview" (dated 30.5 2013) indicates that the Sierra Leone distribution system consists of a limited 161kV system, a 33kV system (much of which does not function) and an 11kV system. The consequence of this is that the 11kV system is utilized to transmit power over significantly longer distances than is desirable, resulting in increased transmission loses.

The project has been in development since early 2013 and the ESHIA was initially commenced in December 2013. From June 2014 the Ebola crisis in West Africa significantly impacted Sierra Leone and prevented continued survey work. As part of ongoing discussions with World Bank / IFC, IFC has indicated that the project is critical to the post-Ebola rebuilding of Sierra Leone's economy. Therefore, CECASL has proceeded with this preliminary ESHIA in order to support ongoing project financing and technical design discussions.

The approach under the Ebola conditions during this period has been to focus the preliminary ESHIA on the key project issues required in order to progress the design. An assessment of issues of lower sensitivity/risk is included where information allows, but some are addressed as actions within the Environmental and Social Management Plan (ESMP). Whilst the World Health Organisation has not yet declared the end of the breakout, at the time of writing, cases have been significantly reduced, and transmission of the virus has been geographically confined to several small areas in western Guinea and Sierra Leone. It is expected that some aspects of the ESHIA may need to be revisited now that survey work and community engagement are possible. The ESMP is presented within Volume II of this submission.

Detailed mitigation will be developed and included as part of the detailed design phase, and the ESMP will be reviewed and updated accordingly at that stage. This approach has been agreed to by the IFC, World Bank and the EPA-SL.

1.5 Project Objectives

According to a 2006 report by the European Commission, Sierra Leone's energy production, supply and current utilization have serious implications for Sierra Leone's economy and environment. Bio-energy is the main source of fuel for approximately 75% to 80% of the country's population (both rural and urban). Petroleum, hydropower and coal are the major source of commercial energy in the country. The electricity sub sector contributes about 0.6 per cent of total energy consumption. Blackouts and power rationing, as a result of low water levels in the hydro dams are currently common. Power supply is restricted to mines or the major towns, where it is irregular and does not provide for minimum requirements. Aside from the project, hopes for improvement focus on the rehabilitation and expansion of the Bumbuna Hydro Power Plant.

According to the Sierra Leone Ministry of Energy and Power, the following key goals have been identified for attainment by the year 2017:

- 75% of the population should have access to individual electricity supplies (access is currently around 6%[2]);
- 15% access to electricity in rural areas (in 2009 this was 1%);
- Integration of the electricity grid with neighbouring countries; and
- Establishment of a framework for development and growth in the sector.

The primary objective of the project is to provide additional reliable and efficient electricity-generating capacity in Sierra Leone.

1.6 Project Scoping

The findings of the ESHIA scoping phase identified the following potential impacts associated with the construction and operation of the project. Full details of the potential impacts and associated mitigation measures are provided in Sections 7 through 14, where impacts are assessed in terms of likelihood and significance;

Socio Economics:

- Existing infrastructure, including water conveyance, waste management and health, and other social services are currently considered to be in poor condition in the project area.
- Construction will provide employment opportunities for approximately 200 people, including local workers.
- The project site itself has no inhabitants (legal residents or squatters). However, a number of residential properties and shanties are located adjacent to the site, with the potential for noise impacts. The project could potentially involve the relocation of surrounding households due to noise impacts.

[2] http://archive.crossborderinformation.com/Article/%EF%BB%BFNew+schemes+line+up+as+Sierra+Leone+promotes+baseload%2c+off-grid+options.aspx?date=20130627# (last accessed 15th April 2014)

- Development of the project site would result in the economic displacement and livelihood impacts on approximately 16 farmers currently farming on site.
- The operational phase will result in increased power generation capacity and supply for the Freetown economy. Skilled jobs for operations and maintenance staff will be provided by the power plant.

Occupational and Community Health and Safety:

- Specific occupational health and safety issues associated with power projects include the potential for exposure to confined spaces, heat, air quality and noise impact.
- The construction, operations and decommissioning of the project have the potential to impact the local communities' health and safety as a result of increased traffic movement and project-related hazards.
- A significant influx of workers from outside the area is not anticipated to result from project construction, as ample labour already exists in the project area. However, increased daily activity at the site would put pressure on already poor local infrastructure.

Noise:

- Construction activity will temporarily increase noise for the dwellings along the southern boundary, to the north of the site bordering South Road, a school-hospital-mosque complex adjacent to the southeast corner of the site and commercial properties along the remaining boundaries of the site.
- The major noise generating equipment associated with the operation phase of the project that will be considered in the noise assessment includes:
    - Six diesel engines operating simultaneously within an engine hall;
    - Four electrical transformers;
    - A cooling radiator array located at the roof level of the building; and
    - Associated infrastructure and buildings.

Air Quality:

- Construction activities are anticipated to temporarily disturb the land and increase vehicle movements, with resultant generation of dust and other fugitive emissions.
- Operational activities will result in emissions from the power plant stack from combustion of the HFO with the power plant engines.

Soils, Geology, Hydrogeology and Hydrology:

- Earthworks, excavation, trenching will impact ground conditions and may impact any shallow groundwater;
- Storage and handling of hazardous materials, including fuel and oils, in both construction and operational phases may pose a risk of land contamination through accidental release.
- Potential for contamination of soil to be uncovered during construction activities exists, in particular in the area of the old fuel pump;
- The abstraction of large quantities of groundwater from the onsite borehole has the potential to reduce groundwater resources available in the aquifer underlying the site.
- There is the potential for pollution of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during construction and operation.
- Contaminated groundwater has the potential to impact the quality of surface waters because of groundwater flows across the site (i.e., the Sierra Leone River Estuary [SLRE]).

- Contamination of surface water features could result from sediment loading as a result of surface water runoff. In addition a variety of materials and chemicals are likely to be used during construction and operation works, which could have varying polluting potential if spilled adjacent to or within the Old Railway Road Stream.
- No construction works will be undertaken within or adjacent to the SLRE or the Wellington Stream; however, there is the potential for works to be undertaken within and adjacent to streams and/or drainage channels that are hydraulically connected to these watercourses.

Ecology:

- The construction of the project has the potential to result in indirect negative impacts on the Sierra Leone River Estuary (a RAMSAR Wetland and International Bird Area) as a result of surface runoff and accidental spills
- During operation, potential impacts could include accidental HFO spills on the estuary as well as air pollution effects on habitats and species.

Wastes:

- Construction activities will generate waste requiring disposal. A major component of construction wastes will be the generation of soil which may require disposal offsite.
- Once operational, there will be few significant sources of solid waste generated, and the additional burden placed on the existing waste management infrastructure in the project area should be low. The principal solid wastes will be sludge from the treatment of HFO and the effluent treatment plant. HFO sludge waste will be burned in a small on-site incinerator designed to meet WBG Environmental, Health, and Safety Guidelines for Waste Management Facilities including, emission requirements in line with EPA-SL and international standards. The resulting ash is to be disposed of in the Central Dump in Freetown. Because this dump is not an engineered landfill and is not appropriate to accept hazardous waste, ashes will be analysed to confirm content is non-hazardous.

Traffic and Transport:

- Construction and operation activities will generate a small increase in heavy goods vehicles (HGVs), approximately 55 at peak, on the local roads with potential impacts to involve highway user safety, pedestrian delay, dust and dirt and movement hazardous loads. Although some minor improvements to local access roadways may be required, community safety risk levels on the local roadways associated with the project would be considered low.

Based on the findings of the screening and scoping stage, the construction and operational elements of the project are unlikely to have significant adverse influence on the following environmental aspects, and therefore a more high level assessment of these aspects has been carried out with details provided in Section 5 of this ESHIA:

- Climate Change (see Section 5.8);
- Cultural Heritage and Archaeology (see Section 5.9); and,
- Landscape and Visual (see Section 5.10).

1.7 Report Structure

The structure of Volume I: ESHIA main report, is as follows:

Non-Technical Summary: This provides an overview of the project, potential environmental impacts and proposed mitigation and monitoring strategies.

Section 1, Introduction and Overview: This section provides an introduction to the project, the findings of the screening and scoping assessment and an overview of the project objectives.

Section 2, Project Description: This section provides a description of the new development (including construction and operation) and an overview of the project location and its surroundings.

Section 3, Policy, Legal and Administrative Framework: This section summarises the key elements of national, local and international legislation and standards that apply to the project.

Section 4, Socio-Economic Baseline: This section presents the socio economic baseline conditions of the project area as identified by desk-based studies and supplemented by site visits.

Section 5, Physical Environmental Baseline: This section presents the baseline environmental conditions of the project area as identified by desk-based studies and supplemented by site visits.

Section 6, Environmental, Social and Health Impact Assessment Methodology: This section details the criteria applied to the assessment of potential impacts arising from the project elements described in the Section 2. It provides definitions of impact magnitude and significance as they apply to the potential effects on environmental aspects.

Sections 7 through 14, Impact Assessments and Mitigation: These sections present the likely impacts of the project elements on the identified social and environmental aspects:

- Section 7 – Socio Economic;
- Section 8 – Occupational and Community Health and Safety;
- Section 9 – Noise;
- Section 10 – Air;
- Section 11 – Soils, Geology, Hydrogeology and Hydrology;
- Section 12 – Ecology;
- Section 13 – Waste; and,
- Section 14 – Traffic and Transport.

Section 15, Stakeholder Consultation: This section presents the consultation that has been conducted for the project and includes a proposed plan for consultation moving forward.

Volume II: ESMP comprises one section, as follows:

Environmental and Social Management Plan: The ESMP presents the social and environmental management, mitigation and monitoring measures, including roles and responsibilities, identified in Volume I by the ESHIA process as required to be undertaken during project implementation and operation to implement the mitigation actions and reduce adverse environmental and social effects to acceptable levels and to enhance potential benefits.

Volume III: Appendices contains further information which supports Volume 1 of the ESHIA.

1.8 Cumulative Impact Assessment

Cumulative impacts may potentially result from implementation of the project at the same time as other identified proposed developments in the area.

Under Ebola conditions during 2014-2015, development has been limited and it is understood from information provided by Sierra Leone consultant INTEGEMS that no significant relevant new projects commenced or received planning permission during the Ebola period.

Prior to the Ebola period, the following significant developments were identified:

- The proposed Addax Petrojetty New Oil Jetty Project;
- A number of roadway projects currently underway in Freetown; and,
- The World Bank-funded NPA transmission line rehabilitation project (the EAP).

These projects are not relevant as a cumulative development for much of the ESHIA; however, where appropriate the ESHIA provides discussion and impact assessment for cumulative impacts regarding these developments.

As future analysis is conducted during the updated ESHIA, any new developments will be assessed and considered as appropriate.

1.9 Trans-boundary Impacts

The project is not located near the national borders and is not of a scale that is likely to result in trans-boundary impacts.

1.10 ESHIA Updates

Due to the Ebola conditions in Sierra Leone during 2014-2015, the survey and monitoring for the ESHIA have been limited. In particular, the conditions captured during noise monitoring at certain locations may reflect potential reductions in ambient noise levels as a result of reduced working activities and travel within the local area under Ebola conditions.

As the project progresses and detailed design is concluded, a greater level of certainty will be available regarding the project’s impacts and the environmental and social aspects that will require management during construction and operation. The assessment will be revisited as Ebola restrictions continue to be lifted.

2. Project Description

2.1 Project Ownership History

Blue Flare Power SL (BVI) Limited (Blue Flare) was founded to pursue opportunities for private sector investment in Freetown's electricity distribution network and power generation facilities. In July 2011, Blue Flare signed two foundational agreements with the GoSL: the Grid Development and Management Agreement (GDMA) and the PPA.

In 2012, TCQ entered into agreements with the founders of Blue Flare, and a Joint Development Agreement with CEC Africa Investments Ltd (CECA) was subsequently signed in April 2013. TCQ and CECA then formed a jointly owned company named CEC Africa (Sierra Leone) Limited (CECASL) based in Mauritius. The ownership of the firm is 49.9% TCQ and 50.1% CECA. In October 2013, it was agreed with GoSL/WBG that the original agreements would be cancelled and that a new PPA be signed that is limited to a generation project. A new Special Purpose Vehicle (SPV) wholly owned by CECASL was formed on the 13th of May that was signed with GoSL on the 15th of May 2014.

2.2 Project Development History

In late 2010, GoSL requested and reviewed three proposals to provide 120MW of generating capacity for the town of Freetown. The founders of Blue Flare were amongst those invited to submit proposals for review. The technical proposal was prepared and supported by a San Francisco-based firm, Suntrough.

During initial negotiations, it was suggested that rehabilitation of the 33kV grid be added to the scope, as a prerequisite to the generation project, due to the poor state of the distribution grid which would limit the ability of generated electricity to be delivered to customers and, therefore, NPA's ability to collect payments. This proposal was set out in a PPA, GDMA and a Project Framework Agreement. These agreements were given GoSL Cabinet approval in July 2011.

After CECASL took on the role of "Project Owner," it was agreed in consultation with WBG that the documents signed in 2011 would be superseded by a revised PPA.

CECASL's experienced project team, including CECA and TCQ personnel, has been active in pursuing the various project workstreams necessary to reach financial close and to commence construction. This ESHIA process is one of the key elements required prior to financial close.

2.3 Project Alternatives

2.3.1 'Do Nothing' Scenario

As outlined in Section 1.4 of this ESHIA, a significant capacity deficit exists with regards to power supply in Sierra Leone, and the use of the electricity distribution network in Freetown area is severely constrained by insufficient transport capacity and frequent outages. The "do-nothing" scenario would not alleviate the current limitations of low power generating capacity, high transmission and distribution losses, poor revenue collection and limited access.

The limitations to power supply development could adversely affect the economic development of Sierra Leone. The opportunity to develop future generations of solutions that enhance efficiency and profitability, contribute to economic diversification, accelerate human development and other growth drivers (such as international competitiveness, labour and employment, governance and public sector reform) would be lost. Therefore the "do-nothing" scenario is not a viable option.

2.3.2 Alternative Sites

A number of sites were considered by the GoSL with regard to the potential for new power generation 568 installations as part of a power sector masterplan produced for the GoSL by the Japan International Cooperation Agency (JICA) in 2008. Although the government has indicated on several occasions that other sites were considered, it has been unable to provide any data to substantiate its search.

Additionally, the government has indicated that the proposed site is the only government-owned land available in the area; however, the project proponent has not been given any further details of the site history or other sites considered, despite requesting this information on several occasions. According to the GOSL, there were no viable alternatives under government ownership as other potential sites with sufficient access proved to be difficult to identify in the area. CECASL found the size to be adequate and proceeded with the lease negotiation on the current site. The land is in an industrial area and, therefore, avoids the environmental impacts associated with greenfield development.

2.3.3 Alternative Technologies

Although there may be air quality emissions reductions associated with other fuel types, reciprocating engines firing HFO were selected as the most appropriate technology for the project primarily due to the absence of existing gas supply infrastructure. The power plant will be sourced through international competitive bidding, which is currently underway, and each phase is likely to be constructed on a turnkey basis under one Engineering, Procurement and Construction (EPC) contract. The diesel generator sets will be provided by major international manufacturers of diesel engines with a strong record in designing and building such engines.

In addition, there were two environmental aspects that resulted in alternative design proposals for water supply and waste disposal. First, the original design potentially required substantial cooling water intake and discharge with associated structures, which could have the potential to cause significant impacts on marine ecology. The design now accommodates for air cooling using the diesel engines that use ‘fin-fan’ radiators, which require negligible amounts of water to fill internal closed loop pipe circuits. This will not require a seawater abstraction and the associated infrastructure. Also, on the advice of the EPA-SL, it is clear that Sierra Leone does not have appropriate landfill facilities for hazardous waste. Therefore, the design alternative to address this gap was to include the installation of an on-site incinerator in the design proposals. The operation of the onsite incinerator will follow the WBG 2007 Environmental, Health and Safety guidelines for waste management facilities, with specific regard to the guidelines for hazardous waste incineration, and EPA-SL emission limits.

The layout for the project was also amended several times considering potential noise effects on adjacent neighbours as well as visual and other potential nuisance effects. The current brownfield site and proposed layout are likely to have considerable environmental advantages over the alternative of constructing new power generating facilities on a greenfield location or in a more heavily populated residential area. Although a comparative environmental assessment of alternative sites has not been carried out, alternative sites have been screened out on the basis that there are no viable alternatives under government ownership with sufficient access requirements.

2.4 Key Elements of Project

The power plant is planned to be developed in stages with an ultimate output of 128MWe. An overview of all three phases is provided in Section 2.4; however, details of design and timing of Phases 2 and 3 have not been confirmed at this time, on that basis the scope of the assessments included in this ESHIA are limited to Phase 1 only. This section summarises key elements of the development.

2.4.1 Site Layout

The plant configuration and layout shown on Figure 2.1 have been developed on the basis of a staged development and construction programme.

Key determinants of the layout and plant facilities have been:

- The limited area;
- The irregular plot shape;
- The need to achieve adequate road access into and around the power plant; and,
- Consideration of potential environmental and social impacts, such as waste, pollution control and noise levels at nearby sensitive receptors (principally adjacent residences, the school-hospital-mosque complex and the Sir Winston Churchill International Secondary School [Winston Churchill Secondary School]).

The current design comprises a single engine house in the centre of the site that can be extended as each phase is developed. A single tank for untreated HFO, two treated HFO storage tanks together with a service tank and a smaller light fuel oil storage tank are planned. In the final configuration, diesel generators are connected to six generator transformers that are connected by cables to the indoor 33kV substation.

A central control room will be provided, along with workshops, water treatment and effluent facilities, fuel oil treatment and other normal services. Exhaust from the Phase 1 stacks will be grouped into a shared enclosure, which will appear as a single stack from surrounding views and will assist with stack emissions dispersion.

2.4.2 Power Station

As previously detailed the power plant is planned to be developed in a number of stages, beginning with 50MWe and with a potential ultimate output of 128MWe to the transmission network. However, Phases 2 and 3 are likely to be developed in the future and any plans associated with these are considered preliminary and could change in the future. It is also important to note that EPC contractors for the project are currently being procured, so some of the detailed design regarding Phase 1 will require review and refinement once the appropriate contractor is secured. At present, design information for the project indicates that the power station will be constructed in phases likely to consist of the following engine configuration:

- Phase 1: 6 x 20v32 engines, each 8.9MW; and,
- Phases 2 and 3: 4 x 18v46 engine, each 17MW.

As indicated on Figure 2.1, permanent plant buildings will consist of:

- A totally enclosed, fan ventilated engine hall;
- A control building;
- A combined administration and workshop building (reuse of existing building on site);
- A security (gatehouse) building;
- A fuel oil pump house; and,
- A substation building.

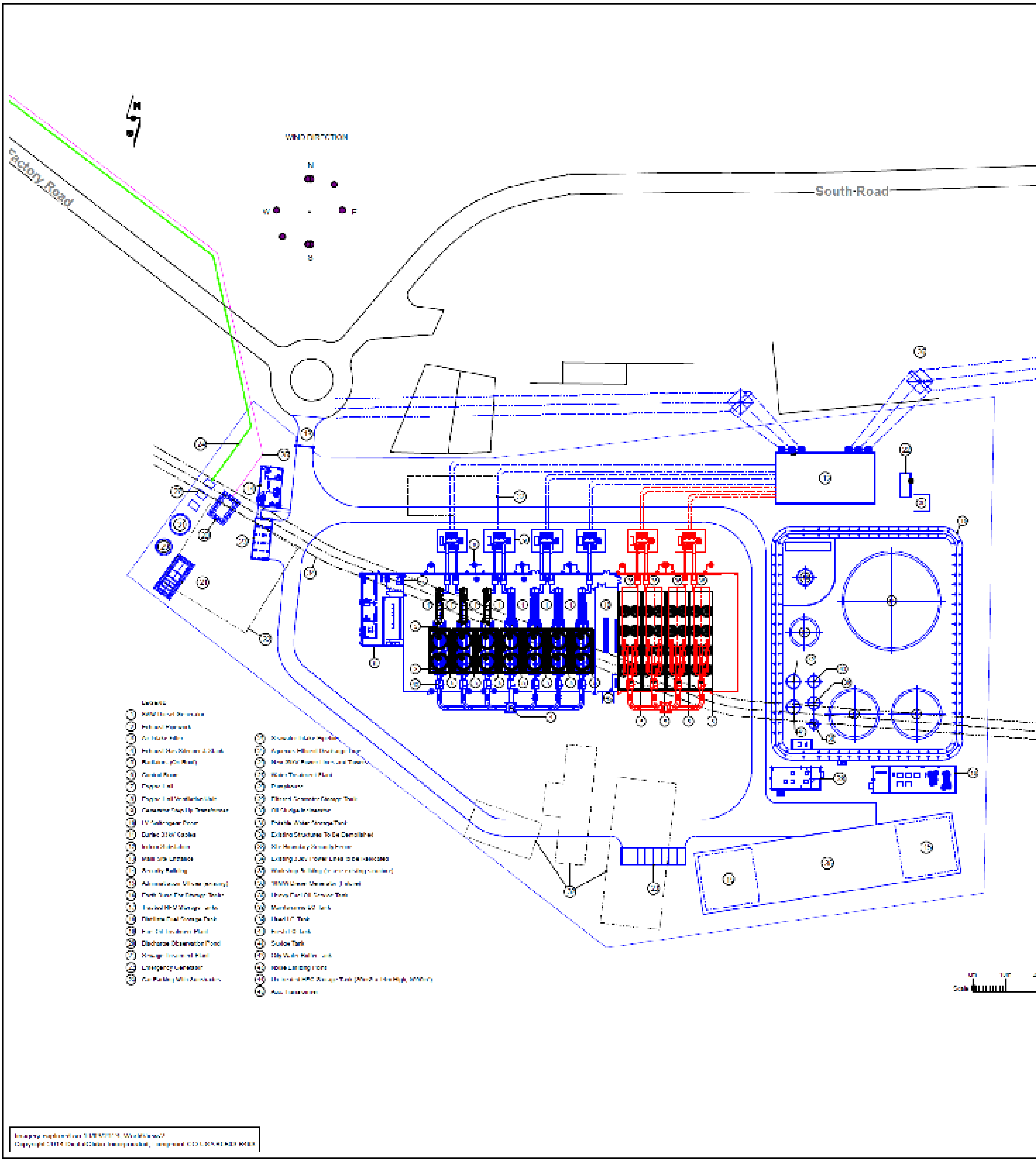
Other elements of the power plant will include:

- Perimeter site fencing and gates;

- A road way connection to the public highway, plus on-site roads, parking with sunshades and sealed areas. Partial regrading will be required to the roads used for the transport of goods;
- The refurbishment and reuse of buildings on the site to create administration offices and workshop facilities;
- A heavy oil filtration and treatment plant;
- Bunded storage for treated heavy oil and diesel oil;
- 11kV to 33kV step-up transformers;
- An indoor 33kV substation and overhead lines to connect from the generator step-up transformers to allow connection, at choice, with the existing 33kV line running to the west;
- Water supply and associated borehole;
- Tanks for filtered raw water (including fire water) and potable water;
- A sewage and effluent treatment plant;
- An observation pond for treated effluent prior to discharge to the environment, to allow inspection to confirm that no visible potential contaminants (such as fuel oil or diesel) are present in the discharged effluent;
- Waste incinerator;
- Messing, toilet and first-aid facilities; and,
- Civil works including roads, fencing and lighting.

A contract for operations and maintenance services for the debt repayment period of 10 years is expected to be in place from the date of commercial operation. During operations, the power plant is expected to employ approximately 45 permanent employees.

Figure 2.1: Project Site Plan


WIND DIRECTION
N
W
E
S
Factory Road
South Road

2.4.3 Plant Cooling System

The engine cooling system typically consists of a high temperature and low temperature (HT-LT) cooling system. The plant-related circuit will be additionally equipped with a nozzle cooling water system. Each system typically consists of a bank of fin fans (radiators) to cool the water, expansion tanks and circulating pumps.

All water systems will serve the Wartsila 20v32 6 diesel engines proposed for Phase 1 and engines developed for subsequent phases, including the complete cooling water forwarding and distribution lines from the radiators to the engines inside the power house.

2.4.4 Fuel

The fuel identified for project operations is HFO. The fuel specification provided for the project confirms that the HFO will have an ash residue of a maximum 0.15% and carbon residue of a maximum 20% to meet the WBG Thermal Power Plant Environmental Health and Safety Guidelines for air quality emissions, which include a fuel sulphur content of 2% or less for plants in a non-degraded airshed. Full details of the fuel specification are provided in Appendix A.

Light distillate oil (diesel) will be used for start-up of the engines. A small capacity tank will be provided to store this secondary fuel. This tank will be located within a dedicated bunded area in the main bund. Engines will be started one at a time. The frequency of the starts will depend on the PPA and how the plant is dispatched. Typically a single engine start, loading to 10,000kW, would consume 2.7m3/hour of this distillate fuel. This diesel fuel will also be used in the small 'black start diesel generator to be used in the event of a complete station black out and disconnection from the grid. The probability of such disconnection from the grid will be dependent on the security and stability of the grid. It would not normally be expected that such a disconnection would be a regular occurrence.

It is assumed that there will be one black start event per year. Initial studies suggest that a 500kVA black start diesel generating set would be adequate. Such a unit would have a fuel consumption of approximately 0.103 m3/hour. It is suggested that this consumption would last for no more than two hours, hence an annual consumption of 0.206m3 in a single, two-hour period.

2.4.5 Tank and Fuel Storage Area

HFO will be received at the new Addax jetty. Both the construction and operation phase of the project will require one vessel movement a month in the region, and the Addax jetty has capacity that is sufficient to meet this requirement. To ensure timely supply of materials at construction and adequate supply of HFO at operation, planning and scheduling of activities will take place in partnership with operators of the Addax jetty. As vessel movements are minimal, these will have no impact further to those addressed in the scope of the ESHIA for the Addax Jetty. Additionally ship-to-shore transfer of materials is also addressed as part of the Addax Jetty ESHIA.

CECASL will construct an appropriately bunded tank, located close to the landing jetty, in which to store HFO. From this tank, the HFO will be pumped via a new pipeline along the existing pipeline route to a terminal point within the power plant boundary. From this terminal point, the HFO will pass to the un-treated HFO storage tank. Individual tanks for un-treated and treated HFO, distillate, clean lubricating oil, used lubricating oil, sludge and oily water will be located within a bunded area. The HFO treatment plant will be located adjacent to the western perimeter of the bunded area.

2.4.6 Water systems

The application of simple cycle diesel engines means that the requirements for water are limited to initial fills and make up for the radiators, potable/washdown water and water for fire-fighting. Water is currently planned to be sourced from a single borehole on the current site (potentially supplemented by local municipal supply), the capacity of which has recently been confirmed and is described in further detail in the hydrology section. Other available water sources in the area include a 'municipal' potable water supply pipe running adjacent to the site (operated by Guma Valley Water Company Limited [GVWC]) and rainwater collection which would take place via proposed larger roof structures on the site, including the roof of the engine hall.

It is understood that a total daily volume of 210m^3/day is anticipated to be needed during the operation of the power plant. This is based on the following requirements:

- Potable water: 10m^3/day
- Service Water: 8m^3/day
- Demin Water: 192m^3/day

In addition, a peak instantaneous flow rate of 55m^3/hour would be required for fire water (beyond the existing capacity provided in the fire water tank).

An oily water treatment system (suitable interceptor) and storage for water to be consumed on site will be provided, together with a small sewage treatment plant. Rainwater collection and borehole water will be filtered before storage in a dedicated "raw water" tank, which will also provide storage capacity for fire water.

The raw water will be passed through a second stage of filtration and UV or chlorination treatment before passing to a dedicated "potable water" tank. There is no plant requirement for de-mineralized water. Treatment of oily water, sewage and any effluent to be discharged from the site will be in line with the more stringent of WB/ IFC EHS Guidelines and Sierra Leone legislative requirements where available.

Waste water treatment capacities will be: include:

- 0.25m^3/hr - Sewage,
- 10m^3/h - Oily water

These will produce an average total discharge offsite of 0.25m^3/hr following treatment.

It will be treated to meet all EPA-SL and international community health and safety standards. The final discharge point for treated water is not established, but is likely to be the stream along Railway Road to the south of the site. Alternatively, storm water drains adjacent to the site entrance may be used for discharge in the unlikely event that no other option can be confirmed. Information on local drainage networks and the condition of surface water features will be collected post-Ebola in order to finalise the discharge location.

2.4.7 HFO Sludge

The on-site treatment of HFO prior to injection into the Diesel engines produces a waste called sludge. The volume of sludge produced will typically be in the range of 1.5% - 2% of HFO treated. Estimated quantities of sludge produced are:

- 50MW, 150-200 kg/hr;
- 89MW, 268-357 kg/hr; and,
- 128MW, 385-513 kg/hr.

This sludge must be disposed of in an environmentally acceptable manner. However, it is currently understood that there are currently no waste disposal facilities within Sierra Leone capable of processing this waste.

The project design includes a small on-site incinerator where HFO sludge waste will be burned with the ash remains disposed of to the existing municipal landfill facility known as Central Dump. Chemical constituents of this ash waste will be confirmed, but will likely contain salts of sodium, vanadium, magnesium, silicon, etc. Operations of the incinerator will be infrequent and intermittent, and are likely to occur once or twice a week. Emissions from the incinerator are considered in the air quality impact assessment.

2.4.8 Emissions to air

The power plant will comply with the requirements for emissions to air set out in the WBG EHS Guidelines for Thermal Power Plants (WBG 2008) (see section 3.3).

At this stage of the project design, information from a potential engine technology provider (Wartsila) were used to determine the emissions to air to enable an appropriate assessment to be carried out. Wartsila engines were selected for the exercise given their wide use in similar developments in sub-saharan Africa. In the event that Wartsila engines are not ultimately used for the project, remodelling will be required based on the selected manufacturers details. The emissions for engines produced by another manufacturer are unlikely to vary significantly to those assessed and would also need to comply with the relevant IFC emission limit values adopted for this assessment.

The initial design for Phase 1 of the project includes six diesel engines based on the Wartsila 20v32 generating sets. It is anticipated that the exhaust stacks from each engine will be grouped together either in a common windshield or in a closely-fitting group. This has been designed to provide better dispersion of emissions to the atmosphere and would lead to lower ground level pollutant concentrations in the vicinity of the site.

The emissions to air for the Wartsila 20v32 generating set is provided in Table 2.1.

Table 2.1: Engine Emissions to Air for Phase 1*

Engine Type	Emission concentration (mg/Nm^3)				Emission rate (g/s)			
	NOx	SO_2	PM	CO	NOx	SO_2	PM	CO
Wartsila 20v32	1460	1170	50	150	29.0	23.2	0.99	3.0

*Fuel Specification used in model developed by Wartsila

As detailed, the power plant will also include a HFO waste sludge incinerator. When the incinerator is operating, it is likely to emit the same pollutants as the engines. However, it is anticipated that the incinerator will only need to operate intermittently, for a few hours per week, and therefore, the emissions are considered to be negligible on a long-term basis, provided that correct temperatures are maintained to avoid the generation of dioxins. Emissions from the incinerator will be quantified at detailed design stage and incorporated into the assessment, which would be required to confirm the detailed design and will meet WBG guidelines.

2.4.9 Noise Emissions

Noise impacts, control measures, and recommended ambient noise levels for thermal power plants are presented in Section 1.7 of the General EHS Guidelines. The WBG noise level guidelines are presented in Table 2.2. It is required that noise abatement measures should achieve either the following levels or a maximum increase in background levels of 3 dB(A).

Table 2.2: WBG/IFC General EHS Guidelines: Noise Level Guidelines (dB)

Receptor	Daytime 07:00-22:00 hrs ($L_{Aeq\ 1hr}$)	Night-time 22:00-07:00 hrs ($L_{Aeq\ 1hr}$)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

2.4.9.1 Sound Power Levels with Standard Mitigation

Sound power data included in the modelling for this project was provided by Wärtsilä, a major international supplier of diesel engines. As it is standard to supply power projects in urban environments with noise attenuation (such as engine halls, air intake attenuators, exhaust silencers, ventilation attenuators), the measures outlined in Table 2.3 have been included in the modelling labelled 'standard mitigation' scenario.

Table 2.3: A-weighted Sound Power Levels with Standard Mitigation

Source	Total SWL, dB(A)	Assumptions in model	Source Location	Sound Data Source
Radiators	112	28 x radiator fans at 97 dBA SWL per fan.	4m above engine hall roof	Wärtsilä library data
Engine hall walls & roof	105	110 dB internal SPL incident at engine hall walls. Engine breakout through Rw=33 dB building walls & roof	Engine hall building envelope	Wärtsilä library data
Charge air	105	14 x attenuated charge air intake apertures with SWL of 94 dBA per aperture.	4m a.g.l at southern engine hall wall	Wärtsilä library data
Engine Hall ventilation outlets	105	7 x ventilation fans at 109 dBA SWL per fan, attenuated with 1400mm attenuator = 96 dBA SWL per fan.	6m above engine hall roof	Wärtsilä library data
Exhaust gas	102	7 x stack outputs at 93 dBA per stack. No directivity. High performance exhaust gas silencer.	At top of 27.5m stack	Wärtsilä library data
Engine Hall ventilation unit	93	7 x units at 84 dBA per unit.	3m a.g.l to north of engine hall	Wärtsilä library data
Breakout from exhaust ducts	89	71m of ductwork radiating SWL of 70 dBA per metre length of duct	Between building and stack	Jacobs Library data
Transformer s	96	4 x transformers at 90 dBA per transformer. No directivity.	3m a.g.l 10m to north of engine hall	Jacobs Library data

2.4.10 Construction Phase and Schedule

The proposed construction schedule for Phase 1 is anticipated to be completed 18 months from financial close, which is likely to be late 2015. At the peak of construction, the project is anticipated to employ up to 200 construction workers from the surrounding communities including Shell, Hotel 5-10, Kissy Thunderhill and Kissy Brook communities, where unemployment levels are currently high. There are currently no plans for a workers' camp.

It is currently anticipated that the site is large enough to provide required construction laydown areas for phase 1. It is anticipated that plots of land will be available locally to be rented for use as laydown areas during construction for subsequent phases. Should offsite laydown areas be required, the EPC contract includes relevant provisions to ensure that the EPC Contractor employs standard and site-specific environmental mitigation controls in line with WBG / IFC standards for pollution prevention and control, community health and safety and potential land acquisition.

2.4.11 Pipeline and Project Infrastructure

Development for the project consists of a fuel pipeline from the Addax Jetty, where fuel will be obtained as shown on Figure 2.2. The pipeline will follow an old HFO line and most of the route will be above ground, and will be within the secure area of the NPA and disused refinery. A walkover of the proposed pipeline by INTEGEMS in March 2015 confirmed that a short section of the existing route (less than 100m, from the NPA gate to the boundary of the old refinery) is currently outside of the NPA boundary and is accessible to the public.[3] As a result, CECASL will re-route this section of the pipeline to enter the site at an earlier point and avoid any public exposure or conflict with surrounding uses. A number of short sections of the route, including the final section from the refinery into the plant site, will be buried for similar reasons.

The pipeline will be approximately 1300m long. As shown on Figure 2.2, a pump station and buffer tank will also be constructed along the pipeline route at the coast as part of this project. The tank would be fenced off and approximately 36m in diameter and 16m in elevation with a capacity of 16,000m^3.

The power will be exported to the national transmission and distribution network, which is owned and operated by the NPA, the connection scope is provided in Appendix B. It is intended that building the plant capacity in stages will allow for the concurrent development of evacuation capacity within the grid through projects such as the EAP, which aims to rehabilitate the grid.

2.4.12 Site access and roads

Access to the site will be via South Road (see Chapter 14). The roads that will be used for the transport of goods will require partial regrading, and maintenance during construction. As described in Section 8.3.2 and Chapter 14, a Transport Management Plan will be developed which will address risks associated with community safety. This will include measures such as raising awareness of general road safety, and in relation to the likely changes in traffic due to project construction. Appropriate checks in relation to this aspect of community safety will be included in the project audit by the contractor and the owner's engineer.

[3] Video footage of the walkover is available.

Figure 2.2: Associated Development

National Petroleum Jetty
NP Facility
Disused Refinery
Wellington Creek
South Road
Factory Road
CECA Project Site
Imagery captured on 10/03/2013, WorldView-2.
Copyright 2014 DigitalGlobe Incorporated, Longmont CO USA 80503-6493
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2.4.13 Project Site Surrounding Area

Land uses surrounding the site include the following:

- **North:** The disused refinery and other primarily commercial and industrial properties, reflecting the industrial zoning of the project site and local area. There is a polio treatment compound on the northern side of South Road and some residential dwellings on the southern side of South Road. There are also some shanty housing and stores located directly adjacent to the site entrance.
- **East:** A school/mosque/health clinic is located directly to the southern end of the eastern boundary. Commercial properties are located adjacent to the remainder of the eastern boundary.
- **West:** The German Academy and the Winston Churchill Secondary School are located along Factory Road. There are some artisanal farming areas within the storm drain overflows along South Road.
- **South:** There are residential buildings along the length of the western portion of the southern boundary, with commercial uses to the southeast. Some shanty developments are present behind shops to the southeast[4].

In general, the area is characterised by industrial and commercial uses with some formal and informal shanty dwellings and school dispersed between. Key features of the surrounding area are shown on Figure 2.3.

2.5 Associated facilities

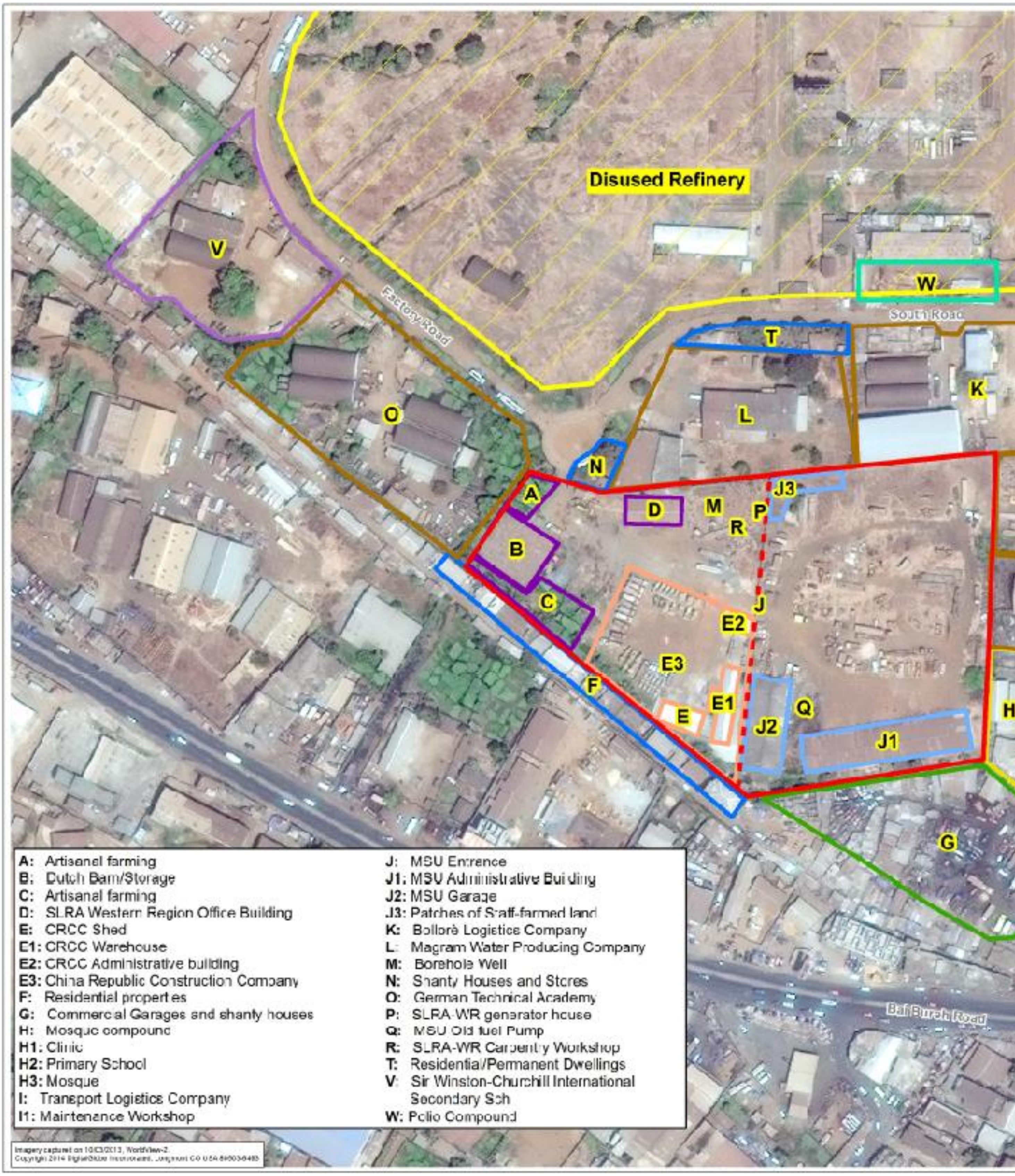
Associated facilities are defined in IFC PS1 as *"facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable*".

PS1 states that environmental and social risks and impacts should be identified in relation to the context of the project's area of influence including any such associated facilities, however there are no associated facilities consistent with this definition to be developed for this project.

- The pipeline is a project facility and, as such, is covered by this ESHIA
- The Addax jetty to be used is not an associated facility because it is a separate government/private sector project that is open to use by others, and was not designed with the plant in mind.
- The transmission line and substations are not associated facilities as both are already existing and are being upgraded as part of a long standing project by World Bank.
- The access road is not an associated facility as it is already in existence, but the road is covered by this ESHIA in the context of transport community risk.

[4] During a site visit in September 2015, it was observed that the eastern portion of area G has been cleared. Anecdotal information indicates that this area has been purchased privately and will be cleared for construction of a warehouse building.

Figure 2.3: Project Site Surrounding Area


Disused Refinery
V
W
South Road
T
K
L
Factory Road
O
N
A
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P
J3
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J
E2
E3
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E1
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J2
Q
J1
H
G
Bai Burah Road
A: Artisanal farming
B: Dutch Barn/Storage
C: Artisanal farming
D: SLRA Western Region Office Building
E: CRCC Shed
E1: CRCC Warehouse
E2: CRCC Administrative building
E3: China Republic Construction Company
F: Residential properties
G: Commercial Garages and shanty houses
H: Mosque compound
H1: Clinic
H2: Primary School
H3: Mosque
I: Transport Logistics Company
I1: Maintenance Workshop
J: MSU Entrance
J1: MSU Administrative Building
J2: MSU Garage
J3: Patches of Staff-farmed land
K: Bolloré Logistics Company
L: Magram Water Producing Company
M: Borehole Well
N: Shanty Houses and Stores
O: German Technical Academy
P: SLRA-WR generator house
Q: MSU Old fuel Pump
R: SLRA-WR Carpentry Workshop
T: Residential/Permanent Dwellings
V: Sir Winston-Churchill International Secondary Sch
W: Polio Compound

3. Policy, Legal and Administrative Framework

3.1 Introduction

Relevant identified legislation, regulations, policies, guidelines and standards from Sierra Leone and International treaties, standards and guidance will be considered in the development of the ESHIA.

3.2 Sierra Leonean Legislation

The applicable legislation and standards from Sierra Leonean legislation is provided in the Table 3.1.

Table 3.1: Relevant Sierra Leonean Legislation

Legislation/Policy	Summary
National Environmental Policy	The National Environmental Policy (1994) seeks to achieve sustainable development in Sierra Leone through the implementation of sound environmental management systems which will encourage productivity and harmony between man and his environment. It also promotes efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of nationals, and serves to enrich the understanding of ecological systems and natural resources import ant to the Nation.
National Energy Policy	The objective of the National Energy Policy (2010) is to ensure the provision of modern energy services for increased productivity, wealth creation and improved quality of life for all Sierra Leoneans. The energy supply sub-sectors covered by this policy are electricity, petroleum and renewable energy, with a focus on increasing the supply of modern energy supplies for Sierra Leone. The policy is geared towards increasing supplies, through a comprehensive reform of the power sector, including liberalization of the sub-sector, attracting private investments and involvement and putting in place more effective mechanisms for monitoring and control. For the petroleum sub -sector, the upstream focuses on oil exploration, while the downstream addresses measures to reduce costs, without compromising security of supply.
National Land Policy (2005)	The National Land Policy promotes the objectives of equal opportunity and sustainable social and economic development. The principles guiding the Land Policy include: (1) protecting the common national or communal property held in trust for the people; (2) preserving existing rights of private ownership and (3) recognising the private sector as the engine of growth and development, subject to national land-use guidelines and rights of landowners and their descendants.
National Water and Sanitation Policy (Draft)	This draft policy was developed in the light of the increasing challenges to the management to water resources in the country.
Environment Protection Agency Act, 2008 (No. 11 of 2008) as amended in 2010.	This Act establishes the Environment Protection Agency, defines its functions and powers, provides for its organization and administration and provides rules for various matters regarding the

	environment in Sierra Leone. The Agency is established as a corporate body managed by Board of Directors and an Executive Director. Part IV of the Act exclusively deals with the activities requiring a full Environmental and social impact assessment and describes the permitting processes leading to the acquisition of an environmental licence.
National Electricity Act, 2011.	This act provides for the establishment of the Sierra Leone Electricity Generation and Transmission Company which should be responsible for the generation, transmission and sale of electricity to the Authority (Electricity Distribution and Supply Authority) also established in section 25 of the act. The Company, headed by a Director General and Board of Directors, takes over ownership of all power generation and transmission assets of NPA, BKPS and Bumbuna Hydropower and is responsible for future development of national grids as determined by the government. The act recognises role of Independent Power Producers in generating and selling electricity to the Authority for retail sale.
Fisheries Management and Development Act, 1988 (Act No. 4).	This Act provides for the management, planning and development of the fisheries of Sierra Leone in the water over which fisheries jurisdiction is asserted from time to time. Authority and administration is covered by Part II; exclusive management and control over the fisheries and other aquatic resources is vested in the Government, with responsibility for administering the Act placed upon the Minister responsible for Agriculture, natural resources and forestry, though a Department of Fisheries is also created by the Act.
Factories Act, 1974	This Act deals with health and safety measures as they concern the factory worker. It protects the worker through demands for all aspects of cleanliness, reports of all injuries, accidents, diseases and death. It makes provision for inspection of facilities, prescribes the powers of an inspector and sets penalties for defaulting parties.

The work of several Ministries, Departments and Agencies (MDAs) also impacts the work of the EPA-SL to varying degrees. These include the Ministry of Finance (fiscal and tax matters), the Ministry of Lands, Country Planning and the Environment, the Ministry of Local Government and Community Development (communal lands) and the Ministry of Works, Housing and Technical Maintenance. These ministries have been and will continue to be engaged with as part of the ESHIA consultation and disclosure process to ensure any relevant requirements or concerns regarding the project are considered as appropriate. Administratively, Sierra Leone is divided into various administrative areas/units: Country, Province, District, Chiefdom, Section and Village.

3.3 International Treaties/Standards/Regulations

The applicable legislation and standards from international treaties, standards and regulations are provided in Table 3.2.

Table 3.2: Relevant International Treaties/Standards/Regulations

Policy/ Legislation	Summary	Year of Adoption	Year of Ratification
Abidjan Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the West and Central African Region	To protect the marine environment, coastal zones and related internal waters falling within the jurisdiction of the States of the West and Central African region. The Parties agree to take all necessary measures to prevent, reduce, combat and control pollution of the Convention area (art. 4). Parties undertake to prevent, reduce, combat and control coastal erosion (art.10) and protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species and other marine life in specially protected areas (art. 11).	Adopted 1981, In force since 1984.	Ratified by Sierra Leone on 7 June 2005
Convention on Migratory Species (CMS)	Sierra Leone is not a signatory to CMS, although has signed a Memorandum of Understanding concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa. This is a non - binding agreement under article IV (4) of CMS. It aims at safe guarding six marine turtle species that have declined in numbers in recent years.	Entry into force: 29 May 1999	
Ramsar Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention)	An international treaty that embodies the commitments of its member countries to maintain the ecological character of their 'Wetlands of International Importance' and to plan for their sustainable use. The criteria for identifying Wetlands of International Importance' include: sites containing representative, rare or unique wetland types; sites of international importance for conserving	Entered into force 2nd February 1971.	Ratified by Sierra Leone 13 April 2000

	biological diversity, which includes specific criteria on species and ecological communities, waterbirds and fish (Ramsar Convention Secretariat, 2011a).		
Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972	To protect the marine environment from all sources of pollution and to prevent, reduce and where practicable eliminate pollution caused by dumping or incineration at sea of wastes and other matter.	Entry into force: March 24 2006.	Ratified by Sierra Leone March 10 2008.
United Nations Framework Convention on Climate Change	To regulate levels of greenhouse gas concentration in the atmosphere, so as to avoid the occurrence of climate change on a level that would impede sustainable economic development, or compromise initiatives in food production.	Entered into force globally 21 March 1994.	20 September 1995
Vienna Convention for the Protection of the Ozone Layer	Acts as a framework for international efforts to protect the ozone layer.	Signed in 1985	Came into force in 1988
Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol)	To protect the ozone layer by taking precautionary measures to control global emissions of substances that depletes it. E.g. binding reduction goals for the use of CFCs.	Global Entry into force 1 January 1989.	
The Stockholm Convention on Persistent Organic Pollutants	To eliminate or restrict the production and use of persistent organic pollutants (POPs) – chemicals that are persistent bio-accumulates found in fatty tissues and are bio-magnified through the food chain, and adversely affect health and the environment.	22 May 2001	Sierra Leone became a signatory on the 27 August 2001. The convention came into force on 17 May 2004.
Aarhus Convention	Establishes a number of rights of the public (individuals and their associations) with regard to the environment.	25 June 1998	30 October 2001

This ESHIA also considers the policies, guidelines and standards of the WBG's IFC. The requirements of the World Bank Multilateral Investment Guarantee Agency essentially reflect those of the IFC Standards for private sector projects. These are outlined in Tables 3.3 and 3.4.

Table 3.3: International Standards Considered for the ESHIA

Guidelines	Summary
Performance Standards on Social and Environmental Sustainability (2012) ('the IFC Standards')	Performance Standards establish standards that the project developer is to meet throughout the life of an investment by IFC: ● Performance Standard 1 (PS1): Assessment and Management of Environmental and Social Risks and Impacts ● Performance Standard 2 (PS2): Labour and Working Conditions ● Performance Standard 3 (PS3): Resource Efficiency and Pollution Prevention ● Performance Standard 4 (PS4): Community Health, Safety, and Security ● Performance Standard 5 (PS5): Land Acquisition and Involuntary Resettlement ● Performance Standard 6 (PS6): Biodiversity Conservation and Sustainable Management ● Performance Standard 7 (PS7): Indigenous Peoples ● Performance Standard 8 (PS8): Cultural Heritage.
WBG, Environmental, Health, and Safety Guidelines (2007 - 2008), World Bank/IFC ('the EHS Guidelines')	The EHS guidelines list general and industry specific impacts and management strategies, occupational health and safety issues and performance indicators to be observed. Relevant for this project are: ● The General EHS Guidelines; ● The EHS Guidelines for Thermal Power Plants; ● The EHS Guidelines for Waste Management Facilities; and, ● The EHS Guidelines for Electric Power Transmission and Distribution.

This ESHIA has also been undertaken with consideration of the African Development Bank's (AfDB) 'Environmental and Social Assessment Procedures' (AfDB, 2001), and the associated 'Integrated Environmental and Social Impact Assessment Guidelines' (AfDB, 2003).

4. Socio-Economic Baseline

4.1 Introduction

Data described within this section was derived predominantly from reports provided by Oxfam (Sierra Leone) for the purposes of the project, including information collated as part of the 2007 Strategic Water Supply and Sanitation Framework (SWSSF) carried out by Atkins, Oxfam and a local associate 3BMD, on behalf of the GVWC, Freetown. An Environment, Conflict and Peacebuilding Assessment technical report completed by the United Nations Environment Programme (UNEP) in 2010 also informed this section. Information available about the Kissy area itself is limited. Therefore, information relating to the Western Area or Sierra Leone as a whole has been used with any likely variation in the Kissy area highlighted where possible. Although this information is not all current, it represents the most up to date information available at this time. Alternative sources of information have also been sought, but under Ebola conditions during 2014-2015, census data is not available as surveys have not been carried out, and it is unknown when they will be completed. As such, it is not possible to collect up-to-date information at this time, and current baseline data will need to be verified during the implementation of the ESMP (Volume II).

4.2 Household Survey

In order to supplement the desktop studies completed for the project and to understand baseline conditions in the local community, INTEGEMS conducted household surveys in March 2015 within a 500km radius of the project site. A total of 320 households from the surrounding community were surveyed as illustrated on Figure 4.1. Participants included adjacent households, farmers, local businesses adjacent schools and complexes and other members of the adjacent community. The household survey included representatives from each type of use in the area. In addition, 18 businesses and five schools were surveyed. This survey work was conducted using proper personal protective equipment (PPE) appropriate under Ebola conditions at the time, and was reasonably extensive under the circumstances. However, it is recognised that conditions under Ebola may not accurately represent business-as-usual baseline socio-economic conditions in the project area, and further survey work (supplemented by project consultation) should be conducted to confirm any conclusions of this survey post-Ebola. The results from the household surveys are presented herein.

The survey noted the following existing socio-economic challenges in the community:

- Inadequate solid waste management and disposal, water and sanitation issues;
- Lack of access to potable water;
- Prostitution, teenage pregnancy and alcoholism;
- Lack of access to basic social services (i.e., health);
- Limited income-generating activities, especially among the youth; and,
- Increase crime theft and security issues in the area remain unaddressed.

The household survey also identified the following key concerns and perceived benefits from the community for the project:

Table 4.1: Household Survey Project Concerns and Benefits

Concerns	Perceived benefits
Increase noise, pollution and vibration	Access to reliable electricity

Potential physical displacement	Potential employment opportunities, but concerned that people do not have the needed skills for those potential jobs
Increased demand for social services and rental accommodations that are currently lacking/limited	Access to potable water
Girls exposed to increased risk, higher teenage pregnancy	Access to solid waste management
Increase traffic and safety issues, especially to children	Potential for improved roads
Increase crime rates and implications for overall social safety	Potential business opportunities
Increased exposure to diseases	

Figure 4.1: Socio Economic Survey Area

4.3 Socio-economic Structure of Sierra Leone

Sierra Leone is a constitutional republic with a directly elected president. It consists of four provinces split into 14 districts. The Western Area province or Freetown Peninsula is comprised of the Rural Western Area and Urban Western Area districts. The project site is within the Urban Western Area district. This is the most affluent area of the country and is the governmental, cultural and financial centre. Despite this characterisation, a 2008 Atkins report classified it as a "poor area" (but not very poor), with medium population density, and having some coverage of essential services and a sense of security.[5] The Kissy peninsula is highly built-up compared to other parts of the country.

4.3.1 Project Area of Influence

The area of socio-economic influence for the project is considered to be 5km around the site based on a review of the population and economic assets likely to be influenced by the project. This area of influence was selected because it covers all of the adjacent communities where the project is expected to create direct economic or social impact. This includes the Fisher Lane district to the north, beyond which is the Sierra Leone River Estuary. To the southeast is Wellington, and to the west and northwest are Allen Town, Maeba Town, Kortright, Foulah Town, Mount Aureol, Tower Hill, Magazine, Jinger Hall, Cline Town Upgun Area and Kissy Dockyard. To the south and southwest are vegetated areas with a lower population density.

4.3.2 Population Demographics

Statistics Sierra Leone (the GoSL Department for statistics) (SSL) indicated that the last national census was undertaken in 2004. Under Ebola conditions, census data scheduled to be collected in 2014 was not available as surveys were not carried out, and it is unknown when they will be completed. Population projections for the project are based on information published in reports obtained from the consultant Corrado Minervini in June 2012. Predictions indicate that in 2012, Freetown's population consisted of 1,069,437, but could almost double between 2012 and 2030 to 1,933,341. Approximately 73% of the population is currently living in slum areas. The Core Welfare Indicator Questionnaire Survey (CWIQ) 2007, undertaken by Statistics Sierra Leone for the GoSL, indicates that 48.3% of the population is male, and 51.7% female. The population nationally has a high proportion of young people (34.7% age below 15, and only 6% only above 60). Within the (more urban) Western Region, this is less marked, with 29% under 15, but only 3.5% over 60. In 2007, average household size was 6.0 in urban areas, and amongst poor households in urban areas, was 11.8. Amongst families in which polygamy is practiced there are typically 2 to 3 wives.

4.3.3 Household Characteristics

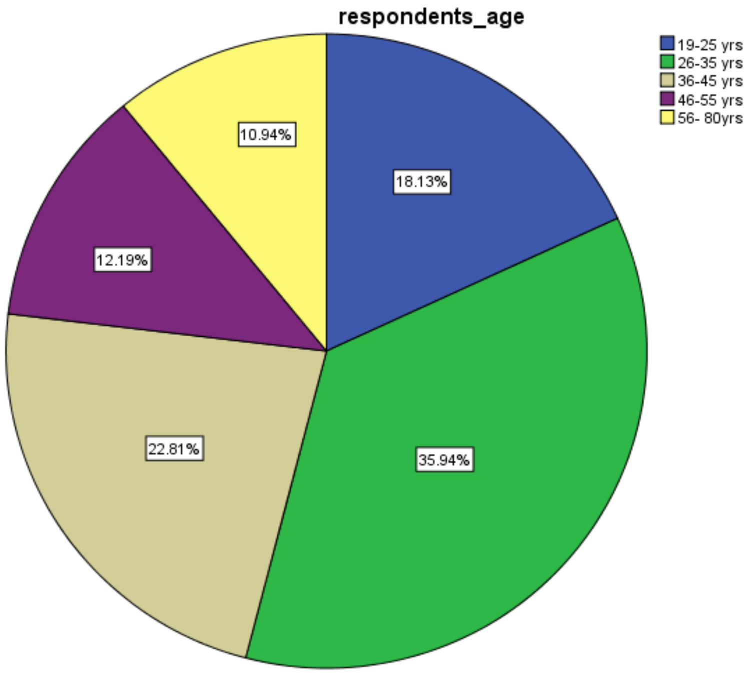
As shown in Table 4.2 and on Figure 4.2 of the households surveyed, more women (56%) than men (44%) responded about their households, predominantly aged between 26 to 35 years (36%) of age. A significant number of respondents (71%) were married, while 22.5% indicated that they are single.

Table 4.2: Frequency of respondent by gender

Gender	% Respondent
Female	55.9
Male	44.1

[5] Atkins, *Freetown Strategic Water Supply and Sanitation Framework: Community Perceptions of Water Supply and Sanitation, Consultation Workshop*, 13th March 2008

Figure 4.2: Age Groups of Survey Participants



Households surveyed were generally divided into those supporting between one to five members and those with six to 10 members, both with equal percentages (44.7%). Only 10.6% of households have more than 10 household members, as illustrated on Figure 4.3.

Dwelling houses in the project area are typically single unit buildings (23%), adjoining units in a compound (22.5%) as well as several single units in a compound (18%). Co-existing households in dwelling units are quite common in the community, with 70% dwelling units combining one to five households. About 4% of surveyed units housed more than 25 households.

According to the survey, many households surveyed indicate that they have lived in the community for less than six years (35%) or between seven to 15 years (33%), as depicted on Figure 4.4. The reasons for households moving to the project area include issues with accommodation (i.e., affordable accommodation or easy access to land), employment or business opportunities and the cost of living in another community. A large number of households moved into the area without prior family ties in the community (59%) and had no difficulty settling into the community (78%). For the households that had difficulty with settling, the reasons provided relate to poor road networks, water supply and difficulties with settling in a new community.

Figure 4.3: Household Size

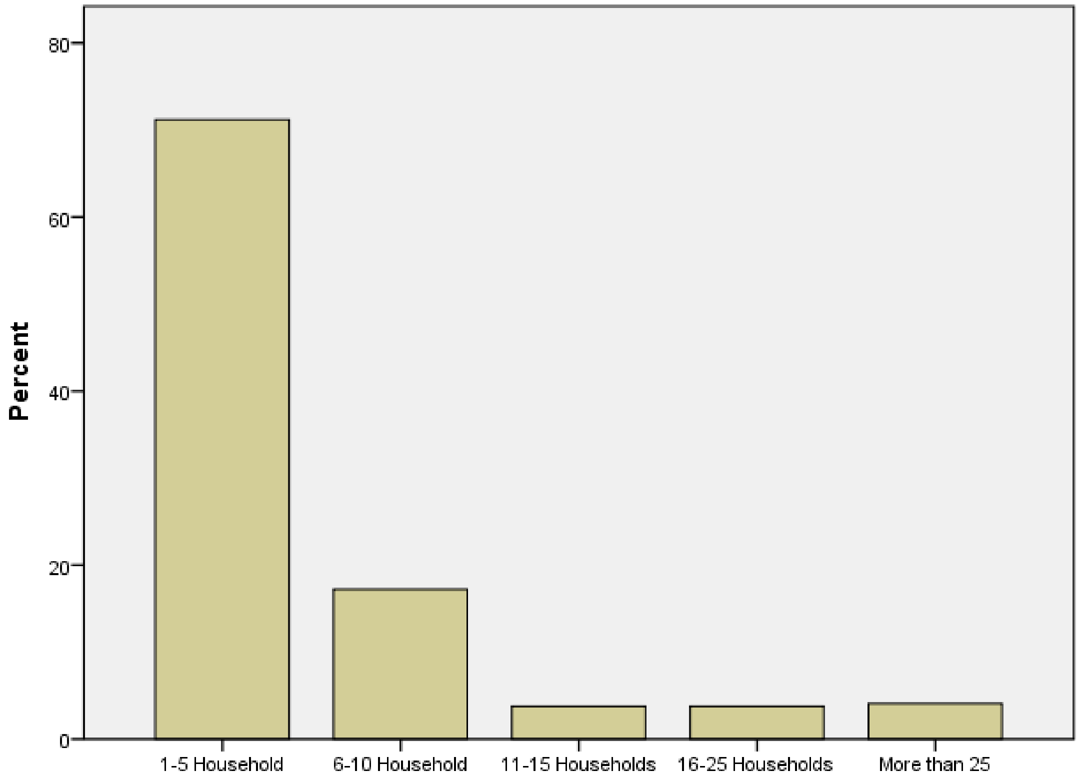
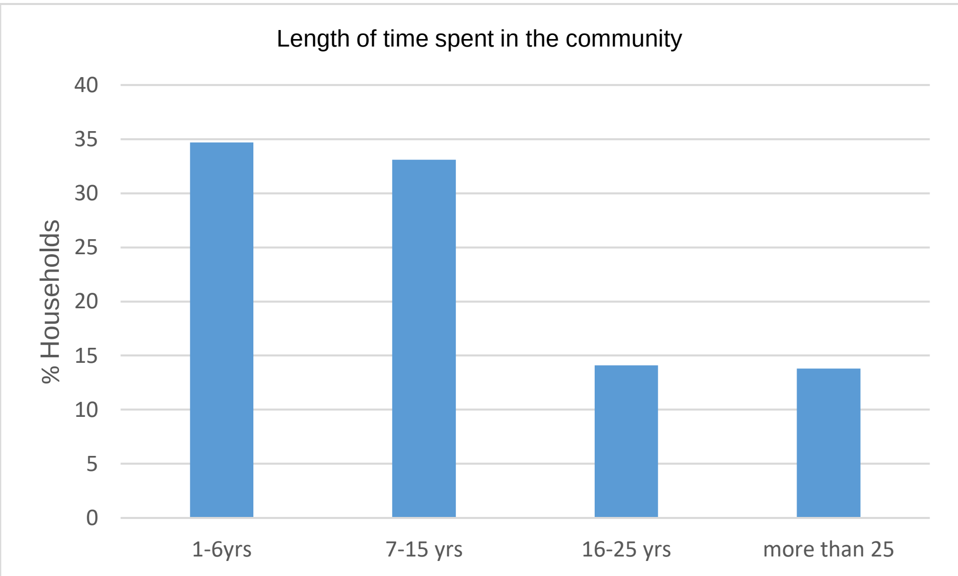


Figure 4.4: Tenancy in the Community



4.3.4 Race, Ethnicity and Language

Ethnic groups found within the Western Area include all of the ethnic groups in Sierra Leone. The Creoles are the indigenes of Freetown, and this ethnic group makes up the highest proportion of the population.

The main ethnicity of the Kissy area is not known, but is assumed to be the same as for Freetown as a whole (Creole). A UNEP Report on Sierra Leone (2010) describes the major religions in the Western Area as Islam (60%) and Christianity (30%) practiced by groups that have migrated into Freetown. The official language of Sierra Leone is English, although Krio is spoken by 90% of the country's population, and by 10.5% as a mother tongue. Mende and Temne are also spoken widely in the north and south of the country rather than in Freetown. According to the household survey, 79% of the local community identify as Muslim and 21% consider themselves Christian, consistent with the UNEP Report.

IFC PS8 recognizes the value of preserving community cultural heritage, which can include tangible resources of cultural value such as scared groves, sacred bodies of water or other natural resources and intangible forms of culture such as cultural knowledge, innovations and traditional lifestyles that could be impacted by a project. The presence of a power station in the area has the potential to result in the introduction of 'foreign' culture into the community. However, as the project area is generally industrialized, the influence of the proposed power station on intangible aspects of culture is unlikely to change as result of the project. In addition, no tangible resources of cultural value have been identified within the project site or its immediate vicinity. Therefore, issues associated with impacts to cultural resources from the project are not considered further in this assessment.

4.3.5 Indigenous Peoples

According to the IFC PS7, Indigenous Peoples are defined as social groups with identities that are distinct from mainstream groups. As such, they may be more vulnerable to the adverse impacts associated with project development and their needs must be carefully considered and protected accordingly. There are a wide variety of ethnicities in Sierra Leone, however, based the survey work completed for the project, it was indicated that there are no Indigenous Peoples living within or directly adjacent to the project site. Therefore, issues associated with impacts to Indigenous Peoples from the project are not considered further in this assessment. However, this conclusion will be verified during any future socio-economic survey work.

4.3.6 Gender Relations

The war in Sierra Leone was associated with high levels of extreme sexual and gender violence towards women and children. Levels of Gender Based Violence (GBV) are difficult to ascertain, but the UNICEF Gender analysis of the situation of women and children in Sierra Leone (2011) report estimates them to be very high.

The Rainbow Centres provide services to victims of rape and sexual assault. In 2009, they provided support to 1,408 clients, compared with 173 fewer in the previous year, indicating an increase in service access. In the same year, only 17 cases out of approximately 4,000 filed were successfully prosecuted in court. The years of civil war have normalised violent behaviour, although this acceptance is beginning to change. For example, the proportion of 15 to 19 year old girls who believe a husband is justified in beating a wife under some circumstances has dropped by 4% in 2005, but remains high, at 63%.

Although equally likely to attend primary school, girls are less likely to complete their education. Reasons cited include sexual exploitation by teachers and the low number of female teachers and other role models, as well as demands from families or themselves to marry and start a family. Another difficulty faced by women is the customary inability for women outside the Western Area to own property or land. A livelihood closely tied to land access and food security can therefore be severely compromised in the event of marital breakdown.

Women are under-represented in almost all non-agricultural employment fields. Gender parity in senior positions is particularly low, and despite a recommendation of the Truth and Reconciliation Commission that political parties ensure at least 30% of their candidates for public elections were women, this has not been achieved. Reasons for this may include barriers to women entering politics (for example low literacy), bullying behaviour in a male-dominated environment, difficulties in financing election campaigns, and in commanding respect. In the project area, women contribute significant income to the household through petty trading other businesses, and are responsible for household expenses such as food stuff, electricity bills, health care, etc.

4.3.7 Vulnerable Groups

Vulnerable people in Sierra Leone include children, women, elderly people, those who are sick, disabled and those who are part of any ostracised or disempowered minority (for example homosexuals). The construction and operation of the project could affect vulnerable people differently to others, while employment opportunities will be made equal between racial and religious groups, but sick and heavily disabled persons may be unable to work. In particular, there are several potentially vulnerable groups that were identified in the project vicinity. These include people living in the polio compound on Queen Elizabeth road close to the north of the project site and the fisheries slum area along the coast and the Blackhall road area (which is some distance away from the site).

Some of the pressures which the project may exert on local services and infrastructure as a result of worker influx may have a proportionally larger impact on vulnerable groups. For example, medical services that could be further stretched by increasing population may have more significant consequences for those who are sick, elderly, disabled and children.

4.3.8 Infrastructure

Access to safe drinking water is essential to help prevent water-borne diseases such as cholera, typhoid and schistosomiasis, and to avoid adverse health effects associated with other contaminants. The need for safe drinking water is closely associated with that for adequate sanitation, refuse disposal systems and healthcare education.

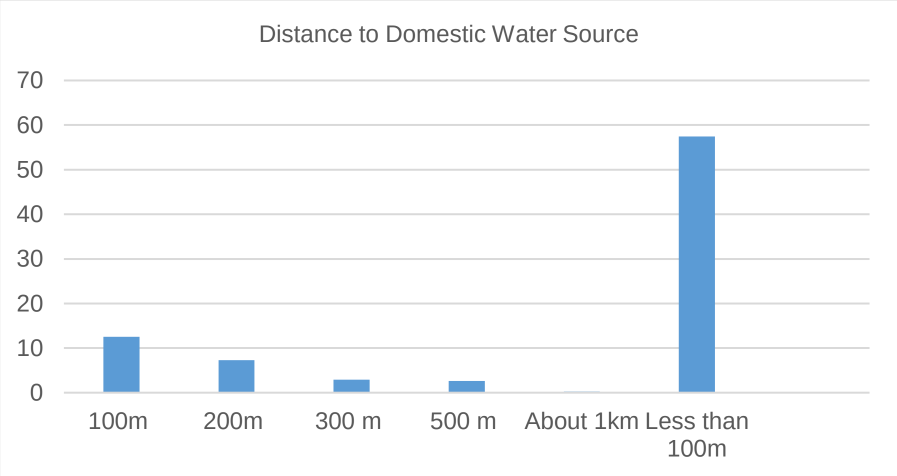
The Atkins study reports that the Western Area generally has a high level of access to safe drinking water compared with provincial regions.[6] There is however strain on facilities as a result of migration that took place during and after the decade of civil unrest that ended in 2002. The movement of people into the catchment areas of watercourses used as water supplies is also associated with the contamination of surface- and groundwater sources. Because of the high population density, contamination can spread very quickly, with cholera a particular problem during the rainy season.

Nearly 70% of inhabitants in the sites studied by the Atkins report were found to rely on standpipes and water vendors. The GVWC supplies piped water to parts of Freetown, but access is limited. The piped water supplies that do exist can be intermittent, particularly during the dry season. The remaining population rely on streams and rivers within the Western Area. Water supply was identified as a major problem for schools in the community. Most of the schools surveyed (80%) have problems with reliable water supply, with water largely supplied by plumbing situated in the school compound (40%), a water well (20%) or plumbing from next door (20%).

According to the survey, most households fetch water for domestic use from the following sources: their neighbour’s house (20%), plumbing outside the house (16%), communal tap (12%), and well water (less than 5%). A combination of these sources is typically employed to meet domestic water needs. Sources of domestic water are generally located within close proximity of the household as shown on Figure 4.5.

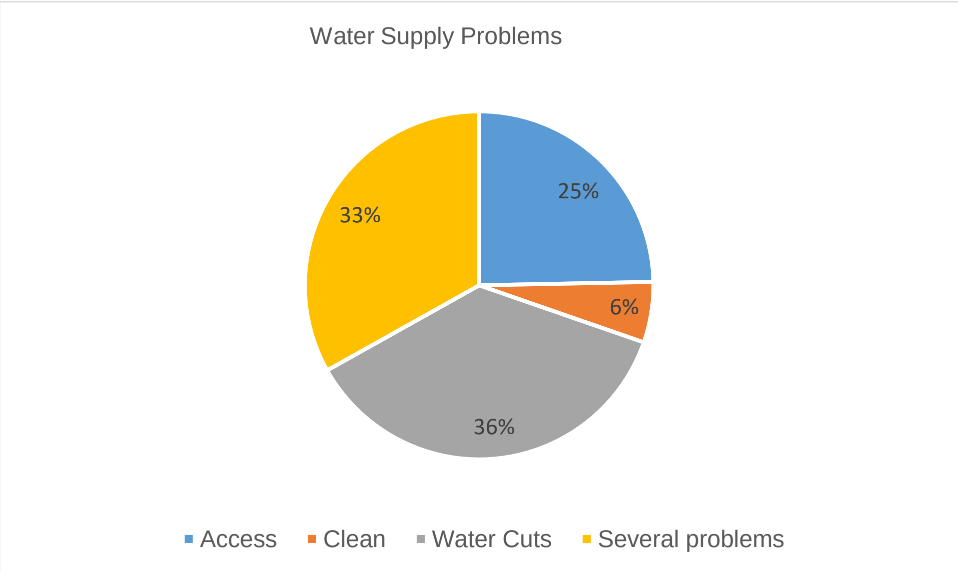
[6]5 Atkins, 2008

Figure 4.5: Distance to Domestic Water



Reliable water supply poses a serious problem, as 73% of households surveyed report having water supply problems in the community. As shown on Figure 4.6, domestic water supply problems are characterised by water cuts, access issues, unclean water and a combination of these problems.

Figure 4.6: Water Supply Problems



As is the case in many parts of West Africa, there is no adequate means of refuse disposal in Freetown. The dumping of refuse on undesignated sites is associated with breeding grounds for disease-causing organisms, vermin, bad odours and other health and safety issues. Burning of refuse is also practiced but can also create problems through the production of noxious fumes, the potential for fires becoming out of control, and explosions associated with the burning of highly combustible materials.

Much of Freetown's road network has been neglected and is in a poor state of repair. With heavy congestion and severe weather conditions (intense heat and humidity in the dry season and heavy rainfall in the wet season), the roads have suffered badly, such that potholes and broken surfaces are the norm. During the first site visit, it was noted that there were several ongoing road construction projects in Freetown. The access roads between the site entrance and Bai Bureh Road are tarmac routes that are generally in poor repair. This project is a small scale project and the current roadway network as shown in Figure 14.2 allows access to the site for construction and operational vehicles. However, additional mitigation measures proposing minor improvements if required are proposed in the instance that roads would be unsafe or unsuitable for use.

The majority of households surveyed are connected to the national power grid (81%), but the majority (78%) also feel that lack of electricity supply affects their domestic needs. Alternative sources of energy for lighting include Chinese-made battery powered lanterns (32%) or generators (19%). A significant number of households do not have any alternative lighting source. Only 40% of the schools surveyed are connected to electricity supply. Most businesses (89%) are connected to the national grid and are reliant on it for their power/electricity needs. However, businesses typically own generators to supplement power needs when there are outages. The majority of businesses (67%) have both national grid power and generators to meet their electricity needs, while only 22% of businesses are fully reliant on their generators.

4.3.9 Health

Maintaining health is a common challenge for many inhabitants in the project area. Significant health threats include HIV/AIDS, malaria and cholera, intestinal worms, typhoid and dysentery. Information from the Ministry of Health and Sanitation's 2012 document Cholera Epidemic 2012: Lessons Learned and other sources report that the cholera epidemic of 2012 was Sierra Leone's worst in 15 years, and the largest outbreak in the West African region for 10 years. The first cases were identified in early 2012, and by November some 22,629 cases had been reported, and 294 lives lost. The prevalence of HIV is in fact considered relatively low, at 1.5% (2012), with 58,000 people living with HIV.[7] About 10% of these cases are children under 15. Additional problems associated with HIV/AIDS prevalence are the 26,000 children orphaned as a result of the disease, and discrimination against people living with HIV/AIDS (PLHA).

The 2014-2015 outbreak of Ebola also impacted Freetown and affected both people and health service provision. Data on Ebola and in particular for the site area will be sought from the World Health Organisation (WHO) and other sources. The household survey reported that knowledge of HIV/AIDS and Ebola virus disease is common and widespread (93% reported being knowledgeable).

Primary healthcare is the patient's first point of contact with health care professionals, usually within the local community. In Sierra Leone this is delivered at Peripheral Health Units (PHUs) which comprise community health centres, community health posts and maternal and child health posts. The ratio of people to PHUs in the Western Area is 32,500:1 compared with the national average of 9000:1. The Atkins report[8] found that the Western area receives the worst level of service provision nationally from the Ministry of Health and Sanitation (MoHS). However, private and NGO-run PHUs (including missionary facilities such as those adjacent to the site) are more widespread in the area than elsewhere. This is likely to ease the pressure on state-operated facilities. Secondary healthcare refers to the services provided by medical specialists, as well as acute care in emergency situations. Availability of such services is, by contrast, higher in Freetown than nationally, with 1,500:1 hospital beds, and 9800:1 doctor. 80% of the country's doctors practice in the capital.

A marked reduction in child (0 to 5 years) mortality nationally has been achieved in recent years. Contributing factors include improvements in immunisation, family planning, nutrition and treatment of childhood illnesses, as well as increasing household wealth. The Free Health Care Initiative was introduced in 2010, and was associated with a 200% increase in the use of essential health services by women and

[7] http://www.unicef.org/infobycountry/sierraleone_statistics.html (last accessed 19/06/14); http://www.unaids.org/en/regionscountries/countries/sierraleone/ (last accessed 19/06/14)

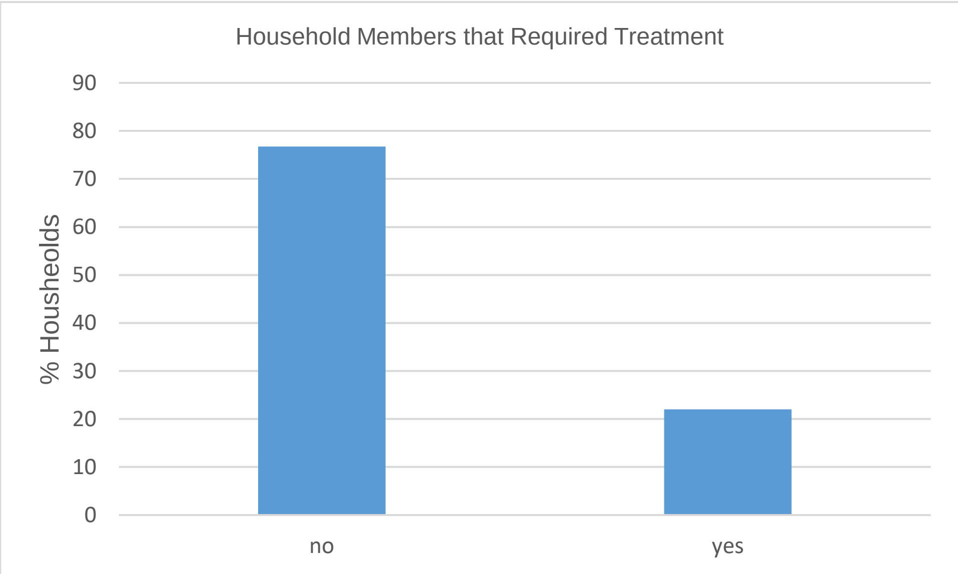
[8] Atkins, 2008.

children. The initiative made healthcare for pregnant and breastfeeding women and for children under 5 years free at the point of use.

The majority of households (79%) surveyed did not have members suffering from reoccurring health problems. Hypertension, diabetes and cardio-vascular disease are among the most prevalent chronic diseases, affecting about 21% of members of households interviewed. Ebola was not highlighted as a common health problem, which may indicate cultural stigma regarding the disease.

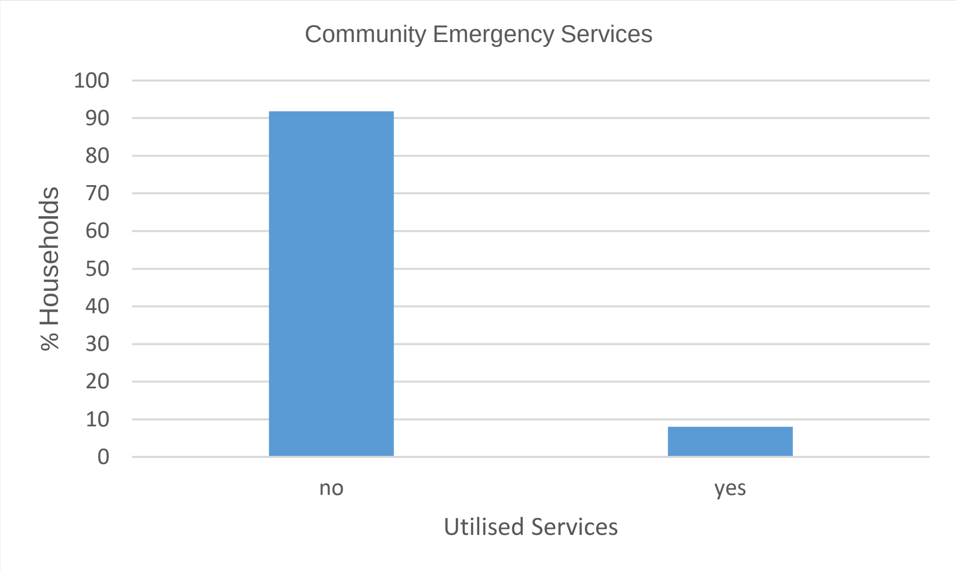
The majority of household members surveyed did not require medical attention in the past 12 months (see Figure 4.7 illustrating the frequency of household members requiring medical treatment).

Figure 4.7: Health Problems that Required Medical Treatment



Health treatment facilities typically visited by the local community are generally located within a 500m radius of people's homes and include government hospitals, satellite clinics, or pharmacies. Long periods of waiting were reported for government medical facilities. However, general waiting periods for medical treatment were relatively short, ranging from 15 to 20 minutes to up to an hour. Emergency health services at the community level are scarce, as shown on Figure 4.8.

Figure 4.8: Availability of Emergency Services



4.3.10 Education

The CWIQ 2007 report surveyed 7,800 households in rural and urban areas, and indicated that literacy within the Western Area was double the national average, at 70%. For comparison, within the Northern region, the literacy rate was 25%. Nationally, 70% of heads of households reported no education in 2007, while this figure was only 25% in the Urban Western Area. Of the 75% in the Urban Western Area that do have some education, approximately 4% have some/completed primary education, 43% have some/completed secondary education, and 28% have post-secondary education. Literacy is generally higher in males than in females across all age groups, and literacy rates are higher in older age groups than younger age groups. This is likely a result of increasing school provision in recent years, and the lack of educational facilities during the civil war pre 2002. According to the household survey, 83% of households with children ages 6 to 15 confirmed that the children were attending school.

4.3.11 Economic Profile

Many households surveyed indicated that they have lived in the community for less than six years (35%) or between seven to 15 years (33%). The reasons that many households have relocated to the Freetown area include the shortage of affordable accommodation or easy access to land, employment or business opportunities and higher cost of living in other communities. Almost 70% of the households that were surveyed generate primary income form petty trading. A small percentage (7% or less) of other occupations included driver, mechanic, health worker, teaching, general labour, craftsman, farmer, security guard and retired. Most households do not have an extra source of income (77%). The average total income per month including cash and other goods that households receive was generally between Le 551,000 to Le 1,000,000, which is equivalent to approximately 126 to 230 US dollars (income of 20% of households) and Le 351,000 to Le 500,000 (income of 18% of households), which is equivalent to approximately 80 to 115 US dollars.

4.3.12 Ecosystem Services

Ecosystem Services are defined by the IFC (2012) as the benefits that people, including businesses, derive from ecosystems. They are organized into four types: (1) provisioning services (the products people obtain from ecosystems), (2) regulating services (the benefits people obtain from the regulation of ecosystem processes), (3) cultural services (the nonmaterial benefits people obtain from ecosystems), and (4) supporting services (the natural processes that maintain the other services).

The artisanal vegetable plots located on the project site provide some Ecosystem Services to local people through the provision of food, but given their small scale, they are considered of value at the local level only. Urban gardens in the local area also include vegetable plots, which provide an Ecosystem Service to local people through the provision of food, but considering their small scale, they are considered of value at the local level only. Other ecosystem services relevant to local communities which occur within the project area of influence include estuary and wetland related resources including any crop plantations in the wetland area; fisheries, commercial and subsidence fishing from the marine environment; freshwater resources such as water wells; and wild foods and other non-timber forest products, including medicinal plants collected from the wetland habitats.

4.3.13 Quality of Life

Ebola has had an obvious impact on quality of life in the project area. It has led to certain community limitations including curfews and reduced community interaction and business. According to survey data, reported barriers to the development of the community include poor leadership and representation of the community (45%) and poor attitudes of members of the community (44%). Poor attitudes were described as greed, selfishness and disunity.

4.3.14 Agriculture and Land Tenure

Most households surveyed in the project area are occupied by renters (51%), while 41% of households identified as owning the house that they live in. Of this group, the majority of home owners have owned their property for 11 years or more.

The majority (88%) of households surveyed in the project vicinity are not engaged in farming, and generally when farming is practiced in the area, it is located away from the residence (82% of farming households). Farming activities are currently practiced within the project site. Clearance of this land will be associated with a loss of economic income.

4.4 Land use

4.4.1 Site Layout and Current Occupants

The key features of the site and surrounding area are shown on Figure 2.3 and referenced by letter (e.g. ‘M’) in the legend. The following discussion refers to the relevant legend key letter where appropriate.

The Sierra Leone Roads Authority-Western Region (SLRA-WR) Area: The remit of the SLRA-WR is to maintain the roads in Sierra Leone’s Western Region. Currently the SLRA-WR area is primarily used to store equipment and machinery. The site does not appear to be heavily used at the moment with only a small number of heavy vehicles or plant (including what appears to be a gravel crusher) in various states of repair.

The main structures in the SLRA WR area include an administration building located along the northern boundary, close to the entrance (offices, toilets and a reception area – ‘D’ on Figure 2.3) and a large Dutch barn (‘B’) in the southwest part of the site that is used to store items including drains, culverts, sign posts and old machinery.

Ancillary features of the administration building include:

- The office potable water tank (between the building and the boundary);
- A borehole (‘M’) to the east of the building (believed to be 3 to 4m deep);

- A temporary structure used as a carpentry/upholstery workshop ('R'); and,
- A shed housing the generator for the administration building ('P').

A key observation from the site visit is the presence of areas of artisanal farming on former waste ground along the western and southern walls of the SLRA-WR area ('A' and 'C' on Figure 2.3). This area is cultivated by local farmers to produce crops primarily for sale at the local market, but also for subsistence.

The following information was obtained from ESHIA team observations and discussions with members of the SLRA staff and one of the farmers during the second site visit (with the EPA-SL):

- It is understood that the farmers are all from neighbouring communities to the south of the site;
- The farmers have been allowed to grow crops on this part of the site. The SLRA-WR has allowed this activity as it is an efficient way to keep the site clear of undergrowth.
- The farmers were observed to take water from Guma Valley Water Company pipes that cross the southern part of the site on the inside of the southern boundary wall ('S'), but waste water from adjacent residential properties to the south of the site also feeds the cultivated area.
- The ground crops are seasonal: dry season – potato and cassava leaves; and wet season – *Corchorus* ('Krain Krain'), green and soya. Supplementing these ground crops there are banana and mango trees along the boundary and occasional sugar canes and maize crops.
- An area of wet season subsistence farming is evident in the north east section of the SLRA-WR site. This includes an area of Pigeon Pea in the far north east corner, adjacent to the generator shed.

It is understood that whilst the artisanal farmers do not have legal tenure over the cultivated land, however a Livelihood Restoration Plan (LRP)/ Abbreviated Resettlement Action Plan (ARAP) for the farmers will be undertaken as part of this project.

China Republic Construction Company (CRCC) Compound: The southeast quarter of the SLRA-WR site contains the CRCC compound. It is fenced off from the WR site by chain fencing topped by razor wire. Security staff members are present overnight. Access is gained through the northern fence of the CRCC compound.

The structures ('E' and E1-3 on Figure 2.3) in the compound consist of an administrative building to the east of the gate, a warehouse and a shed which appears to be used for storing broken down machinery. Several heavy duty plant and vehicles are parked in the western part of the CRCC compound. These include flat back transporters, bulldozers and a number of large cement mixer vehicles. There are also a number of shipping containers.

Between the CRCC structures and the southern perimeter wall is a strip of land that has not been cultivated and is currently overgrown, although there are banana and mango trees present. In the eastern corner of the perimeter wall, adjunct to the MSU boundary, there is a sealed up access gate and a security post.

The Mechanical Service Unit (MSU) Compound: The MSU is a commercial department of the SLRA responsible for repair, maintenance and hire of all SLRA vehicles, plant and machinery. It also procures machinery on behalf of the SLRA. The MSU compound occupies the western and largest portion of the site. Access is via a metal gate along the dividing wall with the SLRA-WR, and is guarded by security personnel at an adjacent gate post building.

The majority of the MSU compound area is covered by trucks and other vehicles in various states of repair.

The MSU compound holds two buildings; a store ('J') to the west and a large maintenance garage and with administrative buildings at each end (J1) which runs along most of the southern boundary of the MSU compound. Adjacent to the eastern wall of the warehouse is a fuel pump and associated area of hardstanding (Q). A small generator house is located at the back of the store building, in the southwest corner of the MSU compound.

In the south-eastern corner of the compound is an area of subsistence farming (mainly cassava crops). In the north west of the compound are a set of used ship containers used as staff facilities. Between these containers and the perimeter fence is another area of subsistence farming. Crops observed were cassava, beans and banana trees. The areas of subsistence farming are cultivated by MSU staff.

It was confirmed that the current occupiers (SLRA, MSU and CCRC) have been consulted by GoSL within the last year about the requirement to vacate the site and that this is being managed by GoSL, prior to handing over the site to the client. However, it was identified that none of the occupiers is aware of an alternative site being finalised and no news has been received in the last 12 months with regard to the process moving forward.

4.4.2 Surrounding Land Use

As stated above, the areas surrounding the project site are zoned industrial. Residential uses in the area are either mostly shanty buildings constructed by the individuals dwelling or are generally occupied by renters. Other facilities, such as the Islamic Compound and the Polio Compound described below, have also been informally established in the area. During the 25 February 2014 inception mission, a walkover was undertaken by the ESHIA team and the EPA-SL along the nearest roads surrounding the site.

The following section presents the key observations from the walkover.

- To the south of the site, adjacent to the SLRA-WR area, is Old Railway Road. Permanent residential dwellings (‘F’) have been constructed along the alignment of an old railway. The dwellings are a mixture of multi-storey (up to five storeys) and single storey buildings.
- To the south of the MSU compound is a mixture of shanty houses and vehicle repair garages (‘G’).
- Adjacent to the southern end of the MSU compound’s eastern wall is an Islamic compound (‘H’). The compound contains a nursery and primary school, a mosque, hospital and an Islamic centre.
- To the east of the MSU compound (north of the Islamic compound), there is a logistics company and lumber yard (‘I’).
- To the north of the MSU compound is the Bolloré Logistical Company (‘K’). Currently, the over ground drainage from the MSU compound flows through the Bolloré site into the opened drainage ditch on South Road.
- To the north of the SLRA-WR compound is the Magram Water Production and Packing Factory (‘L’).
- Immediately to the north of the Magram site, along South Road, there is an area of Shanty houses (‘N’) that stretches up to the site entrance.
- On the northern side of South Road is a ‘Polio Compound,’ beyond which is the decommissioned oil refinery.
- To the immediate west of the SLRA-WR site is the German Technical Academy, beyond which is the Winston Churchill Secondary School. Both of these educational facilitates have access from Factory Road.

4.4.3 Disused Refinery and National Petroleum/Kissy Jetty

During the February 2014 team visit, the disused refinery to the north of the site, and the landing jetty within the NP facility were examined.

The ESHIA team was able to visit the NP facility. .

The main observations on the jetty were as follows.

- The facility is active, with large queues of tankers observed on the surrounding road network.
- The jetty is operational, and there are existing pipelines for fuel supply and fire water into the disused refinery area close the project site.
- The jetty contains in its structure a large cage housing the pumps that supply fire water to the NP facility (and formerly to the dis-used refinery).

However, conditions at the NP jetty have deteriorated since this time. The Addax jetty, construction of which is nearly complete, will therefore be used to receive the HFO.

The main observations on the refinery area were as follows.

- The installation has multiple storage tanks of varying capacity and ancillary infrastructure (including fuel and fire water pipeline network) in varying states of repair. The tank farm appears to have limited environmental controls (e.g., impermeable bunding was not observed).
- Significant rehabilitation work will be required to bring this infrastructure up to operational standards, including the installation of appropriate environmental controls such as bunding.
- The installation has an oil water separator facility that could potentially be repaired and used to process waste HFO sludge for the project, subject to an appropriate agreement with the owner as part of fuel supply negotiations.

5. Physical Environmental Baseline

5.1 Introduction

The environmental baseline of the project and its surrounding areas has been established for each environmental aspect under consideration. This has been achieved largely through consultations with relevant stakeholders, a desktop review of available data, a literature review and site walkovers.

The detailed assessment process has included both additional desk study and data review combined with independent field surveys and computer modelling where appropriate. The detailed assessments have included ambient noise and air quality monitoring.

5.2 Noise

To establish the existing ambient noise environment, two noise surveys have been conducted by INTEGEMS. The first noise survey was conducted during February 2015 during the Ebola virus disease (EVD) situation at the locations outlined in Table 5.1. The locations were selected with due consideration of risks around Ebola and were collected for limited duration. As these locations are close to the boundary of the development site, they may not be representative of all of the noise sensitive receptors in the study area. In addition the measured noise levels were not considered to be representative of business as usual conditions, due to the effect that the EVD situation had on the social and economic activity in Freetown. Because business slowed, and curfews were imposed, human activity was reduced compared to normal conditions. Therefore, a supplementary noise survey was undertaken in September 2015, as shown in Figure 5.1, when business had returned to normal.

Figure 5.1: September 2015 Noise Monitoring

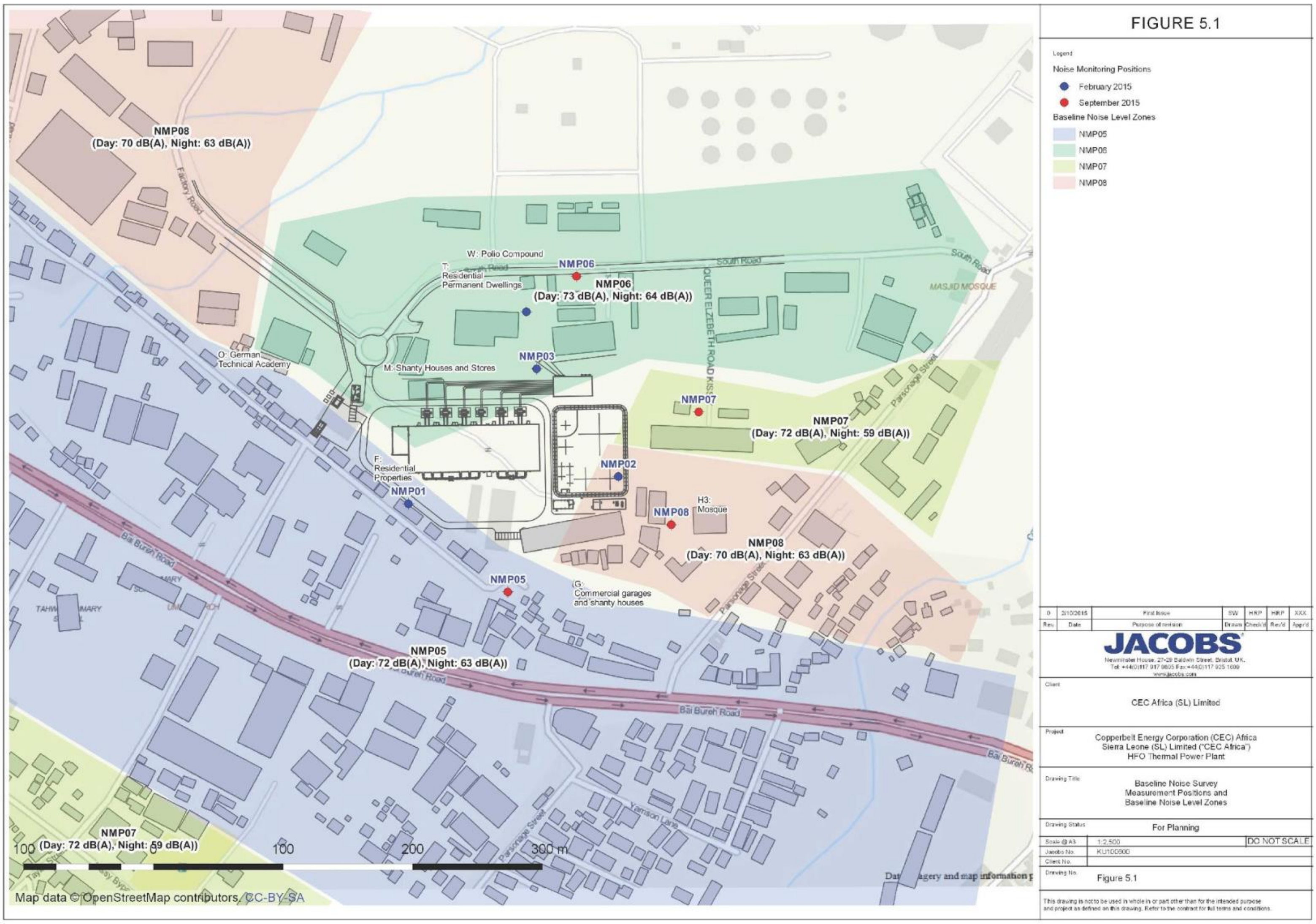


Table 5.1: Noise Monitoring Locations

Measurement Location	Location Description	WGS 84 / UTM Z29N	
		X	Y
NMP01	CRCC Compound	699049	937339
NMP02	SLRA/MSU Compound	699211	937360
NMP03	SLRA/MSU Compound	699148	937443
NMP04	Magram Water Bottling Company Compound	699140	937487

The equipment used to measure sound pressure levels complies with the requirements of Class 1 of British Standard EN 61672-1:2003: "Electroacoustics - Sound level meters - Part 1: Specifications". The measurement equipment was calibrated in the preceding two years by a competent calibration laboratory that can demonstrate that its measurements are traceable to national standards.

Precautions were taken to minimise the influence of wind by using an outdoor windshield, and measurements were taken between periods of heavy rain, and while wind speeds were low. The following broadband statistical noise parameters were logged for each measurement: L_{Aeq}, L_{A10}, L_{A90}, $L_{AF,Max}$.

The mean L_{Aeq} values for each location during the day and night are presented in Table 5.2.

Table 5.2: Logarithmic Average Noise Results for each Location

Location	Mean Daytime LAeq,1h	Mean Night time LAeq,1h
NMP01	49.8	48.6
NMP02	48.0	43.8
NMP03	49.8	45.3
NMP04	50.6	38.9

Since the February 2015 noise survey was conducted, the EVD situation has receded. Therefore, as described a second baseline noise survey was conducted in September 2015 when human activity had returned to normal levels. There was greater scope to select appropriate noise monitoring locations for the September noise survey than for the February noise survey. The four noise measurement locations selected for the September noise survey are shown on Figure 5.1 and are detailed in the table below.

Table 5.3: September 2015 Noise Monitoring Locations

Noise Measurement Position	Location Description	WGS 84 / UTM Z28N	
		X	Y
NMP05	Railway Line	699126	937271
NMP06	South Road	699179	937514
NMP07	Queen Elizabeth Road	699273	937410
NMP08	Sheikh Tais Compound	699252	937323

Noise measurements at all locations were undertaken on publicly accessible land near properties, rather than close to the façades of the dwellings. Measurements were taken at 1.2 – 1.5m above the ground, in free-field conditions (more than 3.5m from any reflecting surface). The same equipment was used for the September survey as for the February survey.

Appendix C presents the results of the measurements undertaken at each measurement location. A small number of measurements have been excluded from this analysis, as they appear to be unusually high but there is no note as to why that might be; these measurements have been presented in red text with a line struck through to provide a conservative assessment.

Table 5.4 below summarises the daytime and night-time baseline noise levels measured at each of the locations.

Table 5.4: Logarithmic Average Noise Results for each Location

Location	Daytime $L_{Aeq,15h}$	Night time $L_{Aeq,9h}$
NMP05	72	63
NMP06	73	64
NMP07	72	59
NMP08	70	63

The September recorded significantly higher noise levels due to increased human activity compared to the February noise survey. The results of the September noise survey are considered to be more representative of typical conditions than those from the February noise survey, and therefore the noise assessment has been revised accordingly.

The logarithmic average baseline noise levels show relatively little variation between NMP05 –NMP08, with a spread of just 3 dB during the daytime and 5 dB at night.

The area surrounding and including the project boundary is zoned by Freetown City Council as commercial/industrial land use, according to the Director of Country Planning. It can be seen from Table 5.4 that the average measured night-time noise levels around the site are below the IFC guideline noise level for industrial areas of 70 dB L_{Aeq}, although this level is exceeded during the day.

However, as Figure 1.2: 'Project Site and Surrounding Area' indicates, many of the buildings surrounding the project currently have residential, institutional or educational usage. According to the IFC EHS Guidelines, It is desirable that noise levels at these locations should not exceed the lower values of 45 dB L_{Aeq} (night time) and 55 dB L_{Aeq} (daytime), or result in a maximum increase in 'background' levels of 3dB. It can be seen from Table 5.4 that the average measured levels currently exceed the IFC limits for residential, institutional and educational uses during both the daytime and the night-time by between 14 – 19 dB(A).

5.3 Air Quality

Urban air pollution has the potential to cause significant environmental problems. The pollutants from combustion activities have the potential to cause detrimental effects to human health or sensitive vegetation and ecosystems.

There is no regulatory local monitoring undertaken within Sierra Leone, although some work carried out by the Njala University, Sierra Leone, indicates that air quality at certain locations in Freetown is considered poor for some substances (Taylor & Nakai, 2012), and these locations could potentially be classified as degraded airsheds.

The key sources of air pollution which influence air quality in the vicinity of the site in the Kissy Docks area of Freetown are likely to be domestic or commercial-scale power generators, burning of household or commercial wastes, residential wood and charcoal ovens, road traffic emissions, industrial emissions and re-suspended dust/particulate matter from poorly surfaced or unsurfaced roads.

Due to unreliable power sources, domestic and commercial power generators, commonly running on diesel are prevalent in most parts of Freetown, including around the site. This will lead to increased emissions of substances associated with combustion in addition to those emitted by road traffic, for example, nitrogen dioxide, sulphur dioxide, particulates and carbon monoxide. The amount of poorly surfaced roads is likely to lead to significant dust generation during the dry season. During the rainy season the potential for significant dust generation is less likely.

5.3.1 Monitoring Survey to Determine Background Concentrations

In the absence of specific air quality information or monitoring data within the vicinity of the CECASL project site, project-specific monitoring was undertaken for the pollutants nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$) at locations surrounding the project site. These measurements were undertaken in order to identify if the airshed is classified as degraded or non-degraded and to determine the background concentration for use in the air quality assessment. 'Background' is the average concentration of pollutants present in the ambient air and is a concept used to enable assessment of the impacts of particular emission sources to air without the need for all sources in the area to be considered explicitly.

The air quality monitoring was conducted by INTEGEMS, using staff with experience of air quality monitoring in Sierra Leone and other countries, including the UK. The monitoring of NO_2 and SO_2 was undertaken using passive diffusion tubes. The tubes were supplied and analysed by Staffordshire Scientific Services (SSS) based in the UK. SSS is a reputable supplier and analyst, and is accredited to undertake the analysis in line with the requirements in the UK, providing services to many local authorities as part of the national reporting requirements.

The monitoring of PM_{10} and $PM_{2.5}$ was undertaken using an Osiris continuous particulate analyser manufactured in the UK by Turnkey Instruments Ltd.

5.3.2 Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2) Monitoring

Triplicate sets of passive diffusion tubes were deployed at 8 monitoring locations for the duration of 12 days between 21st February 2015 and 5th March 2015. The average concentration measured over this period at each monitoring location is presented in Table 5.4 and the monitoring locations are presented on Figure 1 of the Air Quality Technical Report Figures Section.

Table 5.4: NO_2 and SO_2 Diffusion Tube Monitoring Data

Monitoring Location	Site Location	Co-ordinates (UTM WGS 1984 Zone 29N)		Average Concentration ($\mu g/m^3$)	
		X	Y	NO_2	SO_2
DT1	Shell Police Station	699110	937216	n/a*	n/a
DT2	Salhoc Gate	698912	937282	47.2	4.0
DT3	Agriculture Compound	698779	937499	25.2	4.3
DT4	Winston Churchill Secondary School	698879	937562	29.2	3.1

DT5	Opposite Bollore	699266	937530	22.4	2.3
DT6	By the Mosque	699445	937536	28.6	n/a
DT7	Government Independence School	699476	937455	27.5	2.4
DT8	Sheik Tais School	699292	937345	30.3	3.6

*n/a Missing tubes.

The monitoring results indicate that generally, the NO_2 concentrations, albeit measured over a relatively short timescale, were within the annual mean WHO ambient air quality guideline of 40µg/m^3. The exception was the measurement at DT2 (Salhoc Gate) which was elevated compared to the other locations. The DT2 monitoring location is adjacent to the busy Bai Bureh Road and is therefore a roadside measurement which is not generally representative of ambient concentrations at the areas in close proximity to the proposed project site or in other areas not adjacent to the Bai Bureh Road.

The monitoring data were collected during the dry season. This is considered to provide a more conservative basis for assessment compared with the wet season as the rains can potentially reduce background concentrations by stripping contaminants from the airshed or reduce emissions of dust and particulates.

5.3.3 Particulate Matter (PM_{10} and $PM_{2.5}$) Monitoring

Particulate monitoring was undertaken to provide sampling every 15 minutes throughout 24 hours between the 18th February 2015 and 8th March 2015. The monitor was located within the boundary of the proposed project site (as shown on Figure 1 in the Figures section of the Air Quality Technical Report) and is representative of ambient conditions in the site area. This monitoring was representative of particulate concentrations during the 'dry' season. Further monitoring was undertaken between 21st August and 8th September 2015 to measure ambient particulate concentrations during the 'wet' season. The monitoring data collected between the 21st and 23rd September was elevated due to site excavation works and was removed from the dataset. The dry and wet seasons are of approximately equal length (6 months) and therefore an average of the results from both monitoring periods has been used to represent the annual mean ambient concentration. The results of the particulate monitoring are set out in Table 5.5.

Table 5.5: PM_{10} and $PM_{2.5}$ Monitoring Data

Monitoring Location	Site Location	Co-ordinates (UTM WGS 1984 Zone 29N)		Average Concentration (µg/m³)	
		X	Y	PM_{10}	$PM_{2.5}$
'Dry season' Monitoring					
PM1	Within proposed project site	699071	937366	317	51
'Wet Season' Monitoring					
PM1	Within proposed project site	699071	937366	76	12
Average				196	32

The monitoring results indicate that the annual average concentrations are significantly higher than the annual mean WHO ambient air quality guideline of 70 µg/m³ for PM_{10} and are within the 35 µg/m³ air quality guideline for $PM_{2.5}$.

The 24 hour mean PM_{10} concentrations ranged from 112 – 448µg/m³, and were generally above the 24 hour mean ambient air quality guideline of 150µg/m³ throughout the dry season monitoring. The 24 hour mean $PM_{2.5}$ concentrations ranged from 15 to 80 µg/m³ in the dry season, which slightly exceeds the WHO ambient air quality guideline of 75µg/m³. The 24-hour PM_{10} and $PM_{2.5}$ concentrations were well within the guidelines during the wet season monitoring, with maximum 24-hour mean concentrations of 120µg/m³ and 25µg/m³, respectively.

Particulate concentrations are significantly lower during the wet season at the proposed project site location. The elevated particulate concentrations over the dry season are likely to be due to particulate emissions generated by vehicles movements on the local unsurfaced roads and from other domestic and commercial activities in the area. The monitoring surveys are indicative of ambient particulate concentrations surrounding the proposed site, but were of a short duration. Long term monitoring would provide more representative results, which may be lower than those reported.

5.3.4 Summary of Baseline Conditions

Table 5.6 presents the indicative classification of the airshed in the vicinity of the project site for each pollutant that would be emitted by the power plant during operation.

Table 5.6: Background Average Pollutant Concentrations

Classification	Pollutant Emitted to Air by Project				
	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO*
Indicative Classification of Degraded airshed (DA) or non-degraded airshed (NDA)	NDA	NDA	DA	NDA	NDA

* In the absence of monitored CO concentrations, the background concentration was sourced from the WHO Air Quality Guidelines (WHO, 2000) and assumed to be a value of 140µg/m³.

The airshed refers to the local area around the power plant where ambient air quality is directly affected by emissions from the power plant. The size of the airshed depends on plant characteristics, such as stack height, topography and meteorological conditions. The monitoring results are all within the WHO guideline values with the exception of PM_{10}. This would indicate that there is a degraded airshed for PM_{10}.

5.3.5 Ecological Sites

The existing air quality, specifically NO_x and SO_2, at sensitive ecological sites also needs to be considered as part of the air quality assessment. The background measurements obtained in the vicinity of the site are likely to be elevated by anthropogenic sources such as road traffic, industrial and residential sources, and as such are unrepresentative of a rural background or the likely ambient concentrations at the selected ecological sites considered in this assessment (see Section 5.5, which specifies the ecological sites considered in the air quality assessment).

There is no known information on the existing air quality or existing nutrient nitrogen or acid deposition rates at the selected ecological sites to characterise the baseline conditions.

5.4 Geology, Hydrogeology and Hydrology (including contamination)

5.4.1 Introduction

Sierra Leone is not considered to be a water deficient country. However, both water access and water contamination are an issue for much of the population. The main water uses in Sierra Leone include domestic purposes, watering livestock, power generation, irrigation and industries, with agriculture being the largest water consumer. In some regions, water is relatively scarce. Even where the supply itself is adequate in quantitative terms, the quality of the water is in serious decline. Despite the efforts to improve the situation, water shortages and quality degradation are common problems in Sierra Leone (EU, 2009).

5.4.2 Soils and Geology

The coastal regions of much of Sierra Leone adjacent countries are generally low-lying and flat. The Western Area of Sierra Leone is the only mountainous coastal region in West Africa comprising a range of thickly forested mountains rising from sea level to close to 1,000m and dominating the peninsula at the northern end where Freetown is situated. The regional geology here is known as the Freetown Complex, a major intrusion characterized by prominent layering of repeated sequences of troctolitic, gabbroic and anorthositic rocks, together with transitional rock types.

Apart from the areas of hard standing or cultivation, the surface of the site is primarily sand/gravel with patchy weed-type vegetation. There are areas of hard laterite pan outcropping across the ground surface within the MSU compound, which indicates that shallow hard rock is likely to be encountered across the site.

Local soils in the area are known to be well drained with dusky reddish gravelly sandy clay loam to clay loam with sand content increasing with depth with some laterite and quartz gravel materials.

A geotechnical and contamination site investigation was undertaken by contractors in November 2014 on behalf of CECASL. Results of this investigation are summarised in Appendix E and in Section 11.

Eleven boreholes were drilled in total, including three environmental boreholes with installations. The borehole logs from the site investigation show the geology beneath the site to be laterite, underlain by medium grained sand at approximately 5m. In some borehole logs, there is 1m of lateritic gravel with topsoil at the surface. A summary of a representative borehole log is shown in Table 5.7.

Table 5.7: Borehole Log Summary

Depth	Strata
0-1m	Reddish brown lateritic Gravel, top soil with occasional organic materials and rootlets. Gravel is sub rounded of Laterite
1-6m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite
6-15m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained

The ground conditions present are generally likely to be permeable and therefore soil and groundwater will be vulnerable to contamination from surface spills or from migration of offsite sources of contamination.

The key contamination sources on site and receptors are summarised as follows:

- The fuel supply island and fuel tanks in the MSU compound. There appears to be no interceptor drainage system, though there is apparently an oil/water separator. It was noted that fuel spills within MSU compound are contained with sand and the sand is disposed of to the Central Dump.
- Multiple point sources from the large number of vehicles not stored on hardstanding.
- Key receptors for potential contamination are shallow groundwater and adjacent land receiving runoff from the site. Ultimately, the end receiving environment for groundwater and runoff is likely to be the Sierra Leone estuary which could result in cumulative impacts.

25 soil samples were taken during the site investigation and analysed for metals, asbestos, extractable petroleum hydrocarbons (EPH), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). These have been compared to commercial land use guideline assessment criteria (GACs as part of a human health and groundwater impact assessment.

Full results can be found in Appendix E and Appendix F. A summary of the results is presented in Table 5.8, no significant soil contamination was encountered by the site investigation. Bis(2-Ethyylhexyl) phthalate was detected in two samples at a maximum of 316ug/kg, this is a low level that could have potentially been due to a laboratory contamination. Recommended mitigation measures regarding the potential for encountering contamination during construction have been included within the ESMP (Volume II).

Table 5.8: Soils Results Summary

Analysis	Results
Metals	All samples were below the GACs for metals.
Asbestos	Asbestos was not detected in any of the samples. Non-asbestos fibres were detected in BH03 2.5m and BH05 2.5m.
PAHs	All samples were below the GACs for PAHs.
SVOCs	bis(2-Ethylhexyl) phthalate was detected in BH02 0-1m and BH4 0-1m with a maximum of 316ug/kg in BH04.
EPH	All samples were below the GACs for EPH.
VOCs	All samples were below the detection limits for VOCs.

5.4.3 Hydrogeology / Groundwater

Groundwater was encountered at depths between 7.5 and 16.0m below ground level during the site investigations undertaken in November 2014. The water strike levels are listed in Table 5.9.

Table 5.9 Groundwater Level Strikes during Site Investigations (November 2014)

Borehole ID	Groundwater Strike (m below Ground Level)	Ground Elevation (m above Datum)	Groundwater Strike Elevation (m above Datum)
BH01	8.9	35.36	26.46
BH02	15.6	34.13	18.53
BH03	-	34.62	-
BH04	7.08	32.89	25.81
BH05	7.8	35.36	27.56
BH06	7.9	32.17	24.27
BH07	7.6	34.06	26.46
BH08	-	32.91	-
BH1 ES	15.1	35.53	20.43
BH2 ES	8.2	37.18	28.98
BH3 ES	16.0	34.81	18.81

The groundwater strikes recorded during the site investigations indicate a varied water table across the site which might suggest shallower perched groundwater is present (between 7 and 9m below ground level) above the main water table at 15 to 16 m below ground level. The elevation of deeper strikes (considered likely to be representative of true groundwater surface) indicates that groundwater flow is likely to be broadly in line with the local topographic gradient towards the north and the Sierra Leone River Estuary.

A later site visit by CEMMATS Group Ltd, in preparation for a pumping test in the existing abstraction borehole in the SLRA WR area, identified that all but three of the site investigation boreholes were found to be dry. Where groundwater was identified, the water level was measured at a depth between 8.3 and 15.2m below ground level.

An existing abstraction borehole is located within the SLRA WR area of the site. This borehole was inspected in March 2014 as part of a pumping test exercise for the site investigations at the site. This identified that the abstraction borehole is approximately 70m deep, with the static (non-pumping) water levels at approximately 17m below Ground Level, which corresponds to the deeper groundwater strikes recorded in site investigation boreholes. Details of the observations made by the contractor (CEMMATS Group Ltd) are provided in Table 5.10.

Table 5.10: SLRA WR Abstraction Borehole Observations (March 2015)

Parameter	Measurement / Observation
Borehole depth	70 m
Borehole diameter	125 mm (5 inches)
Casing type / thickness	PVC / 2mm thickness

Static water level	17.2 m
Size of existing pump	100 mm (4 inches)
Current pump setting depth	45m

Pumping tests performed on this borehole showed that the borehole has a low efficiency to pumping, resulting in a high drawdown of water levels in the borehole during pumping. As a result, the pumping test results indicate that the likely maximum sustainable abstraction rate from the borehole would be between 1.2 and 1.3 litres/second (100 to 110m^3/day). However the pumping test results indicate that the aquifer may be able to yield a greater volume of water in a more fit-for-purpose borehole.

Three groundwater samples were taken during the site investigation to assess the quality of the groundwater beneath the site. These samples were analysed for metals, EPH, PAHs, VOCs and SVOCs. Additional samples were collected from the abstraction borehole during the pumping test programme, although the results from this analysis had not been received at the time of writing.

The groundwater sample results were compared to the UK Environmental Quality Standards (EQS) and UK Drinking Water Standards (DWS) as part of the human health and groundwater quality assessment included in Appendix E. No significant contamination (e.g. free phase product or significant dissolved hydrocarbons) was encountered, though elevated EPH concentrations (two boreholes were significantly above the EQS and UK DWS) are such that potential hydrocarbon contamination sources may be present in the area potentially form a contaminant plume from the industrial site, and appropriate construction mitigation considerations should be employed (e.g. watching brief and control measures where required, installation of monitoring wells at the site to monitor these contaminants). Full results are presented in Appendix E and Appendix F, with a results summary provided in Table 5.11. Mitigation measures are outlined in Section 11.

Table 5.11: Hydrogeology Results Summary

Analysis	Results
Metals	Below EQS with the exception of copper and zinc. These samples were well below the UKDWS however.
PAHs	All below the limit of detection
SVOCs	All below the limit of detection
EPH	EPH in BH01ES and BH03ES were above the EQS and UK DWS of 10ug/l with a total of 702.1ug/l in BH03ES and 350ug/l in BH01ES.
VOCs	1,2-Dichloroethane was detected in BH01ES and BH03ES with a maximum of 3700ug/l in BH01ES.

5.4.4 Hydrology

The ESHIA will consider and assess the potential direct, indirect and cumulative impacts on hydrology resulting from the construction and operation of the project within its zone of influence. The zone of influence for hydrology extends 1km beyond the land-take boundary of the proposed project and where required extends beyond this to account for potential impacts outside this 1 km extent.

5.4.4.1 Surface Water Features & Quality

The key hydrological features in proximity to the project site are indicated on Figure 2.2. The key sensitive hydrological feature is the SLRE. This is located some 400m to the north of the project site. The SLRE is a Ramsar site, and BirdLife International has designated it as an International Bird Area (IBA). The area supports mangrove forests and significant numbers of bird species, including 23 species of global conservation concern and of those, 12 are globally threatened. Principal threats to the Sierra Leone River Estuary have been identified during the site visits and desktop assessment undertaken as part of this ESHIA, as vegetation clearance and unsustainable fishing. There are no details of the current ambient water quality within the estuary. Consultation undertaken to date identified one of the main issues as being plastic waste.

Reference has been made to the ESIA for the Petrojetty New Oil Jetty Project: Main Report (2013). As noted in a site visit undertaken as part of that study, surface films of oil and grease on the water were observed and were linked to waste water discharge or leakage incidents from the transfer and storage facilities of the surrounding oil companies, or waste water from shipping vessels. The sewage system within Freetown discharges to the SLRE and also a number of industries discharge into the drainage network and river which ultimately flow to the SLRE (Sankoh et al. 2009).

The second most significant surface water feature in proximity to the project site is the Wellington Creek. This stream is located some 200m to the east of the project site and this stream discharges to the SLRE. There is also a small stream located to the south of the project site that runs along the southern side of Old Railway Road and then turns north through the grounds of the Winston Churchill Secondary School and a disused refinery area before ultimately discharging to the SLRE. There are no details of the current ambient water quality within the Wellington or Old Railway Road streams.

There is currently no formal storm water drainage system on the site, apart from some small perimeter drains around the hardstand of the SLRA-WR administration building. Drainage across much of the site is, therefore, anticipated to be as surface runoff. Much of the site appears to drain towards the north in line with the prevailing topographic gradient and the western portion of the site by the site entrance slopes to the northwest. There are holes in the northern perimeter walls of the site to allow the runoff to pass through. Similar holes are present in the northern perimeter walls of the adjacent commercial premises to the north.

A site visit to the compound of one of the adjacent properties to the north identified that there is a concrete drain running along the northern side of the site boundary wall that transfers water away from an adjacent building. It was not possible to confirm the direction or receiving location of this drainage feature.

Beyond the properties to the north, it appears that the drainage route for overland flow is cut off by road side storm drains along the south side of Factory Road. Tracts of land between the drains and the commercial premises, which may have previously received overflow from the drains during wet season, are now either cultivated by garden farmers or taken up by shanty dwellings. The direction of flow within the road side storm drains was not confirmed, but in the vicinity of the site entrance, it appears to be to the west towards the small stream.

Existing drainage within and adjacent to the project site will need to be confirmed during the detailed design phase.

5.4.4.2 Water Services

Sewage effluent management on the site is currently through use of septic tanks with no municipal sewer connection identified.

The GVWC provides water supply services to Freetown, delivering water mainly from the Guma Dam (located in the Western Area Forest Reserve south of Freetown), supplemented by borehole groundwater.

The water supply to eastern Freetown is currently activated by GVWC for 4 days each week, for 10 hours covering the working period. This is a set schedule and is a minimum supply target, which is expected to improve. There is maintenance of the service once/ twice a month.

People were observed to be collecting water from the broken GVWC water pipe inside the northern boundary of the site. There is also a GVWC water pipe on Factory Road northwest of the site that is used by what may be a cooperative of local people.

A section of the site is used by artisanal farmers to grow cash crops, such as Cassava leaves, Potato Leaves, Corchorus (Krain Krain) and Soya. There are approximately 16 agricultural plots on the site, along the course of a drainage channel, which originates from the residential properties to the south of the site. Potential impacts to these farmers are dealt with in the socio economic assessment (see Section 7).

5.4.4.3 Commercial Fisheries Resources

Consultation undertaken with the Conservation Society of Sierra Leone indicated that there were 28 fishing communities in the estuary area. However, consultation undertaken with the Sierra Fishing Company (SFC) indicated that no industrial fishing is done in the estuary, as there is a 5-mile exclusion zone. SFC indicated that artisanal fishermen do use the SLRE, but they are not located within the vicinity of the Kissy Docks area.

5.4.4.4 Flooding

Flooding is a significant issue in Sierra Leone and the Freetown area. Much of the problem has been attributed to changes in land cover on the hills outside Freetown, partly due to pressure on the land from migrants driven to the periphery of the city by the civil war. However, urbanisation itself has exasperated the problem (Action Aid International, 2006). In relation to the project site, anecdotal information from site workers indicates the site suffers from significant surface water ponding/flooding during the wet season (June to November).

5.5 Ecology

This Section presents detailed information on the baseline ecological resources in the vicinity of the project site.

5.5.1 Designated sites

No designated areas overlap with the project site boundary. However, there are two designated areas in the vicinity of the site:

- The Sierra Leone River Estuary Ramsar Wetland and IBA; and
- Western Area Peninsula National Park.

Sierra Leone River Estuary Ramsar Wetland and IBA: Sierra Leone River Estuary Ramsar Wetland and IBA is located c.400 m north of the project site, and immediately adjacent to the pipeline. It is the drowned estuary of the Rokel or Seli River. The site is bounded to the north by a coastal plain indented by creeks, and to the south by the mountainous Western Area peninsula. At the point of entry into the Atlantic Ocean, the estuary widens to about 11 km and abruptly deepens along its southern shore to form a natural harbour (the third-largest in the world). The estuary is lined by 110 ha of mud and sand foreshore, backed by mangrove, and 1,800 ha of intertidal mudflat and muddy sandflats. For the sake of this assessment in Section 12 of this ESHIA it is assumed that the mud and sand foreshore, mangrove and intertidal and muddy sandflats are all qualifying habitats in the Ramsar Wetland designation, although this is not explicitly stated in the Ramsar webpage for the site (Ramsar Convention, 2000).

The predominant mangrove tree species are Rhizophora racemosa, Avicennia germinans, Laguncularia racemosa and Conocarpus erectus, and these cover a total of 34,234 ha (19% of the total area of mangrove in Sierra Leone). The designated site's most important areas of mangrove and associated habitats are located along Bunce River approximately 3 km east of the site, along the coast northeast and northwest of Tagrin Point, which itself is located in the northern part of the estuary and over 6 km northeast of the project Site, and in Pepel and Tumbu more than 15 km to the northeast. A small area of mangrove also occurs at Aberdeen Creek, which is located in western Freetown and more than 6 km west of the site.

Table 5.12 lists the key qualifying bird interests in the Ramsar Wetland and IBA.

Table 5.12: Qualifying Species Interests in Sierra Leone River Estuary Ramsar Wetland and IBA

Species	Season	Population estimate[9]
Great white egret (*Ardea alba*)	Winter	500 individuals
Kentish plover (*Charadrius alexandrines*)	Winter	2,100 individuals
Grey plover (*Pluvialis squatarola*)	Winter	2,300 individuals
Common ringed plover (*Charadrius hiaticula*)	Winter	8,600 individuals
Common redshank (*Tringa tetanus*)	Winter	4,000 individuals
Sanderling (*Calidris alba*)	Winter	2,900 individuals
Curlew sandpiper (*Calidris ferruginea*)	Winter	9,500 individuals
Waterbird assemblage	Winter	20,000 to 49,999 individuals

A total of 36 wader species have been recorded in the estuary and numbers are stated by Birdlife International to exceed 20,000 regularly. The Sierra Leone River Estuary is one of the four major sites for wintering waders in the country. Concentrations are usually found along the banks of the Bunce River and Aberdeen Creek, where mangrove provides suitable roosting sites, as well as breeding habitat for such species as western reef heron (or striated heron) *Butorides striatus*. Less common migrant Palearctic waders (less than 500 individuals) include ruddy turnstone *Arenaria interpres*, Eurasian curlew *Numenius arquata*, marsh sandpiper *Tringa stagnatilis* and Temminck's stint *Calidris temminckii*.

Monitoring carried out by IBA in 2013 revealed that the site is being degraded by various agents, including rapid over-exploitation of fish and other aquatic resources across most (>50%) of the designated area, and residential and commercial development and pollution from domestic & urban waste water across some (<50%) of the area.

Some limited conservation initiatives were reported to be in place. Although a management plan was known to exist it was out of date or not comprehensive, and less than 10% of the area was subject to conservation management at that time.

The Ramsar webpage for the Estuary (Ramsar Convention, 2000) states that it is threatened by vegetation clearance and unsustainable fishing, with efforts being made to conserve certain core areas within the site. It notes that vast areas of untouched mangrove forest still exist, and that traditional fishing and agro-forestry for fuelwood can be managed sustainably in collaboration with an existing EU-funded Artisanal Fishing

[9] Source: Birdlife International (2015).

Community Development Programme. In addition, fine beaches in some areas provide hope for well-managed tourist development.

Western Area Peninsula National Park: This no-hunting reserve consists of 17,688 ha of closed rainforest as well as two reservoirs, and is located on the hills of the Western Area Peninsula, about 5 km south of Freetown. The nearest section to the project site is located c.1.5 km to the south. The reserve occupies a narrow chain of hills approximately 37 km long and 14 km wide, with a range of peaks, the highest being Picket Hill in the south, which rises to about 900 m. The reserve was set up in 1916 and gained National Park status in 2013.

A total of 374 bird species, including occasional vagrants and migrants that visit water bodies within the forest, have so far been recorded in the reserve. They include two threatened species, namely white-necked rockfowl *Picathartes gymnocephalus* and green-tailed bristlebill *Bleda eximius*, both of which are forest specialists. Fifty species of mammal have also been recorded in the reserve, including seven species of primate. Five of these are threatened and include western chimpanzee *Pan troglodytes verus*, red colobus *Procolobus badius*, western black-and-white colobus *Colobus polykomos*, sooty mangabey *Cercocebus atys* and Diana monkey *Cercopithecus diana*. Other threatened mammals include leopard *Panthera pardus*, Jentinks duiker *Cephalophus jentinki*, black duiker *Cephalophus niger* and Maxwell duiker *Cephalophus maxwellii*. An endemic toad, *Cardioglosus aureolli*, and a rare frog, the Freetown long-fingered frog *Arthroleptis aureole*, also occur.

According to the United States Agency for International Development (2007), the management of the reserve appears to be losing ground to incidental development within the reserve boundary, increased agricultural exploitation, charcoal production, and fuelwood and rock collecting. This has resulted in a visible reduction of forest cover along the numerous extraction tracks leading up to the watershed. Maintenance of sufficient forest cover (greater than 60 percent) is only evident within the inner core of the reserve.

5.5.2 Habitats

The Project Site and Local Area: The project site is a brownfield site entirely comprised of modified habitat and mainly characterised by warehouses, garages, office buildings, truck parking and workshops. The area is highly disturbed and features considerable areas of bare ground and hardstanding.

Some artisanal farming takes place on former waste ground along the western and southern walls of the site. Crops include potato, cassava leaves and soya. A few individual trees occur along the northern and eastern site boundaries, as well as along the proposed HFO pipeline corridor.

Similar to the project site, the local area within 2 km of the project site boundary is dominated by urban and industrial development, including Kissy, Kissy Dockyard, Maeba Town and Allen Town. The area has a long history of modification from human activities associated with maritime industry, oil installations, factories and settlements. As a consequence, there is very little vegetation within this zone, with the exception of some urban gardens, vegetable plots and occasional trees, notably cotton tree (or kapok) *Ceiba pentandra*, mango *Mangifera indica* and oil palm *Elais guineensis*, as well as hedges, scrub, grasses and exotic herbaceous weeds, including elephant grass *Pennisetum purpureum*, Guinea grass *Panicum maxima* and butterfly pea *Centrosema pubescens* (CEMMATS Group Ltd, 2013). In some places trees form larger stands, notably groups of cotton trees up to 100 years old in age and stands of oil palm likely to have been planted by private house owners. Hedges are used in some places to demarcate boundaries. These mainly comprise exotic species such as *Bougainvillea* spp and tickberry *Lantana camara* and locally Manila tamarind *Pithecellobium dulce*.

The local area is drained by watercourses which flow northwards from the hills south of Freetown. They include a watercourse c.200 m west of the project site that crosses Factory Road and flows through disused industrial land to the bay west of the NP Facility. A tributary of this stream passes close to the southern boundary of the site. The most significant surface water feature in the area is Wellington Creek, located c.250 m east of the project site and c.75 m east of the proposed HFO pipeline route at its closest point.

Wellington Creek flows in a 50-100 m wide corridor characterised by vegetable plots and steeper slopes clothed in herbaceous and woody vegetation. It drains into the Sierra Leone River Estuary to the east of the NP Facility.

Both watercourses are subject to wastewater discharge from domestic households, local businesses and industry, and they are also used as dumping sites for domestic and industrial solid waste (CEMMATS Group Ltd, 2013). It is stated in the ESIA for the Addax jetty development, that runoff from the hills, especially during the rainy season, brings large quantities of sediments generated from deforestation (mainly for housing construction on the hillsides) and that much of the non-oil pollution and contamination of coastal areas is associated with these drainage systems (CEMMATS Group Ltd, 2013). The sedimentation also has the effect of creating stagnant water in some places, which combined with overgrown vegetation, creates suitable conditions for mosquitos and dragonflies.

The ESIA for the Addax jetty development also states that a number of small springs occur in the local area, most of which dry up during the dry season (CEMMATS Group Ltd, 2013). A low number of wells are also found in community areas, which, together with the seasonal springs serve as the major sources of water for domestic use.

The Sierra Leone River Estuary Ramsar Wetland and IBA within 2 km of the Project Site: In terms of habitats, the main reason for designating the Sierra Leone River Estuary a Ramsar Wetland is the quality and quantity of its mangrove resources. There are a few tracts of mangrove within 2 km of the project site, although this comprises modified, very degraded and in some areas completely depleted mangrove vegetation. The species include red mangrove Rhizophora racemosa and white mangrove Avicennia africana (CEMMATS Group Ltd, 2013).

Most of the intertidal / littoral zone within 2 km of the project site is narrow and has been modified into embankments and jetties for the operations of maritime and oil companies. In addition to the mangroves, small patches of mixed intertidal rocky, sandy and muddy shores remain that serve as habitat for a variety of shoreline organisms, such as limpets, barnacles, mussels, oysters, cockles and a number of annelids and many other marine invertebrates. However, the quality of these small patches is being degraded due to both regulated and unregulated construction activities, transfer of mined sand and oil pollution (CEMMATS Group Ltd, 2013). These pressures mean that much of the coastline has been considerably modified and that primary productivity has declined considerably. As a result of this, harvesting of oysters, cockles and other intertidal products is indicated as being almost non-existent in most of the intertidal flats of the project area.

The coastal vegetation within 2 km of the project site includes small modified remnants of coastal park savannah, which is mainly confined to industrial facilities and which is much degraded (CEMMATS Group Ltd, 2013).

The Western Area Peninsula National Park within 2 km of the Project Site: Western Area Peninsula National Park is located c.1.5 km south of the site. However, within a 2 km distance habitats within the National Park are modified and mainly comprise derived savannah with scattered scrub and trees. As described earlier, maintenance of a forest cover greater than 60 percent is only evident within the inner core of the reserve (USAID, 2007). Aerial photography suggests that dense forest begins c.7 km south of the project site.

5.5.3 Fauna

The Project Site and Local Area: Due to the degraded and highly disturbed nature of the project site, the potential for faunal species of conservation interest to be present is low.

Walkover surveys carried out for the Addax Jetty ESIA recorded a range of species, most of which are common and widespread in Sierra Leone (CEMMATS Group Ltd, 2013). The potential for faunal species within the site was mainly associated with larger specimens of cotton tree which can acts as roosting and breeding sites for large birds, such as the raptors black kite *Milvus migrans*, lizard buzzard *Kaupifalco* *monogrammicus* and hooded vulture *Necrosyrtes monachus* all of which are reported to be present in the local area in the Addax Jetty ESIA (CEMMATS Group Ltd, 2013). The tree can also host fruit bats and invertebrates.

The Jetty ESIA surveys focused on butterflies, birds and mammals in the local area. Apart from a range of common and widespread species, the following species of greater conservation interest were also recorded:

Butterflies:

- Euphaedra inanum – endemic to West Africa.
- Mylothris poppae – endemic to West Africa.

Birds:

- Western reef heron – Ramsar assemblage species, IUCN Endangered.

Reptiles:

- Nile monitor Varanus niloticus – listed on Appendix II of CITES.
- Olive ridley Lepidochelys olivacea – vulnerable, listed on Appendix I of CITES.
- Loggerhead Caretta caretta – endangered, listed on Appendix I of CITES.
- Leatherback Dermochelys coriacea – vulnerable, listed on Appendix I of CITES.
- Green sea turtle Chelonia mydas – endangered, listed on Appendix I of CITES.
- Hawksbill Eretmochelys imbricata – endangered, listed on Appendix I of CITES.

Although five species of marine turtle were reported in the Addax Jetty ESIA surveys as occurring on sandy beaches that line portions of the coastline, the ESIA states that there are no indications that their breeding range extends into the local coastline (CEMMATS Group Ltd, 2013).

No mammal species of note is reported to occur in the local area in the Addax Jetty ESIA (CEMMATS Group Ltd, 2013), and mammal presence is likely to be very low. An interview with a middle-aged respondent suggested that between 20 and 30 years ago a particular species of monkey, possibly the Campbell's monkey *Cercopithecus campbelli*, was present in mangrove and gallery forest along the coastal fringes in the vicinity of the study area, but this species has not been seen in a long time because of hunting and habitat destruction.

None of the species of conservation interest within the Western Area Peninsula National Park were recorded in the local area during the Addax Jetty ESIA surveys (CEMMATS Group Ltd, 2013).

Full detail of the assessment of potential impacts and details of mitigation measures regarding ecology are presented in Section 12 of this ESHIA.

5.6 Waste Management

Waste management planning in Sierra Leone falls under the remit of the Ministry of Health and Sanitation. An Integrated National Waste Management Strategy document was released by the ministry in 2012. The strategy includes a comprehensive framework for the management of healthcare, municipal and industrial waste along with recommendations for educational programmes to raise awareness of domestic waste management and associated good practices.

Recent industrialisation and associated urbanisation has led to significant population increase in Freetown, particularly within slum areas. This overwhelmed the limited waste handling capacity of the previously existing Freetown Waste Management Authority. Poor solid, liquid and healthcare waste management, combined with poor community and personal sanitation/hygiene practices is indicated as closely related to high infant mortality due to spread of malaria, diarrhoea and cholera.

The strategy is in the early stages of implementation and significant new waste infrastructure is yet to be developed. No engineered landfills are thought to be present within Sierra Leone. Whilst formalised collections are beginning to take place, it is believed that many households may burn waste or dispose of it at the nearest ad-hoc dump site, often within stream or river valleys.

The Masada Waste Management Company ('Masada') is the sole body responsible for all waste handling in Freetown. The company was set up following the closure of the Freetown Waste Management Authority in late 2013 and is a quasi-government organisation.

Masada handles commercial, industrial and domestic waste using existing dump sites (including Central Dump and Kingtom), inherited from the previous management authority. These structures are not engineered landfills and are not appropriate to accept hazardous waste. Masada does accept hazardous waste; however, it is currently stored and is not processed or disposed.

Masada plans to build a modern integrated solid waste management facility to be built in Kerrytown, which include hazardous waste management along with composting, mixed recycling facility and engineered landfill. However, at present the timeframe for the new facility is unknown and there is no firm evidence that suggests this project is likely to commence in the near future.

The company operates two programmes – a commercial service and door to door residential service. Wheely bins are now in circulation with the programme providing two sizes of bins (230l for residential and 1,100l for commercial). Collections occur on two shifts (day/night), with different teams covering different areas, including Eastern Freetown (and Kissy Docks). In May 2014, Masada started a waste stream characterisation for Freetown in order to inform the design of the integrated waste management facility.

5.7 Transport

The movement of people and goods in Sierra Leone is almost entirely dependent upon the road system. It is understood that some 97%[10] of all transport is by road. The provision of a basic and properly maintained highway system is therefore of critical importance to the country.

During site visits, the transport network in Freetown was observed to be poorly maintained and heavily congested, particularly during the morning and evening peaks.

Table 5.13 provides details of the extents of the road network to be included in the scope of this assessment, and also estimates the notional capacities of these links. These capacities have been derived from guidance taken from the UK Design Manual for Roads & Bridges (DMRB) Volume 5, Section 1, Part 3 TA 79/99 'Traffic Capacity of Urban Roads.'

Table 5.13: Notional Road Link Capacities

Road Link	Road Type*	Road Type Description	One-way hourly flow (vehs)**
Racecourse Road / Cline Street	UAP3	Variable standard road carrying mixed traffic with frontage access, side roads, bus stops and at-grade pedestrian crossings.	1,110-1,530

[10] Delegation of the European Union to Sierra Leone

Bai Bureh Road	UAP2	Good standard single/dual carriageway road with frontage access and more than two side roads per km.	1,260-1,550
Africanus Road / Factory Road / Parsonage Street / South Road	UAP3	Variable standard road carrying mixed traffic with frontage access, side roads, bus stops and at-grade pedestrian crossings.	1,110-1,530

** UAP (Urban All-Purpose)*

*** Flow assumes a 60:40 directional split. Values given represent the busiest flow (60% figure).*

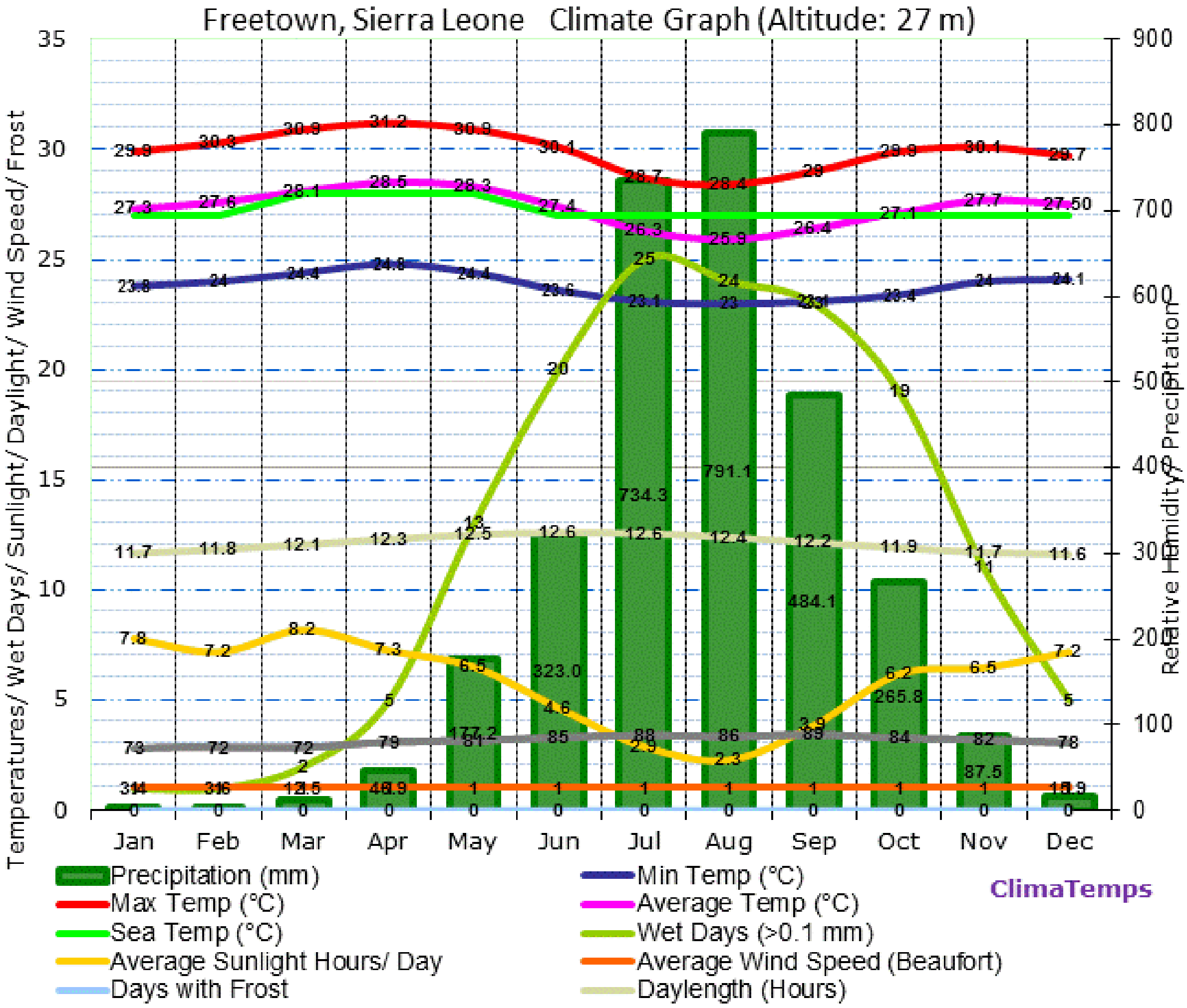
Since no traffic data is currently available for the road links around the proposed development it is not possible to identify the levels of capacity the roads identified are operating at. However, as outlined above, based on information from site visits, it would appear that these roads are heavily congested, particularly in the morning and evening peaks, and therefore the road links are operating at saturated traffic conditions (where the actual flow has exceeded the theoretical capacities outlined in Table 5.5).

5.8 Climate, Rainfall and Climate Change

Figure 5.2 presents climate data for Freetown. Freetown, as with Sierra Leone and other West African countries has a tropical climate with two distinct seasons; the dry season which occurs between November and April and the wet season which occurs between May and October, with a peak of up to 800mm rain during August.

The temperature generally ranges between 22 and 32^{0}C. As the project site is located approximately 500m from the sea, it is likely to experience higher wind speeds than inshore locations.

Figure 5.2: Graph of Freetown Climate Data[11]



A detailed review of information sources regarding potential for climate change in the Sierra Leone Region is presented in the ESHIA Scoping Report (Appendix C), presented in Appendix G of this ESHIA. Risks to the project are generally considered low. The risk of flooding can be planned for by a consideration of predicted climate change in the drainage system design. Within the ESMP, a recommendation will therefore include that an appropriate increase in drainage capacity is to be incorporated into the design to account for potential increased rainfall relative to the historical and current norm.

The review in Appendix C of the ESHIA Scoping Report also considers climate change related temperature change impacts on engine efficiency and implications for greenhouse gas emissions. No specific mitigation can be implemented to prevent efficiency decrease due to temperature change and in any case this is expected to be comparatively minor. However, data relating to engine efficiency should be considered in the selection of the engines to be used. Selecting an engine with a high threshold point over which efficiency decreases occur, and/or a exhibits a slow rate of efficiency decline will ensure that output can be maintained as near as possible to the optimum, and thus minimise operation costs and emissions. This has been included as an action in the ESMP.

[11] http://www.freetown.climatemps.com/graph.php [data source presumed to be Lunghi Airport, but not confirmed]

The ESMP also includes requirements regarding annual reporting of greenhouse gas emissions in line with the requirements of the IFC PS3.

5.9 Archaeology and Cultural Heritage

IFC PS8 defines cultural resources as "(i) tangible forms of cultural heritage, such as tangible moveable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values; (ii) unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes, and waterfalls; and (iii) certain instances of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles."

The site is located within the heavily urbanised Kissy Docks area of Freetown. Those areas of the site that do not contain buildings are either hard rock outcrops or likely to be shallow sand/gravel (potentially made ground). Waste land within the site has been farmed at different times over the last 3 years.

The Atkins 2008 Review of Environmental and Social Factors reports that the majority ethnic group in Freetown, Creoles, do not practice activities that involve sacred sites or other protected features. It is possible that sites of cultural importance used by other tribes may lie within the study area, but the potential for this is considered to be very low given the highly industrialised nature of the area. The recent civil war also means that archaeological and historical sites are unlikely to be present.

A desktop survey completed as part of this ESHIA identified no information regarding the archaeological or cultural heritage significance of the site. Additionally consultations with representatives of identified users of the site (SLRA, MSU, CRCC and farmers) have not identified any practices of cultural heritage significance within the site. Given the developed nature and current use of the site, it is considered unlikely that the site has cultural resource value of note.

With no identified cultural resource features within the study area the topic has been scoped out of this ESHIA. In the event that evidence is identified during construction that indicates items of cultural significance may be present, a cultural resource expert should be appointed.

The Cultural Resource Expert would require:

- A proven background working on cultural resources reports;
- A thorough knowledge of applicable legislation, standards and guidelines;
- An understanding of the criteria for evaluation and classification of significance of impacts;
- An ability to understand and communicate to the EPC Contractor how cultural resource issues may affect the preconstruction and construction phases and programme of the proposed development; and,
- A capability to produce accurate, focused and comprehensive research findings.

To carry out a field inspection:

- A detailed methodology should be produced;
- Field work should be carried out in a systematic fashion;
- All features should be recorded, described and photographed; and
- All limitations to the survey must be noted.

The field inspection and potential subsequent mitigation measure, including the potential requirement for a chance find procedure, would be completed in line with the requirements of the IFC PS8 Cultural Heritage.

If any artefacts or cultural heritage sites are discovered during the field inspection or construction phase, the EPC Contractor shall inform the Sierra Leone Ministry of Tourism and Cultural Affairs and proceed according to their recommendations.

5.10 Landscape and Visual

Given the size and scale of the development in the context of the heavily industrialised and urbanised Kissy Docks area, there will be no significant effects associated with Landscape and Visual amenity. In consultations with the EPA-SL, it was also confirmed that landscape and visual impacts are not considered to be a significant development constraint in Sierra Leone. Nevertheless, the following discussion of the current baseline is provided as a basis to scope out this assessment at this phase.

The site is currently operating as a commercial/industrial facility, and there are two significant industrial facilities within 400m to the north (the disused refinery and NP facility). There are already three significant structures located on the site (canopy in the SLRA-WR compound and the workshop and stores in the MSU compound). Some of these will be reused and are relatively similar in height to the main features of the proposed plant (engine hall, radiators and main elements of the switchyard).

The area surrounding the site is predominantly flat coastal area (potentially a former wave cut platform) that stretches from the SLRE for 2 to 3km, before rising as the foothills of the Western Area National Park mountains. In the Kissy Dock/Eastern Freetown area, there are numerous buildings of similar or greater proportions to those already on the site and those proposed for the development, several telecommunications masts and emissions stacks (on the disused refinery) and fuel tank farms (in both the refinery area and the NP facility). These are interspersed with significant numbers of large trees.

Essentially, the area's 'sense of place' is derived from this heavily urbanised and industrial setting, and the area is not considered to have significant amenity value from a landscape and visual perspective. Given the setting described above, the construction of a relatively low rise power plant is therefore not anticipated to result in a significant change in the landscape character of the site. Views of the site will mainly be restricted to neighbouring properties, and the nature of this view will not change significantly from the current baseline. The upgrade of nearby roads and clearing of debris on the project site is likely to represent an improvement to the appearance of the area.

On this basis, landscape and visual impacts associated with the project are not expected to be significant, and a detailed assessment will not be undertaken as part of the ESHIA. However, in the absence of a detailed assessment, it is highlighted that the visual implications of the development will still be considered appropriately within the project design. The ESMP (Volume II), therefore, includes relevant measures regarding the design of the buildings to reduce height/spread where possible and the use of complementary finishes to the significant components of site infrastructure.

6. Environmental, Social and Health Impact Assessment Methodology

6.1 Overview of the ESHIA Process

An ESHIA is a systematic, scientific and participatory process to assess potential environmental, social and health impacts of a development, including consideration of project alternatives and cumulative impacts with other planned developments. The ESHIA process ensures that new developments, and extensions to existing developments, are located and designed in such a way as to minimise environmental and social impacts.

The objectives of an ESHIA are:

- To identify environmental constraints and opportunities within the study area, taking account of the characteristics of the development and the local environment;
- To identify potential impacts and interpret the nature of these impacts;
- To describe the mitigation measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment, including the appropriateness of avoidance and prevention measures; and
- To determine the significance of any residual environmental effects following mitigation measures
- To underpin the ESMP for implementation, management, monitoring and reporting of mitigation measures.

6.2 The ESIA Study Report

This document is the ESHIA study report, the following sections present an overview of the general impact assessment methodology applied to the assessment of potential impacts arising from the project elements. The findings of this assessment relevant to each of the environmental aspects listed in Section 1.6 are outlined in Sections 7 through 14, along with a description of any mitigation measures required. Impacts predicted as being of medium to high significance prior to the consideration of mitigation are assessed against appropriate mitigation measures to predict the residual impact significance.

This ESIA Study Report is supplemented by the Environmental and Social Management Plan (ESMP) which is provided as Volume II of the ESHIA. The ESMP summarises the mitigation action plan and shows how these will be implemented, managed, monitored and reported.

This ESHIA Study Report enables the EPA, local community and other key stakeholders to determine whether or not the proposals (including recommended mitigation) are acceptable. This report also informs the permitting process as the recommended mitigation measures and other actions included in the ESMP form conditions of the EIA Permit issued by the EPA.

In order to evaluate environmental impacts and determine their effects and significance, it is important that assessment criteria are identified. The various methodologies that have been used within each specialist area or discipline are made clear within the appropriate sections of this ESIA Study Report.

Each specialist impact assessment section includes the following information:

- **Predicted effects:** an evaluation of the proposed project's impacts in quantitative and qualitative terms. In general, the effect of an impact is assessed by a combination of sensitivity of the environment and the degree of alteration from the baseline state (both positive and negative) which can be predicted. Environmental sensitivity may be categorised by a multitude of factors such as the threat to a rare or endangered species, transformation of landscapes or changes to soil quality or land use. Impacts can have both direct and indirect effects, be cumulative, short-term, medium term or long term, permanent or temporary and have positive or negative effects. Impacts can be analysed in terms of the source of pollution and the pathways by which they travel to arrive at a receptor;

- **Significance of effects:** Project impacts are determined to be 'significant' or 'not significant'. Significance is a combination of magnitude and sensitivity to change and is evaluated in terms of the geographic effect, duration and frequency, irreversibility, and any regulatory standards which may apply. For effects where an assessment of significance cannot be determined (e.g. for reasons of uncertainty), this issue will be highlighted and an explanation given as to why significance could not be determined.
- **Mitigation measures:** a description of the measures proposed to minimise potential significant adverse effects; and
- **Residual impacts:** determination of the project's remaining level of effect after all the required and recommended mitigation measures are implemented.

6.3 Procedure for Assessment of Environmental Impacts and their significance

The methodology developed and adopted for the impact assessments provides a tool for assessing and evaluating the significance of effects and is based on the following criteria:

- The type of effect (i.e. whether it is positive/acceptable, negative/unacceptable, neutral or uncertain);
- Duration and/or frequency of occurrence (short-term/frequent, long term/long return period, intermittent);
- The policy importance or sensitivity of the resource under consideration in a geographical context (whether it is international, national, regional or local, as defined in Table 6.1); and
- The magnitude of the effect in relation to the resource that has been evaluated, quantified if possible, or rated qualitatively as high, medium or low, as defined in Table 6.2.

Both professional judgement and the results of modelling analysis are used to assess the findings in relation to each of these criteria to give an assessment of significance for each effect. Effects are considered to be major, minor or negligible and can be negative or positive. Where positive impacts are identified mitigation is not required.

Table 6.1: Geographical Context and Policy Importance

Geographical Context	Topic Definition
International	Important at global, African or trans-boundary levels
National	Important in the context of Sierra Leone
Regional	Important in the context of Freetown
District	Important in the context of the Eastern Freetown / Kissy Docks Area
Local	Important within the site and up to 1km from the site

Table 6.2: Magnitude Criteria

Magnitude of effect	Negative effects	Positive effects
High	Widespread community concern. Failure to meet legal compliance requirements. Fatality or serious health disability. Severe or possibly irreversible damage to an important ecosystem or resource.	Widespread community benefit. High contribution to safety or prevention of fatalities. High level of technology transfer. Prevents serious damage to an important ecosystem or resource.
Medium	Local community opposition and levels of complaint. Regulatory concerns. Lost time injury or short-term health effects. Medium term damage to an ecosystem or resource.	Contributes to local development and economy. Provides confidence to regulators. Prevents medium term damage to an ecosystem or resource.
Low	Minor community opposition or complaints. Able to comply with legal requirements. Local/minor health effects requiring short-term treatment. Short-term, minor damage to an ecosystem or resource.	Low level of community support. Economic benefits not distributed locally.

As a guide Table 6.3 presents a significance evaluation tool which calculates the significance of the effect by a combination of importance/ sensitivity and magnitude.

Table 6.3: Evaluation of Significance of Effect

Sensitivity of Impact	Magnitude of Impact		
	Low	Medium	High
International	Minor/ Moderate	Major / Moderate	Major
National	Minor/ Moderate	Moderate	Major
Regional	Minor	Moderate	Major
District	Minor / Negligible	Minor / Moderate	Minor / Moderate
Local	Minor / Negligible	Minor	Minor / Moderate

6.4 Mitigation Philosophy

Mitigation measures are measures proposed through the consideration of alternatives, physical design, project management or operation to avoid, reduce or remedy any significant adverse effects on people and the environment resulting from the proposed development.

The mitigation strategy employed is a hierarchical one which aims to primarily avoid potential impacts, to reduce those that remain, and lastly, where no other measures are possible, put forward compensatory measures. This approach is outlined as follows:

- Minimisation of environmental effects through avoidance and therefore minimising the number of reduction and remediation measures required to be 'built-in' to the project design;

- Minimisation of any remaining potential effects (e.g. by the use of appropriate construction methods or timing); and
- Thirdly, where avoidance or reduction are not feasible, measures to remedy any remaining effects predominantly during the construction phase of the project have been promoted (e.g. habitat management and landscaping proposals).

6.5 Other Developments and Cumulative Effect Assessment

It is a key part of any ESHIA process that the additional or cumulative impacts associated with nearby existing or proposed developments, or where relevant any transboundary effects, be considered and the results reported. This cumulative effect assessment is concerned with identifying situations where a number of effects from separate projects combine to cause a significant effect on a particular resource.

Projects being developed by others can be considered if operational, under construction, holding permits or in the permitting process. The details of the existing and proposed surrounding developments are provided in Section 1.8. The cumulative impacts, taking into consideration these existing and potential developments, have been assessed for each environmental and aspect and findings are included in the detailed ESHIA assessments.

6.6 Environmental and Social Management Plan

An ESMP has been produced as part of the ESHIA and is presented in Volume II. The ESMP is sufficiently robust to support International Lending requirements as stipulated in IFC PS1 – Environmental and Social Assessment and meet the requirements of the EPA EIA requirements.

The ESMP ranks and prioritises recommended environmental and social actions, describing time period for implementation. In addition, the ESMP indicates the roles and responsibilities of project personnel and third parties such as local and regional administrations and sub-contractors.

This ESMP will be used as a framework in the development of subsequent detailed management plans for detailed design, construction, operation and decommissioning phases. An Environmental Management Systems (EMS) team will be appointed for each project phase to review and further develop as required this framework ESMP. For the operational phase the ESMP will be developed into a full Environmental & Social Management System (ESMS) that will be aligned with ISO14001 that provides a formal and internationally acceptable structure that will be the central repository for all environmental and social plans and procedures.

7. Socio-Economic

This section assesses the potential socio-economics impacts of the proposed project during the construction operational and decommissioning phases.

Table 7.1 summarises the importance of socio-economic resources within the study area based on the ESHIA methodology set out in Section 6.

Table 7.1: Attributes of Socio-Economic Importance within the Study Area

Attribute	Importance	Rationale
Ecosystem Services, Community Health and Safety	Regional and Local	IFC PS 4, 6, 7, 8
Commercial Fishery Resources	Regional	Value on a regional scale
Local Water Supply, Fish Stocks, Crops	District	Value on a district level to supply ecosystem services
Employment and Economic Development	Regional and Local	Value on a regional and local scale due to importance to eastern Freetown and Kissy Docks area for informal services such as food sales

7.1 Impact Assessment

7.1.1 Physical Displacement/Resettlement Impacts

7.1.1.1 Construction and Operation

The project site itself has no inhabitants (legal residents or squatters). No physical resettlement impacts are anticipated from the proposed project.

7.1.2 Economic Displacement and Livelihood Impacts

7.1.2.1 Construction and Operation

Farming

Portions of the project site are currently being cultivated by 16 artisanal farmers. These areas are being cultivated without legal tenure. However, the farmers have been given permission to grow crops on this part of the site by the SLRA-WR, which has allowed this activity because it is considered an efficient way to keep the site clear of undergrowth. The crops grown here are seasonal: dry season – potato and cassava leaves; and wet season – *Corchorus* (‘Krain Krain’), green and soya. Supplementing these ground crops, there are banana and mango trees along the boundary and occasional sugar cane and maize crops. An area of wet season subsistence farming is evident in the northeast section of the SLRA-WR site. This includes an area of Pigeon Pea in the far north east corner, adjacent to the generator shed. It is understood that the farmers are all from neighbouring communities to the south of the site. Clearance of this land will result in the economic displacement of the 16 women farmers. Some of the farmers may be considered vulnerable as at least one is a widow and all of the farmers are dependent on their crops for subsistence.

Ecosystem Services

As discussed in the Ecology, section of this document, ecosystem services relevant to local communities which occur within the project area of influence include:

- Estuary and Wetland related resources including any crop plantations in the wetland area.
- Fisheries, commercial and subsidence fishing from the marine environment.
- Wild foods and other non-timber forest products, including medicinal plants collected from the wetland habitats.

The key ecosystem services which have the potential to be affected by the project are fisheries and loss of agricultural areas. However, the ecology assessment is not predicting any impacts to fisheries or agricultural resources. The project is most likely to have a negative impact on the wetland and estuary if any spillage of contaminants in the project area occurs. Any potential impacts to ecosystem services should be confirmed by surveys conducted post-Ebola.

7.1.2.2 Impact Significance

Livelihood impacts that would result from crop loss on site and related to fishing as well as ecosystem services would be considered moderately adverse and of local geographical significance. Crop loss for farmers currently farming on the site would be considered moderately significant and of a medium magnitude. CECASL will implement a LRP)/ARAP consistent with IFC PS5 and AfDB requirements including providing adequate opportunity to re-establish the livelihoods of the artisanal farmers in a transparent, equitable and consistent manner. This would include taking steps to assess the livelihood impact and to improve or restore income-earning capacity such as identifying and providing relocating the farmers to land of comparable productive value to the 16 farmers, providing alternative sources of income as necessary, and providing transitional support and compensation. As one of the farmers is a widow, and many of the farmers depend on their crops for subsistence, the farmers are considered vulnerable, thus the LRP/ARAP will include transitional and support measures commensurate with this. This LRP/ARAP will be completed ensuring that land clearance and all livelihood restoration measures including identification and provision of alternative land to the artisanal farmers would be completed prior to land clearance and the commencement of project construction currently planned for January 2016.

According to the ecology section of the ESHIA, physical impacts to fish species are not anticipated, with effects on the estuary and associated wetland addressed via appropriate mitigation and therefore impacts to ecosystem services are considered minor adverse.

The magnitude of overall economic displacement effects is considered to be moderate. This issue will be addressed via a LRP/ARAP to be completed by CECASL.

7.1.3 Employment

Employment impacts arising from the construction, operations and closure phases of the project would include:

- Generation of direct employment by the project.
- Economic development created as a result of indirect employment by suppliers of goods and services to the project.

Direct employment created by the project would be considered a beneficial effect. Employment estimates provided by CECASL in March 2015 consist of the following:

- At the peak of construction, the project is anticipated to employ up to 200 construction workers.

- During operations, the plant is expected to employ approximately 45 permanent employees.

Potential employment impacts are discussed separately below under construction and operations.

7.1.3.1 Construction

At the height of construction, 200 employees would be employed on-site that are anticipated to be resourced from the surrounding community, which would result in beneficial employment and indirect employment impacts for suppliers including goods and services providers for the project such as food vendors and petty traders and building materials companies. At this time, a workers camp is not anticipated to be required for the project. However, if the selected EPC contractor elects to develop camp for employees, a plan for mitigation and monitoring associated with the camp would be required subject to the approval of CECASL and EPASL. The construction period will last approximately 18 months, commencing in late 2015. The majority of employment during construction is likely to be relatively short-term and the extent of employment opportunities for local communities will depend upon skills levels and proximity. There is the potential for women to be disproportionately affected by this benefit as many of the construction jobs will be geared towards men. However, an influx of temporary employees to the site on a daily basis would increase the demand for services and expose the community to security risks.

Freetown under business as usual conditions is a robust community and is likely to be able to provide local labour for a construction project of this size. During the 2014-2015 Ebola crisis, there has been a high level of unemployment in the Kissy Dockyard and surrounding communities (Shell, Hotel 5-10, Kissy Thunderhill, Kissy Brook communities). Furthermore, it is common that people commonly mobilize from one part of Freetown to the other, such as for the WFP warehouse, where the company that supplied labour provided transportation to the site for work. As a result, a workers camp or an influx of workers and associated impacts is considered negligible for this project.

7.1.3.2 Operations

During project operations, employment impacts are considered to be positive. Permanent jobs associated with the project would include 45 positions. It is not clear whether or not these jobs will be able to be sourced from the local community as this would largely depend upon skill levels and training in the local and regional community. Despite the fact that employment opportunities are offered by the local power industry, local communities are often limited in their ability to take advantage of them. The level and range of skills and applicable working experience available in the community can be limited by education and relevant skills training. Without targeted training support from the project, the ability to acquire a position, and successful performance once hired, will favour experienced (skilled) personnel for professional roles, the majority of whom would likely come from abroad. This could create the potential for resentment from the local community towards outsiders.

The project will also provide a good source of potential indirect employment and economic growth for the area, although it will be relatively small.

7.1.3.3 Direct Employment

The project would have a moderate beneficial impact on employment during construction and potentially during operations both in the project area of Influence and in the wider geographical region. Considerable construction and a few potential operational employment opportunities could be generated by the project and providing that local recruitment and employment procedures are applied, and training of the workforce is undertaken for the project, then the overall benefits of direct employment can be maximised. As the project moves towards decommissioning and closure, there will be a subsequent decrease in the workforce requirements.

7.1.3.4 Indirect Employment

Plant staff and contractors will require vendors, suppliers and service providers to meet the daily operating needs of the project together with the domestic needs of its employees. This could include goods and services including food vendors, laundry, supply of vehicles and transportation services, security patrols, as well as some construction equipment. There will be opportunities for utilising local goods and services for the project and related activities.

Typically, 3.2-3.5 jobs in service and supply sectors are created for each direct job generated by oil and gas projects.[12] At the local and regional levels, this is likely to stimulate work for agricultural producers, as well as induce growth in other industries such as retail, hospitality, transportation, etc. This would be considered a minor beneficial impact.

A summary of the aforementioned socio-economic prior to mitigation are presented in Table 7.2.

[12] MACROECONOMIC IMPACTS OF THE DOMESTIC OIL & GAS INDUSTRY, NPC, September 15, 2011 (PWC multipliers used).

Table 7.2: Summary of Socio-economic Impacts during each phase (prior to mitigating measures)

Topic	Importance	Source of Effect	Effect Summary Description
Economic Displacement	Local/District	Project development	Construction and Operations Development of the project site would result in the economic displacement and livelihood impacts on approximately 16 farmers currently farming on site.
Ecosystem Services	Regional	Water impacts, ecology impacts	Construction and Operations Impacts from the project on the Estuary or the marine environment or other water resources could have knock-on effects for associated ecosystem services.
Employment	Local/Regional	Increase in direct and indirect employment	Construction 200 employees are anticipated to be required at the peak of construction. Additional goods and services would also be required to support construction of the project. Operations 45 permanent employees would be required for project operations. Some associated goods and services would also be required for project operations.
Increased demand for social services and increased pressure on local infrastructure,	Local/District	Daily influx of workers to the area	Construction 200 employees are anticipated to be required at the peak of construction. Additional goods and services would also be required to support construction of the project.
Security risks/crime	Local/District	Daily influx of workers	Construction 200 employees are anticipated to be required at the peak of construction. Additional goods and services would also be required to support construction of the project.

7.2 Mitigation

The specific mitigation and enhancement measures to be implemented for the proposed project are detailed below.

7.2.1 Economic Displacement

CECASL will prepare a LRP/ARAP to ensure that international standards for livelihood restoration are met. The Plan will be developed in consultation with the NPA and the affected farmers, prior to commencement of project per the requirements of IFC PS5. Development of the LRP/ARAP would include the following activities:

1. Collect census level data on income and crops and consider vulnerability of the affected community of artisanal famers.

2. Develop a system for compensation for crop loss on the site;

3. Continue consultation with the affected famers according to the requirements of IFC PS1 including the establishment of a grievance mechanism for the project that would be available to the local community; and,

4. Where determined as required by the outcomes of the above activities, provide training and livelihood assistance programs to the community including, for example, the potential to diversify, savings and credit opportunities, and business and enterprise training.

Within development of the LRP/ARAP, a commitment to adequate livelihood restoration has been made.

7.2.2 Employment

In line with the requirements of IFC PS2, it is important that the employment process is well managed and that the local community is able to actively participate in the project where they are appropriately qualified. CECASL will implement the following requirements regarding employment.

- Employment policies requiring preferential hiring of local community members where they are appropriately skilled. Pass through of this policy to the EPC Contractor and supply chain partners including sub-contractors to the EPC contractor;

- Ensure a transparent hiring process is conducted help the community to understand strategic staffing decisions for the project to avoid conflict;

- Develop a Workforce Development Strategy – a commitment to maximize employment and skills opportunities for local people; and,

- Develop a training and skills programme to impart best practice in the skilling of local people for construction and operational jobs. and,

- Encourage contractors to provide apprenticeship opportunities to local people

The following enhancement measures would contribute to maximising the benefits of the project and will be considered by CECASL as part of consultations around community benefits:

- Short-term training programs for women and youth: Additional training programs including savings, meeting food and health safety standards and other technology training programs for youth shall be offered that will help them to establish new and/or improved livelihoods; ; and,

- Establish a local job readiness programme and encourage the construction supply chain to continue to invest in workers.

7.3 Cumulative Impacts Assessment

Under Ebola conditions during 2014-2015, few projects in the vicinity are presently underway, including roadway improvements and construction of the Addax Jetty (which is projecting a low workforce estimate due to the specialized nature of the work). However, given the general lull in business and development at present, this issue will be revisited during the monitoring phase post-Ebola and under business as usual conditions. Under current conditions, the impacts associated economic displacement are likely to be minor adverse . The plant size is relatively small and with few other projects occurring in the area, and most impacts being local, the overall magnitude of cumulative impacts is likely to be low. In future, careful monitoring of the mitigation measures proposed and their effectiveness would help to ensure that cumulative impacts remain minor adverse.

7.4 Residual Impacts

With the measures described above, the residual significance is expected to be minor adverse. In the long-term, livelihood restoration and employment related impacts are anticipated to improve conditions in the community and would be substantially reduced with proper management.

8. Health and Safety

The General WBG EHS Guidelines and the WBG EHS Guidelines for Thermal Power Plants provide an overview of the key environmental, health and safety topics that are particularly relevant. IFC PS4 also addresses Community Health and Safety requirements.

The World Bank Group's EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC's PS 3 on Pollution Prevention and Abatement.

8.1 Potential Impacts

8.1.1 Occupational Health

Specific occupational health and safety issues associated with power projects include the potential for exposure to confined spaces, heat and air quality and noise impacts.

In addition to these occupational health concerns, there are also health and safety risks associated with construction, operation and decommissioning activities and emergency situations.

- **Confined Spaces:** Confined space hazards in this and any other industry sector are potentially fatal. Confined space entry by workers and the potential for accidents may vary among power facilities depending on design and on-site equipment. Therefore, confined spaces on site could result in adverse health and safety impacts to workers.
- **Heat:** Occupational exposure to heat occurs during construction activities, and during operation and maintenance of pipes, wells, and related hot equipment. Therefore, heat associated with operational and construction equipment on site could result in adverse health and safety impacts to workers.
- **Noise and Air Quality:** Workers could be exposed to noise particulate emissions during construction activities diesel engines, drilling and other heavy machinery are utilised. Operational noise and air quality emissions could also expose workers to excessive noise and air quality emissions.
- **Other Concerns:** Potential occupational health and safety issues during construction activities would also include:
    - Falls and slips;
    - Failures of support systems and/or platforms;
    - Collision with mobile plant or vehicles;
    - Road safety relating to water trucks;
    - Exposure to dust and to hazardous materials;
    - Explosions;
    - Burns;
    - Crushing by heavy plant or collapse of structures;
    - Falling debris;
    - Adverse weather conditions;
    - Falls into voids during piling; and,
    - Contact with concrete.

8.1.2 Community Health, Safety and Security Impacts

Health and safety impacts arising from the construction, operations and decommissioning are likely to include the following:

- Increased risk of traffic hazards and incidents associated with the construction routes;
- Exposure to project related hazards associated with construction, operational and decommissioning activities;
- Increased potential for conflict with security guards and the possibility of unnecessary use of force;
- Fire risk from crude oil stored on site; and
- Increased incidence of communicable disease.

8.2 Impact Assessment

8.2.1 Occupational Health and Safety

Impacts on worker and occupational health and safety associated with confined spaces, air quality and noise concerns, heat, potential accidents and emergency concerns would be considered major adverse. Implementation of proper health and safety plans would reduce these risks significantly.

8.2.2 Community Health and Safety

During construction, materials will be delivered to the site and during operations traffic flow is predicted to increase gradually. This would lead to an increase in the potential for other health related impacts associated such as increases in noise, dust, risk of accidents and exposure to hazardous materials. Project deliveries will be scheduled for daytime hours whenever possible due principally to safety reasons, but with the secondary benefit of noise reduction through the night. The introduction of increased HGV traffic and general increasing traffic volumes presents a safety risk to the community and to workers. In addition, there will be the potential for increased road traffic accidents from increased construction traffic. Emergency response for potential accidents will also be an important consideration. Appropriate health and safety standards would need to be applied at the site to address effects associated with accidents.

Contractors that come from outside the area would rent homes locally. Large numbers of workers on-site during construction could also increase the risk of communicable disease. In addition, dust from construction can cause temporary respiratory effects and possibly exacerbate existing respiratory illnesses for workers. Personal safety issues are also a concern including threats to personal security and property as a result of unruly or disruptive behaviour by workers or other individuals on-site.

8.2.3 Impact Significance

Community safety impacts from increased roads and traffic, increase the risk of communicable diseases and safety risks and exposure to hazards would be considered a minor adverse impact. Effects would likely be short-term and localised and risks would be highest during the peak construction period lasting approximately 4 months. Children and other vulnerable people including the elderly and those with existing health problems would likely be most susceptible to the community health risks.

A summary of the aforementioned health and safety risks prior to mitigation are presented in Table 8.1.

Table 8.1: Summary of Community Health and Safety Impacts during Each Phase (Prior to Mitigating Measures)

Topic	Importance	Source of Effect	Effect Summary Description	Potential Effect Unmitigated		
				Magnitude	Significance	Impact Type
Occupational Health and Safety	National	Exposure to confined spaces and heat	Operations Failure to meet legal compliance requirements. Fatality or serious health disability.	Medium	Major	Direct, negative long term
Occupational Health and Safety	National	Accidents, air quality and noise impacts	Construction Failure to meet legal compliance requirements. Fatality or serious health disability.	High	Moderate	Direct, negative short-term
Community Health and Safety	Local	Traffic, hazardous material impacts	Construction Increased traffic and the transport and use of hazardous materials during construction could result in accidents.	Medium	Minor	Direct, Negative short-term
			Operations Increased traffic and the transport and use of hazardous materials could result in accidents during operations.	Medium	Minor	Indirect negative short-term
Community Health and Safety	Local	Air quality, noise,	Construction Increased dust and noise impacts are anticipated during	Low	Minor	Direct negative short-term

			construction, which could lead to community health and safety effects.			
			Operations Increased air quality and noise emissions from traffic and plant operation.	High	Moderate	Direct Negative, Long-term

8.3 Mitigation

8.3.1 Occupational Health

8.3.1.1 Confined Spaces

Engineering measures will be implemented to eliminate, to the degree feasible, the existence and adverse character of confined spaces. Other mitigation should include:

- Permits will be required for entry into those locations classed as confined spaces. These spaces should be provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent practicable;
- Safety precautions will include Self Contained Breathing Apparatus (SCBA), life lines, and safety watch workers stationed outside the confined space, with rescue and first aid equipment readily available; and,
- Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, use of the necessary personal protective equipment (PPE), as well as the serviceability and integrity of the PPE will be verified.

8.3.1.2 Heat

Prevention and control measures to address heat exposure include:

- Reducing the time required for work in elevated temperature environments and ensuring access to drinking water;
- Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc.;
- Use of PPE as appropriate, including insulated gloves and shoes; and,
- Implementing appropriate safety procedures during the exploratory drilling process.

8.3.1.3 Noise

Noise abatement technology includes the use of rock mufflers, sound insulation, and barriers during drilling. These activities will be carried out in the demolition phase of the construction stage (1 month duration)

Noise limits for different working environments are provided in Table 8.2.

Table 8.2: Noise limits for different working environments

Noise Limits for Various Working Environments		
Location/Activity	**Equivalent level LAeq 8 hour (dBA)**	**Maximum LAmaxfast dBA**
Heavy Industry (no demand for oral communication)	85	110
Light industry (decreasing demand for oral communication)	50-65	110
Open offices, control rooms, service counters or similar	45-50	-
Individual offices (no disturbing noise)	40-45	-
Classrooms/Lecture Halls	35-40	-
Hospitals	30-35	40

8.3.1.4 Health and Safety Management Systems

A health and safety system for construction and operational activities will be developed as a requirement of the ESMP for routine activities. The operational system will be based on the requirements of ISO18001 for Occupational Safety and Health Management Systems (OSHMS).

A health and safety plan will be developed as a requirement of the ESMP that will include a process hazard analysis and HAZOP will be prepared to cover the full project infrastructure The information generated from the HAZOP will be used to prepare a pipeline failure safety plan.

The protection of personnel and equipment is of paramount importance. Fire safety and Emergency Response Plans will be developed and implemented as part of the ESMP. The designs for the plant will incorporate provisions for fire prevention (developed procedures), fire detection (sensors and alarms), and fire suppression (water and foam and portable extinguishers). The facility will have equipment installed including gas detection, heat sensors and manual pull stations in the event of a fire and an audible alarm system. Typically National Fire protection Association (NFPA) 850 recommendations will be implemented for insurance purposes.

8.3.1.5 Additional Occupational Health and Safety Measures

- Workers shall receive property PPE and associated health and safety training including procedures for emergency response.
- First Aid and Safety training will be provided to workers.
- A worker health monitoring programme shall also be established to ensure proper management of occupational health and safety concerns and incidents.

With the safety measures described above, the residual significance of construction impacts is expected to be reduced to minor as workers become more familiar with dealing with health and safety issues.

With the planned safety measures and requirements described, the residual significance of operational impacts is expected to be mitigated to as low as reasonably practicable based upon current practice.

8.3.2 Community Health and Safety

The following mitigation measures are recommended to reduce potential community health and safety effects:

- A Transport Management Plan shall be implemented for any construction traffic to reduce the potential for accidents.
- All project operations vehicles and contractor vehicles will have a speed limit set for travel through settlements and areas where there are no posted speed limits.
- A Worker Policy and Code of Behaviour including security personnel shall be developed which includes guidance on visits, prescribed actions for conduct violations and a grievance mechanism for complaints.
- The EPC contractor will adhere to the internationally established Voluntary Principles on Security and Human Rights developed for the extractive energy sectors to ensure that adequate health and safety training of security personnel takes place. If needed, the EPC contractor shall involve external stakeholders (i.e. police or local authorities) in any on-site security incidents and ensure that appropriate incident response procedures are implemented in accordance with the recommendation of the Interactions Between Companies and Public Security included in the Voluntary Principles on Security and Human Rights.
- An important aspect of minimising the spread of communicable diseases within the community is worker health screening, particularly as many construction workers are expected to be local people. A worker health screening programme shall be developed and implemented during the peak construction period or at any time when workers on site number more than 100.
- Community Emergency Response Plans will be developed and tested including workers and nearby residents in the vicinity of project-related traffic. These will include emergency response related to traffic accidents, the potential releases of chemicals and other hazardous materials, and fires.

With the safety measures described above, the residual significance is expected to be reduced to minor as proper traffic management and traffic calming measures are put into place to traffic levels and as proper safety management plans are implemented.

8.4 Cumulative impacts

Under Ebola conditions during 2014-2015, a few projects in the vicinity are presently underway including roadway improvements and construction of the Addax Jetty (nearly complete). However, given the general lull in business and development at present, this issue should be revisited during the monitoring phase, now that the disease outbreak has largely been controlled. Under conditions at the time of writing, the impacts associated with community health and safety are likely to be minor adverse. The plant size is relatively small and with few other projects occurring, and most impacts being local the overall magnitude of cumulative impacts is likely to be low. In future, careful monitoring of the mitigation measures proposed and their effectiveness would help to ensure that cumulative impacts would be negligible.

8.5 Residual Impacts/Conclusion

Overall adverse impacts associated with health and safety for workers and the community would be reduced by the implementation of appropriate health and safety systems. Implementation of appropriate mitigation measures if properly implemented would significantly reduce project effects and address any potential health and safety concerns.

9. Noise

This section of the ESHIA assesses the potential for construction and operational impacts of the project with respect to noise.

Noise disturbance is frequently raised as a significant issue by local communities concerned about development, and is often the focus of complaints relating to operations. In some situations, it can lead to adverse health impacts. It is therefore appropriate to consider, and if necessary mitigate, the potential noise impacts that the project may have.

9.1 Noise Level Guidelines

International guidelines for ambient noise levels are set out by the IFC/World Bank in their General Environmental, Health, and Safety Guidelines (2007). Furthermore, the World Health Organisation (WHO) has set out international guidelines for indoor noise levels to avoid sleep disturbance. Each of these guidelines is described in more detail below.

9.1.1 World Bank Guidelines

The WBG has published EHS Guidelines for Thermal Power Plants (WBG 2008) which set out industry-specific examples of good international industry practice. In respect of noise, these guidelines note that amongst the principal sources of noise in thermal power plants are turbine generators and auxiliaries, boilers and auxiliaries, fans and ductwork, pumps, compressors, piping, valves and cooling towers.

Noise impacts, control measures, and recommended ambient noise levels for thermal power plants are presented in Section 1.7 of the General EHS Guidelines. These noise level guidelines are presented in 1 below. It is required that noise abatement measures should achieve either the following levels or a maximum increase in background levels of 3dB(A).

Table 9.1: IFC General EHS Guidelines: Noise Level Guidelines (dB)

Receptor	Daytime 07:00-22:00 hrs ($L_{Aeq\ 1hr}$)	Night-time 22:00-07:00 hrs ($L_{Aeq\ 1hr}$)
Residential; institutional; educational.	55	45
Industrial; commercial	70	70

Whilst not explicit, the IFC guidelines in practice are commonly applied to the noise from the development only and not to the cumulative level of baseline plus development related noise. The guidelines are also commonly interpreted as being relevant to the long-term operational noise emissions from the project, rather than the short-term construction noise levels.

The IFC EHS guidelines also present examples of noise reduction options that should be considered where noise levels exceed these guideline values, along with recommendations for noise monitoring to be carried out either to establish existing ambient noise levels or to verify operational noise levels.

The noise guidelines presented in Section 1.7 of the General EHS Guidelines are based on the 1999 World Health Organisation (WHO) Guidelines for Community Noise.

Although the General EHS guidelines do not stipulate any environmental vibration criteria, the IFC requires potential impacts from vibration to be mitigated.

9.2 Potential Noise Impacts

The operation of the equipment associated with the construction and operation phase of the project have the potential to lead to noise impacts at residences, schools, healthcare facilities and other nearby sensitive receptors.

Depending on the magnitude of the impact, and the activities being conducted at the receptor, the following effects may result:

- Small changes in behaviour such as turning the volume up, speaking more loudly, occasionally closing windows and a perceived reduction in quality of life.
- Material changes in behaviour such as avoiding certain activities during noisy periods, keeping windows closed most of the time, difficulty concentrating on tasks, reduced speech intelligibility and diminished quality of life.
- Health impacts such as annoyance, reduced cognitive performance, sleep disturbance (arousal, motility, sleep quality and reported awakening), the autonomous release of stress hormones, increased risk of hypertension (high blood pressure) and ischaemic heart diseases (including myocardial infarction).

9.3 Construction Noise Assessment

Potential construction noise impacts to humans include sleep disturbance, an increased incidence of social and behavioural problems (including annoyance and increased aggressive behaviour) and in extreme cases, hearing impairment of construction workers not wearing hearing protection or taking other preventative measures.

Construction noise levels will vary depending on the activity being undertaken, the construction plant being used and with the distance from receptors. Major phases of construction are likely to be:

- Earthworks and Site Preparation
- Piling
- Creation of Hard Standings
- Construction of Foundations
- Building Erection
- Creation of Roads

The plant associated with the various phases is expected to be similar to that provided in Table 9.2. The noise levels at 10m from each activity has been predicted in accordance with British Standard BS:52281:2009+A1:2014.

Table 9.2: Construction Source Levels

Activity	Equipment	

	BS5228 Ref.	Plant Description	L_{Aeq} @ 10m, dB	No.	% Use	Adjusted L_{Aeq} @ 10m, dB	Activity L_{Aeq} @ 10m
Earthworks & Preparation	C2.3	Tracked excavator; 102kW; 22 t	78	2	75	79.8	86.8
	C2.26	Wheeled loader; 209kW	79	2	75	80.8	
	C2.30	Dump truck (tipping fill); 306kW; 29 t	79	2	75	80.8	
	C2.10	Dozer; 239kW; 41 t	80	2	75	81.8	
Piling	C3.1	Hydraulic hammer rig Hydraulic hammer rig; 145kW; 16 m length / 5 t hammer / plywood dolly	89	2	30	86.8	86.9
	C3.7	Power pack; 147kW; 6 t	70	2	50	70.0	
	C3.28	Tracked mobile crane; 184kW; 110 t	67	2	75	68.8	
Foundations	C4.33	Poker vibrator	78	2	75	79.8	83.7
	C4.18	Cement mixer truck (discharging)	75	2	75	76.8	
	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	78	2	75	79.8	
Building Erection	C4.38	Wheeled mobile telescopic crane; 610kW; 400 t	78	2	50	78.0	85.6
	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	78	1	75	76.8	
	C4.73	Hand-held circular saw (cutting paving slabs); 1.5kW; 7.6 kg / 235 mm diameter	84	2	5	74.0	
	C4.93	Angle grinder (grinding steel); 2.3kW; 4.7 kg	80	2	25	77.0	
	C4.53	Lorry with lifting boom; 50kW; 6 t	77	2	75	78.8	
	C4.56	Wheeled excavator; 63kW; 14 t	83	1	50	80.0	
Hard Standing	C4.18	Cement mixer truck (discharging)	75	2	75	76.8	82.8
	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	78	2	75	79.8	
	C4.18	Cement mixer truck (discharging)	75	2	75	76.8	
Roads	C5.18	Tracked excavator; 172kW; 35 t	80	2	75	81.8	83.9
	C5.20	Vibratory roller; 98kW; 8.9 t	75	2	75	76.8	
	C5.30	Asphalt paver (+ tipper lorry); 112kW; 12 t hopper	75	2	75	76.8	

As Table 9.2 demonstrates, construction works are estimated to generate high noise levels in the range 83-87 dB LAeq at a distance of 10m and therefore personal hearing protection should be worn by construction workers.

Based on the table above, estimated construction equipment noise levels for the various activities at the offsite receptors are presented in Table 9.3.

Table 9.3: Estimated Construction Noise Levels[13]

Location	Estimated Activity L_{Aeq}

[13] These values are estimated, not modelled and they do not include background noise levels.

	Earthworks & Preparation	Piling	Found-ations	Building Erection	Hard Standing	Roads
	87 dB	87 dB	84 dB	86 dB	83 dB	84 dB
F: Residential Properties	70 - 75 dB	70 - 75 dB	65 - 70 dB	65 - 75 dB	65 - 70 dB	65 - 70 dB
G: Commercial garages and shanty houses	60 - 65 dB	60 - 65 dB	55 - 60 dB	60 - 60 dB	55 - 60 dB	55 - 60 dB
H2: Primary School	55 - 70 dB	55 - 70 dB	55 - 65 dB	55 - 65 dB	50 - 65 dB	55 - 65 dB
H3: Mosque	55 - 70 dB	55 - 70 dB	55 - 65 dB	55 - 65 dB	50 - 65 dB	55 - 65 dB
M: Shanty Houses and Stores	70 - 90 dB	70 - 90 dB	65 - 85 dB	70 - 90 dB	65 - 85 dB	65 - 85 dB
O: German Technical Academy	60 - 75 dB	60 - 75 dB	60 - 70 dB	60 - 75 dB	55 - 70 dB	60 - 70 dB
T: Residential/Permanent Dwellings	60 - 65 dB	60 - 65 dB	60 - 65 dB	60 - 65 dB	60 - 60 dB	60 - 65 dB
W: Polio Compound	60 - 65 dB	60 - 65 dB	55 - 60 dB	55 - 65 dB	55 - 60 dB	55 - 60 dB

The IFC Guidelines do not set limits for temporary noise from construction, and nor are there any in Sierra Leonean legislation. However, due to the temporary nature of the construction, it is likely that noise levels as high as 70dB(A) during the day would be tolerable at residential receptors during the day. However, construction noise may impair the ability for speech to be understood at the School and German Technical Academy. It is therefore recommended that if teaching within these establishments is to take place during the construction period, then consultation is held between the relevant developers and educational establishments to ensure that potential impacts on pupils are mitigated.

Construction noise levels are estimated to be extremely high and would likely require additional mitigation during the construction works. There are also shanty houses located near the entrance to the site that could be affected. A Noise Management Plan will be developed for the project that will consider construction noise and measures to further reduce it.

Estimated levels of vibration associated with the construction works are not expected to be significant and no damage to nearby properties in anticipated.

9.4 Operational Noise Assessment

This report considers noise emissions arising from the operation of the plant associated with the project which, briefly, comprise:

Phase 1:

- Seven diesel engines operating simultaneously within an engine hall;
- Four electrical transformers;

- A cooling radiator array located at the roof level of the building; and,
- Associated infrastructure and buildings.

All of the scenarios consider operation under steady-state conditions, rather than during start-up, maintenance or emergency conditions.

9.4.1 Methodology

9.4.1.1 Noise Modelling

Noise modelling software provides a way of constructing a three-dimensional computer model of terrain, ground characteristics and noise sources which enables the prediction of noise at any point within the modelled area.

In order to compute the environmental noise emission level from plant items and operations at the representative noise sensitive receptors, noise emission modelling was undertaken using the CadnaA noise prediction software. The software was configured to use the noise prediction methodology set out in ISO9613[14], which is suitable for the prediction of noise levels in the community from sources of known sound emission.

The noise prediction method described in part 2 of ISO9613 is general, and is suitable for a wide range of engineering applications where the noise level outdoors is of interest. The noise source(s) may be moving or stationary and the method considers the following major mechanisms of noise attenuation:

- Geometrical divergence (also known as distance loss or geometric damping);
- Atmospheric absorption;
- Ground effect;
- Reflection from surfaces; and,
- Screening by obstacles.

The method predicts noise levels under metrological conditions favourable to noise propagation from the sound source to the receiver, such as downwind propagation, or equivalently, propagation under a moderate ground based temperature inversion as commonly occurs at night.

9.4.1.2 Noise Sources

The key noise sources associated with the project are as follows:

- **Engine Hall:** The diesel engines within the engine hall generate noise as a result of combustion as well as the movement of the mechanical components of an engine. Noise is emitted from the engine casing, air intakes and exhausts. Compared with other types of power generation, diesel engines produce a higher level of lower frequency noise. The walls and roof of the engine hall reduce the amount of sound radiated into the external environment;

[14] International Standard: ISO 9613-2: 1996(E): Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation.

- **Exhaust Stack:** Exhaust gases from the engine pass through silencers (or mufflers) to reduce the noise before entering a vertical stack via metal ductwork. Exhaust noise is emitted from the mouth of the stack, as well as from metal ductwork;
- **Combustion Air Intake:** A direct ducted connection to the outside of the engine hall is used to supply fresh air to each diesel engine. Due to the extremely high level of noise associated with engine intakes, the air intake duct includes high performance silencers (or mufflers) that reduce the noise;
- **Engine Hall Air Supply:** In order to provide fresh air to the engine hall, air handling systems with fans will be located at rooftop level. Noise from within the engine hall, as well as noise produced by the fan itself, has the potential to radiate into the external environment;
- **Electrical Transformers:** Noise from electrical transformers is caused by magnetostriction (where the metal sheets forming the core extend and contract in response to the alternating magnetic field), and from the cooling system. 11 kV to 33kV step-up transformers are located externally to the north of the engine hall in the current design; and,
- **Cooling Radiators:** In order to maintain optimum engine temperatures, a pump circulates water through the diesel engine cylinders and head jacket, which heats the water. The hot water is pumped to an air cooled radiator system located on the roof of the building and is then recirculated. Fans on the radiator radiate noise into the external environment.

9.4.2 Input Data

9.4.2.1 Site Layout

In order to address noise concerns, the plant layout was revised three times to move potentially noisy equipment further from the houses located along the southern project boundary.

During the scoping phase, the first proposed layout included the main plant buildings and features (engines, etc.) in a north-south orientation, within the south-eastern portion of the site. In response to observations during initial site visits, including comments from the EPA-SL during a site walk over in February 2014, the position of the main noise generating elements of the plant were moved further away from the residential area and Islamic complex to the south east of the site by rotating the plant by ninety degrees (anti-clockwise). Two iterations of layout change were undertaken at that stage, supported by preliminary numerical noise modelling.

In the earlier iterations, the radiators were located to the south of the plant. In the subsequent iterations, the radiators and the plant were shifted to the north to decrease the noise impact to the structures to the south. The current site layout, position and the height of buildings / plant in the noise model are derived from the drawing included on Figure 2.3.

The ground level in and around the site is assumed to be generally flat, and therefore no topographic screening effects have been considered in the noise model. The outlines and heights of buildings adjacent to the proposed were considered in the modelling based on the building height survey completed by INTEGEMS in August 2015. . This dataset extends 230m - 630m from the site, which is considered sufficient for the purposes of the study.

The ground areas around the closest dwellings are generally natural scrub land, and are therefore the area is considered to be acoustically porous.

9.4.2.2 Sound Power Levels with Standard Mitigation

Sound power data included in the modelling was provided by Wärtsilä, a major international supplier of diesel engines. As it is standard to supply power projects in urban environments with noise attenuation (such as engine halls, air intake attenuators, exhaust silencers, ventilation attenuators), the measures below have been included in the modelling labelled 'standard mitigation' scenario.

Table 9.4: A-weighted Sound Power Levels with Standard Mitigation

Source	Total SWL, dB(A)	Assumptions in model	Source Location	Sound Data Source
Radiators	112	28 x radiator fans at 97 dBA SWL per fan.	4m above engine hall roof	Wärtsilä library data
Engine hall walls & roof	105	110 dB internal SPL incident at engine hall walls. Engine breakout through Rw=33 dB building walls & roof	Engine hall building envelope	Wärtsilä library data
Charge air	105	14 x attenuated charge air intake apertures with SWL of 94 dBA per aperture.	4m a.g.l at southern engine hall wall	Wärtsilä library data
Engine Hall ventilation outlets	105	7 x ventilation fans at 109 dBA SWL per fan, attenuated with 1400mm attenuator = 96 dBA SWL per fan.	6m above engine hall roof	Wärtsilä library data
Exhaust gas	102	7 x stack outputs at 93 dBA per stack. No directivity. High performance exhaust gas silencer.	At top of 27.5m stack	Wärtsilä library data
Engine Hall ventilation unit	93	7 x units at 84 dBA per unit.	3m a.g.l to north of engine hall	Wärtsilä library data
Breakout from exhaust ducts	89	71m of ductwork radiating SWL of 70 dBA per metre length of duct	Between building and stack	Jacobs Library data
Transformers	96	4 x transformers at 90 dBA per transformer. No directivity.	3m a.g.l 10m to north of engine hall	Jacobs Library data

9.4.2.3 Sound Power Levels with Enhanced Mitigation

Due to the location of the project, this assessment has considered potential reductions in noise associated with the main sources identified above. After consultation with suppliers of acoustic mitigation for power plants, it is considered possible to achieve the reductions indicated in Table 9.5.

Table 9.5: A-weighted Sound Power Levels with Enhanced Mitigation

Source	Mitigation	Reduced SWL, dB(A)
Radiators	It is possible to achieve a 5 dB reduction from the standard level, by selecting quieter radiator fans.	107
Engine Noise through building walls & roof	In principal, it could be possible to enclose the engines within hall, to reduce the noise levels within the hall, but this would be extremely expensive, and would add complexity to the design. Instead, it is the preferred approach to provide a higher specification of building. It is considered that a higher acoustic specification for the walls and roof (e.g. by using heavier wall construction or a double skinned construction) would achieve a reduction of Rw=45dB, instead of the Rw=33 construction assumed in the standard model.	95
Charge Air	An additional air intake silencer could provide up to an additional 8 dB of attenuation compared to the standard noise level.	97
Engine Hall ventilation outlets	By increasing the size of the ventilation splitter attenuators to 3m, an additional 6 dB of reduction could be achieved compared to the standard noise level.	99

9.4.3 Noise Sensitive Receptors

A total of 9 sensitive receptor areas in close proximity to the project site have been defined for the noise study, which are listed in Table 9.6 below. These have been identified from Figure 2.3.

Table 9.6: Modelled Sensitive Receptor Locations

Ref.	WGS 84 / UTM Z29N	
	X	Y
F: Residential Properties	699043	937336
G: Commercial garages and shanty houses	699177	937270
H2: Primary School	699245	937293
H3: Mosque	699265	937327
N: Shanty Houses and Stores	699030	937440
O: German Technical Academy	698958	937443
T: Residential/Permanent Dwellings	699075	937504
W: Polio Compound	699153	937528

In addition, all of the buildings in the building dataset which are not known to be industrial were considered to be residential dwellings for the purposes of this assessment in order to be conservative.

9.4.4 Predicted Noise Levels

The noise levels due to the operation of the project have been predicted using a 3D noise model prepared in Cadna/A. The predictions for the following areas have been undertaken at 4m height above ground, which can be taken to be the approximate height of a second storey window, whilst the noise levels at specific buildings are calculated at the top floor window.

Table 9.7: Predicted noise levels due to Project

Location	Predicted Sound Pressure Level at closest point of each receptor	
	Standard Mitigation	Enhanced Mitigation
F: Residential Properties	68	61
G: Commercial garages and shanty houses	57	52
H2: Primary School	52	48
H3: Mosque	56	50
N: Shanty Houses and Stores	64	58
O: German Technical Academy	58	53
T: Residential/Permanent Dwellings	60	55
W: Polio Compound	58	52

Noise plots showing the predicted noise contour levels due to the operation of the site with standard and enhanced levels of mitigation are shown on Figures 9.1 and 9.2 of Appendix C.

9.4.5 Consideration of IFC Guidelines

The IFC guideline state that:

"Noise impacts should not exceed the levels presented in Table 1.7.1, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site".

Compliance with the IFC guidelines therefore requires two comparisons; firstly with the absolute noise levels presented in Table 1.7.1 of the guidelines, and secondly the predicted change in noise levels due to the operation of the site must be compared with the 3 dB criterion.

9.4.5.1 Absolute Noise Levels

It can be seen from Figures 9.1 and 9.2 that with the standard mitigation, the IFC guideline noise level for industrial areas of 70dB(A) is predicted to be complied with at the site boundary. Therefore, the project is predicted to meet the IFC limits implied by the official zoning for the area.

However, since many of the identified sensitive receptors are actually residential, institutional, or educational buildings, the IFC limit that would apply at night is 45dB L_{Aeq}, or an increase of no greater than 3dB from current levels.

A comparison of the predicted noise levels with the 45 dB L_{Aeq} criterion demonstrates that with the standard and enhanced mitigation package, the noise levels will exceed this criterion for considerable distances from the site boundary.

9.4.5.2 Change in Noise Levels

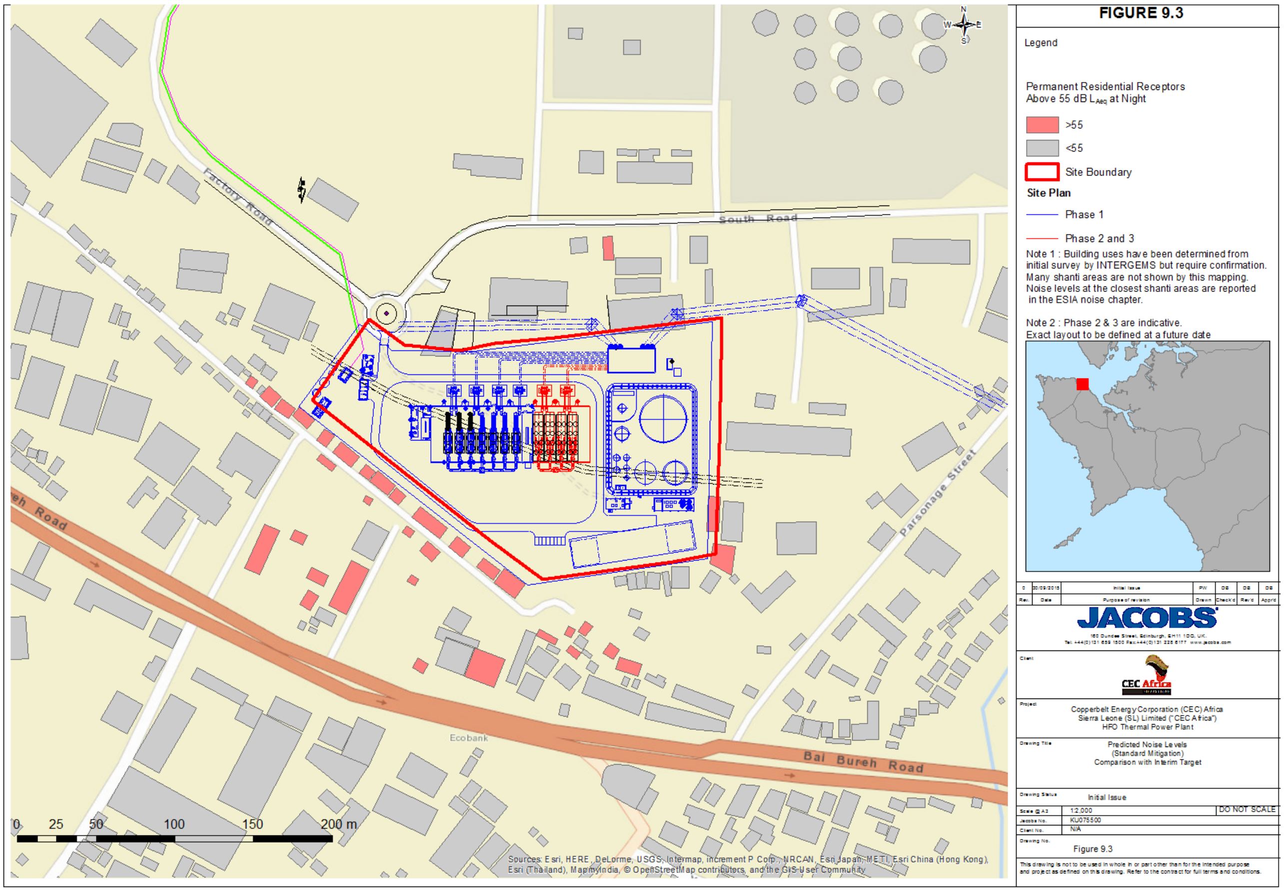
A comparison with the existing baseline noise levels has also been conducted, to determine whether the proposed development will result in a change of 3dB or more from the current noise levels. To facilitate this analysis, the building have been grouped into zones and attributed with the most appropriate baseline noise levels measured during the September 2015 noise survey. The noise measurement position that is considered to be most representative for each zone has been selected depending on proximity, the distance of the buildings in that zone from major roads, and the character of the area. The baseline noise levels attributed to buildings in each zone is shown on Figure 5.1.

Calculations have been undertaken to identify how the predicted operational noise from the proposed development would change the baseline night-time noise at each building. The results of these calculations showed that because the night-time noise levels measured during the September 2015 are consistent with those which could be expected in a predominantly industrial area, the predicted change in noise level does not exceed 3 dB at any building in the project vicinity. A change of 3 dB in fluctuating environmental noise is generally considered the minimum that is perceptible, and therefore these noise changes of less than 3 dB that would result from the project would not be considered to result significant adverse impacts. Therefore, no additional mitigation beyond the design measures considered in the modelling would be required.

9.4.6 Health Endpoints

Although the change in noise levels does not exceed 3 dB at any building, the noise levels predicted at the closest dwellings due to the operation of the proposed development are high, and if consistent over a year would be above the thresholds associated with the onset of cardiovascular effects, hypertension and, in some cases, ischaemic heart disease. These considerations are not specifically required by the World Bank assessment methodology, but are reflective of a growing trend to consider health endpoints when conducting noise assessments in European countries. Although this is an industrial area, there are still residential uses and health effects for those living close to the proposed development as shown in Figure 9.3 will be considered for additional noise reductions. A Noise Management Plan will be developed one month after financial close including additional engagement with the houses shown to consider further measures to reduce night time noise levels to 55 dB LAeq at these dwellings.

Figure 9.3 Predicted Noise Levels at Residential Receptors



9.5 Enhancement Measures

To comply with the IFC guidelines, no further mitigation is required. However, as discussed above, it is considered prudent to limit noise from the site to 55 dB L_{Aeq} at the nearest dwellings to ensure the site does not worsen the current noise environment. Therefore, a Noise Management Plan will be developed for the project that could include a noise insulation grant scheme, but will be developed in consultation with the relevant residential receptors.

A summary of the potential impacts on noise-sensitive receptors expected due to the proposed project is presented in Table 9.8, along with details of any relevant mitigation or enhancement, as appropriate.

Table 9.8: Summary of Impacts on Noise for Each Attribute during Each Phase (Prior to Mitigating Measures)

Attribute	Importance	Source of Effect	Effect Summary Description
Noise-sensitive receptors, such as residences, schools and healthcare facilities	Local	Construction activities: • Earthworks and Site Preparation • Piling • Creation of Hard Standings • Construction of Foundations • Building Erection • Creation of Roads	<u>Construction noise</u> Construction noise levels are estimated to be extremely high, albei temporary and likely to be tolerable at residential receptors during Construction noise may impair the ability for speech to be understo the School and German Technical Academy.
	Local		<u>Construction vibration</u> Levels of vibration associated with the construction works are not expected to be significant and no damage to nearby properties is anticipated.
	Local	Phase 1 - Operation activities: • Engine Hall • Exhaust Stack • Combustion Air Intake • Engine Hall Air Supply • Electrical Transformers • Cooling Radiators	<u>Operation</u> In order to address noise concerns, the plant layout was revised th times to move potentially noisy equipment further from the houses along the southern project boundary. Standard design mitigation and enhanced mitigation is included wi assessment. No significant operation noise increases are predicted associated project. However, enhancement measures to reduce noise levels to 55 dB proposed to address possible health effects associated with high n time noise levels over a prolonged period.

9.6 Residual Impacts

With implementation of the enhancement measures recommended above, the site will not perceptibly worsen the current noise environment at the closest noise sensitive receptors, and therefore there will be no residual adverse impacts.

9.7 Cumulative Impacts

Post-Ebola, there are still relatively few projects in the vicinity presently underway including roadway improvements and construction of the Addax Jetty which is near completion. Therefore, under current conditions, the cumulative impacts associated with noise are likely to be moderately adverse with few other projects occurring, and most impacts being local.

9.8 Conclusions

Based on the findings presented above, there is the potential for significant construction noise impacts, which will require the contractor(s) to implement noise control measures during the construction works. The construction noise impacts will be temporary in nature and will be addressed in the Noise Management Plan. The predicted operational noise levels indicate that the IFC guideline absolute noise levels are likely to be exceeded at some of the nearest sensitive receptors, even with enhanced levels of acoustic mitigation. However, the change in noise level from the baseline situation is predicted to be less than 3 dB at all sensitive receptors. Therefore, there will be no significant adverse noise impacts as a result of the operations.

However, it is recommended that a Noise Management Plan be developed to consider noise enhancement measures to reduce night time noise levels at the residences shown in Figure 9.3 to 55 dB LAeq or less to the extent feasible. This Plan will consider a noise insulation grant scheme and any other feasible design measures and would be developed based on further consultation with the residents of these households.

10. Air Quality

This section provides an assessment of the potential air quality impacts associated with Phase 1 of the proposed project. Phase 1 will have a number of emission sources to air which will give rise to emissions of pollutants during the operational phase. This section also describes the potential air quality impacts and relevant mitigation measures associated with the construction phase of the proposed project.

The key elements of the assessment are:

- Construction phase: identify the potential impacts from nuisance dust and exhaust emissions associated with construction activities, and where required, identify appropriate mitigation measures;
- Operational phase: to assess and describe the significance of the potential air quality impacts resulting from the combustion of HFO in the generating sets with due regard to relevant human exposure and also sensitive vegetation and ecosystems.

The main pollutants of concern in this assessment are those associated with the combustion of HFO, vehicle exhaust emissions and nuisance dust from construction activities and vehicle movements.

The assessment has primarily been undertaken using an internationally recognised dispersion modelling technique and concentrations of pollutants emitted by the combustion processes associated with the project have been predicted at sensitive locations within the vicinity of the development site. The predicted concentrations have been compared to relevant ambient air quality guidelines specified for the protection of human health.

A stack height determination study was undertaken to determine the appropriate stack height with regard to the resulting predicted ground level concentrations of pollutants in comparison to the ambient air quality guideline values. This ESHIA identified that stack height will need be 65m in order to appropriately manage the project’s potential impacts on ambient air quality. Therefore, a stack height of 65m was assumed in the air quality modelling for the project. The stack height determination is presented in the Air Quality Technical Report, Appendix D.

10.1 Relevant Legislation, Conventions and Standards

10.2 Air Quality Emissions Limits

The project will comprise a number of reciprocating engines fuelled by HFO. The WBG, EHS Guidelines for Thermal Power Plants” (WBG, 2008) specifies emission guidelines for a range of electricity generating combustion plants and those applicable to Phase 1 of the proposed HFO power plant are shown in Table 10.1.

These emission guidelines make provision for the current state of ambient air quality in the project area, by means of categorising the receiving atmospheric environment as either a “non-degraded airshed” or a “degraded airshed”, with the following definitions:

- Non-degraded airshed (NDA) – if all nationally legislated air quality standards are complied with, or in their absence, if all applicable World Health Organisation (WHO) Ambient Air Quality Guidelines (AAQG) or other internationally acceptable standards are complied with; and

- Degraded airshed (DA) – if any nationally legislated air quality standards are significantly exceeded or, in their absence, if any applicable WHO AAQG or other internationally acceptable standards are exceeded significantly.

Table 10.1: WBG Air Emission Guidelines for Reciprocating Engines (mg/Nm^3, or as indicated)[a]

Reciprocating Engine	Particulate matter (PM)		Sulphur dioxide (SO_2)		Nitrogen oxides (NO_x)	
	NDA	DA	NDA	DA	NDA	DA
Liquid Fuels (plant >50 MW_{th} to <300MW_{th})	50	30	1,170 or use of 2% or less S fuel	Use of 0.5% or less S fuel	1,460[b]	400

[a] Concentrations in mg/Nm^3 expressed at reference conditions of 0 degrees Celsius, one atmospheric pressure, 15% oxygen content and dry gas.
[b] Compression ignition, bore size diameter (mm) <400.

10.2.1 Ambient Air Quality Standards / Guidelines

An air quality standard or guideline is considered to be the level of an air pollutant, such as the concentration in ambient air that is adopted by a regulatory authority as enforceable. Guideline values provide a concentration below which no adverse effects or indirect health significance is expected, although it does not guarantee the absolute exclusion of effects at concentrations below the given value.

Sierra Leone does not currently have any nationally legislated air quality standards or guidelines. Therefore, the approach outlined within the WBG, EHS Guidelines on Air Emissions and Ambient Air Quality (WBG, 2007) was used in the assessment of air emissions set out within the ESHIA, as requested by the EPA-SL.

The WBG guidelines state that in the absence of national air quality standards or guidelines, the WHO AAQG or other internationally recognised standards should be used to assess the potential impact of projects with significant emissions to air. The WBG guidelines specifies that the United States National Ambient Air Quality Standards or the European Council Directive (2008/50/EC) (EC, 2008) setting limit values for a number of pollutants as suitable alternative sources of air quality standards or guidelines.

For the purposes of undertaking an air quality assessment as part of this ESHIA, the predicted ambient concentrations of air pollutants determined using a detailed quantitative technique were compared against the relevant WHO AAQG and the EC Directive Air Quality Limit values, which are presented in Table 10.2. These are specified in Table 1.1.1 of the WBG EHS Guidelines (WBG, 2007) and supplemented with additional ambient air quality guidelines set out in the WHO air quality guidelines (WHO, 2000).

Table 10.2: WHO Ambient Air Quality Guideline Values

Pollutant	Averaging Period	WHO AAQG values/ Interim targets ($\mu g/m^3$)	EC Directive Air Quality Limit Values ($\mu g/m^3$)
Protection of public health			
Nitrogen dioxide (NO_2)	1 hour mean	200	200 (not to be exceeded more than 18 times a calendar year, equivalent to the 99.79th percentile)

	Annual mean	40	40
Sulphur dioxide (SO_2)	10 minute mean	500	n/a
	24 hour mean	125[a]	125 (not to be exceeded more than 3 times a calendar year, equivalent to the 99.18th percentile)
Particulate matter (PM_{10})	24 hour mean	150[a]	50 (not to be exceeded more than 35 times a calendar year, equivalent to the 90.41st percentile)
	Annual mean	70[a]	40
Particulate matter ($PM_{2.5}$)	24 hour mean	75[a]	n/a
	Annual mean	35[a]	25
Carbon monoxide (CO)	8 hour mean	10,000	10,000
Protection of vegetation and ecosystems			
Nitrogen oxides (NO_x) Ecosystems	24 hour mean	75	n/a
	Annual mean	30	30
Sulphur dioxide (SO_2) Ecosystems	Annual mean	20	20

[a] *Interim target 1 source Table 1.1.1(WBG, 2007)*

The averaging periods are designed to protect sensitive receptors where exposure to a concentration above a respective time period may cause adverse effects. For example, for a one hour averaging period the maximum concentration of that pollutant should not exceed that value in any one hour in the year, whereas for a 24 hour averaging period, the maximum 24 hour mean concentration of that pollutant should not exceed that value for any one day of the year. For an annual averaging period, the average concentration of that pollutant over the calendar year should not exceed the relevant value.

Emissions of oxides of nitrogen (NO_x) and sulphur dioxide (SO_2) from a power plant can potentially lead to effects on vegetation and ecosystems through deposition of acid and nutrient nitrogen. The WHO air quality guidelines (WHO, 2000) set out critical loads, or a method to derive the appropriate critical load, to enable assessment of emissions to air at sensitive sites. The critical loads are a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge. Compliance with these benchmarks is likely to result in no significant adverse effect on the natural environment at these locations.

Further information on the critical loads used within the assessment of air emissions as part of this ESHIA is provided in the Air Quality Technical Report.

10.3 Sources of Emissions to Air

Air pollution can have both chronic (long term) and acute (short term) adverse effects on human health and ecosystems.

10.3.1 Construction Phase

During the construction phase of the proposed project, the most significant issues that could potentially impact on ambient air quality are combustion gas emissions and nuisance dust.

The principal sources of combustion gases for the construction elements are the exhausts of vehicles, construction equipment and temporary power generation (if required). However due to the expected minor and temporary impact of the emissions arising from these sources due to the relatively low traffic numbers and the scale and density of on-site plant/ machinery, these do not form part of this air quality impact assessment. Further details on the expected road traffic movements associated with the construction of the power station components are provided in Section 14 of this ESHIA.

As with any construction site, dust may be generated as a result of surface preparation and earthworks, including earth moving and materials handling. Internal site traffic moving on un-surfaced routes/ roads within the development site may cause sufficient mechanical disturbance of loose surface materials to generate dust, particularly during the dry season. The proposed development includes the following main components which may, without sufficient management or mitigation, potentially generate dust:

- demolition activities associated with the demolition and removal of existing buildings and structures on the project site;
- preparatory earthworks to allow the construction of the power plant including, clearing of vegetation, soil stripping and stockpiling;
- bulk earthworks including site grading and excavation work; and
- the construction of the main components of plant including establishing and preparing concrete foundations for major plant and buildings, construction of buildings and installation of equipment.

Due to the nature of the construction process, potentially dust emitting activities will not be constant and emissions would fluctuate according to the operating periods for each item of plant, weather conditions and the combination of machinery being used at any one time. The location of emission sources will also change as the construction progresses.

10.3.2 Operational Phase

During the operational phase of the proposed project, point source emissions of combustion gases from the proposed plant could potentially have an effect on local air quality. The atmospheric emissions will be generated by the combustion of HFO by the engines and will predominately consist of oxides of nitrogen (NO_x), sulphur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$) and carbon monoxide (CO).

- Oxides of nitrogen – NO_x produced from gas turbines comprise nitric oxide (NO) and NO_2 – the proportion of NO and NO_2 within the exhaust gas varies, but typically NO is the predominant species and generally comprises greater than 90% of the emitted NO_x at release. The NO_x emissions are produced during combustion (i.e. the reaction of HFO with air). NO is potentially less harmful than NO_2 and it is NO_2 that is associated with adverse effects upon human health. NO in the exhaust gas is oxidised in the atmosphere to form NO_2 and the amount that is converted to NO_2 in the atmosphere increases with distance from the source. However, the reverse process converting NO_2 to NO also takes place in the atmosphere. For this assessment, it was assumed that 70% of the emitted NO_x was converted to NO_2 for the determination of long term averages regardless of the distance from the source. It was assumed that 35% was converted to NO_2 for the determination of short term averages, which follows the UK Environment Agency (EA) NO_x to NO_2 conversion method (EA, 2010), which is considered to be conservative. Over the distances considered in the assessment, the conversion rates are likely to be much lower than this in practice. For that reason, an alternative approach using the

Janssen method (Janssen et al, 1988) is also considered for discussion purposes. Further detail on this is provided in Section 2.4 of the Air Quality Technical Report in Appendix D.

- Carbon monoxide – CO emissions are a measure of combustion completion as higher values of CO indicate more incomplete combustion or less oxidation of CO to CO_2. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues.
- Sulphur dioxide – SO_2 primarily arises from anthropogenic activities and more specifically combustion of fuels containing sulphur and sulphur compounds. SO_2 is emitted in negligible quantities during the combustion of natural gas but generally at higher concentrations for liquid fuels such as HFO which have a higher sulphur content. SO_2 can affect the pulmonary function and lead to respiratory symptoms.
- Particulate matter – fine particulate matter such as PM_{10} (particulate matter with aerodynamic diameter of 10 microns or less) or $PM_{2.5}$ (particulate matter with aerodynamic diameter of 2.5 microns or less) is emitted during the combustion of liquid fuels such as HFO and are related to the combustion efficiency and characteristics of the HFO. Generally, the greater the ash and carbon residue in the HFO, the higher the particulate emissions during combustion. The range of potential health effects from exposure to PM_{10} or $PM_{2.5}$ is broad, but effects are predominantly to the respiratory and cardiovascular systems.

Emissions of NO_x and SO_2 can react in the atmosphere and contribute to acid deposition, which can affect the pH balance in water and soils with the potential for detrimental impacts. Increased nitrogen deposition can also affect sensitive vegetation and the biodiversity of sensitive ecosystems.

Emissions to air from staff, maintenance and delivery road vehicles accessing the site during the operational phase of the project would comprise some of those substances described above. However, these emissions are considered to be insignificant as the volume of road traffic will be relatively low (and is not considered further within this assessment). Further details on the expected road traffic movements associated with the operation of the project are provided in Section 14.

10.4 Assessment of Impacts

This air quality impact assessment considers the impact on human health associated with the emission and dispersion of emissions to air from the combustion of HFO during operation as well as the displacement and subsequent dispersion of dust during the construction of the proposed project.

10.4.1 Construction Phase

Due to the temporal and varying nature of pollutant emissions associated with the construction phase of the proposed project, use of quantitative techniques such as dispersion modelling is not appropriate. The potential impacts during the construction phase are described in Section 10.5 through the consideration of the nature of site activities, nearby sensitive receptors and the prevailing weather conditions. The recommended mitigation measures required to reduce any potential impact to negligible or low levels are set out in Section 10.7.

10.4.2 Operational Phase

The relevant air quality impact assessment criteria have been identified following a review of the standards and established guidelines for the protection of air quality for the relevant pollutants.

A review of existing ambient air quality in the area has been undertaken to understand the baseline conditions with respect to the pollutants mentioned above. The review of existing ambient air quality and details of the project specific air quality monitoring is set out in more detail in the Air Quality Technical Report in Appendix D.

To assess the likely air quality impact from the proposed project, air dispersion modelling has been conducted. Air dispersion modelling using appropriate dispersion modelling software is an internationally accepted tool that can be used to determine if the design and location of emission sources result in acceptable air quality in the vicinity of a proposed project. This determination is made by comparing the maximum predicted dispersion modelling results at appropriate locations to the ambient air quality guideline stated in the applicable government regulations or other international standards. As such, if the predicted dispersion modelling results are within the air quality limits and the plant contribution is within acceptable thresholds, the plant design is assumed to be acceptable for regulatory approval.

For this assessment, the UK Atmospheric Dispersion Modelling System (ADMS) version 5 dispersion modelling software was applied. In general, the results produced by AERMOD (an equivalent dispersion model developed in the US) and ADMS under identical input data and meteorological conditions are essentially very similar. Both ADMS and AERMOD are listed as appropriate for assessing "more complex and refined models" in the WBG EHS Guidelines (WBG, 2007).

A full description of the dispersion modelling methodology, emissions data, study inputs, associated uncertainties and assumptions is presented within the Air Quality Technical Report in Appendix D. A brief outline of the approach is presented below.

- Determination of likely background concentrations of the relevant pollutants (NO_x / NO_2 SO_2, CO, PM_{10}, $PM_{2.5}$ and including nutrient nitrogen and acid deposition), established from available monitoring data or relevant air quality information.
- Based on the current design for Phase 1, undertake computer dispersion modelling of the relevant releases from the HFO engines using representative meteorological data, to identify likely concentrations of pollutants at relevant exposure on a modelled receptor grid with dimensions 5km x 5km and also at specific sensitive ecological receptor locations.
- Evaluation of significance by comparing predicted concentrations against the WHO ambient air quality guideline values and other accepted air quality standards where appropriate, taking the existing background concentrations into account where possible.

The evaluation of significance with regard to the potential human health impacts are considered below:

The EHS guidelines (WBG, 2007) specify the following general approach to assessing potential air quality impacts:

"Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:

- *Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines (see Table 1.1.1), or other internationally recognized sources;*
- *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed."*

The WBG EHS guidelines (WBG, 2007) also specify the following in relation to facilities which are located within a degraded airshed:

"facilities should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average guidelines or standards".

The WBG Thermal Power Plants guidelines (WBG, 2008) also specifies that facilities in degraded airsheds should minimise incremental impacts by achieving the emission guideline values set out in Table 6 of the Thermal Power Plants guidelines.

The predicted concentrations were assessed firstly against the relevant WHO AAQGs and secondly against the WBG requirements set out above.

It should be noted that the WHO AAQG values are generally more stringent than other recognised air quality standards or limits. For example, the European Commission Directive (2008/50/EC) (EC, 2008) allows a certain number of exceedences of the short term mean limit values for some of the substances, whilst still affording a high level of protection to human health. The WHO ambient air quality guidelines are generally based on the 100th percentile and do not allow any exceedences. The exception being for 24-hour mean particulate concentrations (PM_{10} and $PM_{2.5}$), which use the 99th percentile, allowing the guideline value to be exceeded up to three days per year. Therefore, the predicted concentrations due to emissions from the proposed power station as a percentage of the guideline value will generally be higher as a result of adopting the WHO AAQGs, and the associated assessment can be considered more conservative. On this basis the predicted concentrations as a percentage of the EC Directive limit values will also be considered and are presented for discussion purposes.

Concentrations were modelled on a receptor grid with 50m spacing, covering a 5km x 5km grid square centred on the proposed project site – this enabled the determination of the maximum ground level concentrations. It also facilitated the generation of contour plots of the predicted ground level concentrations, for the relevant modelled pollutants. The modelled grid parameters are provided in Table 10.3.

Given the stack height of 65m, it was decided that calculating concentrations at discrete sensitive receptors within close proximity to the site would not be required as these would be predicted to experience concentrations lower than the maximum modelled grid concentrations which were used for the assessment.

Table 10.3: Modelled Grid Parameters

Grid	Grid Coordinate		Number of points
	Start	Finish	
X	696574	701574	101
Y	934863	939863	101

10.4.3 Ecological Receptors

Air pollution has the potential to adversely impact terrestrial and fresh-water ecosystems. The sites of ecological interest identified within 10km of the proposed project site include the following:

- Sierra Leone River Estuary (including Aberdeen Creek) (SLRE) RAMSAR; and
- Western Area Peninsular National Park (WAPNP).

The Sierra Leone River Estuary is a designated RAMSAR for its mangrove wetlands and bird interest. The habitat area of interest extends to include much of the coast line east of the proposed site and the shorelines around Tagrin Bay and the Bunce River. Aberdeen Creek is located approximately 9km west of the proposed site.

The WAPNP is an area of equatorial rainforest located approximately 2km south, south-west of the proposed site at its nearest point. The forest is not protected despite its status and has become degraded through suburban sprawl and anthropogenic influence. High density forest likely to be of higher ecological importance starts at approximately 6km SSW of the proposed site (approximately at the location of receptor ID E6-3).

Ecological receptors at worst case locations (i.e. likely highest concentrations) were selected at each site of ecological interest as presented in Table 10.4. The locations of the ecological receptors are shown on Figure 2 of the Air Quality Technical Report, Appendix D.

Table 10.4: Modelled Sensitive Ecological Receptor Locations

Receptor ID	Habitat Type / Direction from site	UTM co-ordinate (WGS (1984) Zone 29N)	
		X	Y
E1-1	Mangrove – Aberdeen Creek, West	690137	939080
E1-2	Mangrove – Aberdeen Creek, West	689877	938206
E1-3	Mangrove – Aberdeen Creek, West	689618	938237
E1-4	Mangrove – Aberdeen Creek, West	689335	938226
E1-5	Mangrove – Aberdeen Creek, West	689080	938214
E2-1	Mangrove – North east	703931	942924
E2-2	Mangrove – North east	704057	943092
E2-3	Mangrove – North east	704500	943047
E2-4	Mangrove – North east	704301	943154
E2-5	Mangrove – North east	704454	943177
E2-6	Mangrove – North east	706761	944349
E3-1	Mangrove – South southeast	701562	935520
E3-2	Mangrove – South southeast	701513	935410
E3-3	Mangrove – South southeast	701748	935368
E3-4	Mangrove – South southeast	701932	935206
E3-5	Mangrove – South southeast	702686	934810
E3-6	Mangrove – South east	705017	934689
E3-7	Mangrove – East south east	706978	936341
E3-8	Mangrove – East south east	708253	936990
E3-9	Mangrove - East	708514	938472
E4-1	Mangrove – North east	702788	942741
E5-1	Mangrove – North	699268	937914
E6-1	Rainforest – WAPNP, South southwest	697874	935652
E6-2	Rainforest – WAPNP, South southwest	697367	934321
E6-3	Rainforest – WAPNP, South southwest	697055	931644
E6-4	Rainforest – WAPNP, South southwest	699085	934712

10.5 Construction Phase Impacts

The level of dust generation and dispersion is dependent upon a number of factors including:

- the type of construction activities taking place;
- the occurrence of hot, dry weather;
- the prevailing wind speed and direction; and
- the mitigation measures adopted.

The potential for dust to be generated during the construction phase at the proposed project site will be short-term and temporary in nature. Site clearance, demolition and bulk excavation works (the construction works of greatest potential impact) will be carried out during the initial phase of construction. Excavation and site levelling will use machinery such as front loaders, bulldozers and similar plant, with spoil material which will not be incorporated into the development and landscaping being removed from site.

Residential and other sensitive receptors downwind of the predominant wind direction (that is wind blowing from the west of the site towards the east) would typically be the most susceptible to dust emissions. The windroses for four years of meteorological data recorded at the Lungi International Airport are shown in the Air Quality Technical Report in Appendix D.

The nearest downwind sensitive property to the site is adjacent to the eastern site boundary (the Mosque compound with primary school, clinic and mosque). There is a high potential for unmitigated windblown dust emissions to reach this property and other sensitive or residential properties further downwind of this location.

The nearest residential properties to the east of the site are those located on the opposite side of the Wellington Creek, approximately 300m from the site boundary. However, there are also many residential properties adjacent to the southern site boundary and some properties on the northern site boundary. A technical academy is located to the north west of the site boundary.

Although many of these locations are not downwind of the prevailing wind direction from the site, there remains a risk that dust emitted from construction activities could lead to impacts due to their close proximity to the site.

The wind direction (based on data from Lungi International Airport weather station) is towards the Mosque compound for approximately 40% of the year (wind directions between 260° and 340°) and is therefore at high risk of experiencing dust impacts unless appropriate mitigation measures are implemented to prevent or minimise dust emissions.

Although emissions will fluctuate and sources will vary according to the combination of machinery used, the location on site and prevailing weather conditions. There is potential for significant dust impacts to potentially affect human health and also generate nuisance dust, without mitigation measures in place.

Mitigation measures are proposed to minimise dust impacts at nearby properties and other more distant receptors and to prevent potential dust nuisance events from occurring. In the event that visual monitoring finds that dust emissions are unacceptable on the site during certain meteorological conditions (i.e. a hot dry period with high winds) or justified complaints are received, construction work will be tailored or additional mitigation put in place to ensure that dust emissions due to the construction works reduce to acceptable levels.

The nearest potential ecological receptor (SLRE) is approximately 450m to the north of the site boundary. Relevant UK guidance (IAQM, 2014) for assessing the dust risk for construction activities states that a construction dust assessment is required if an ecological receptor is within 50m of the proposed site boundary or the haul route used by construction vehicles. On this basis, there is unlikely to be any construction dust impacts at ecologically sensitive areas.

10.6 Operational Phase Impacts

This section presents the predicted pollutant concentrations at the modelled receptor grid and specific human health and ecological receptors for the operational phase of the proposed project. The results presented here are for the Phase 1 scenario, assuming 6 x Wärtsilä 20v32 generating sets emitting via a common stack grouping with stack heights of 65m. The results presented are the maximum concentrations for any of the four years of meteorological data included in the assessment.

The tables give the following information:

- the relevant WHO AAQG;
- the background concentration of the pollutant;
- Process Contribution (PC), the maximum modelled concentration of the substance due to the emissions from the proposed facility alone;
- Predicted Environmental Concentration (PEC), the maximum modelled concentration due to process emissions combined with the estimated background concentration; and
- PC and PEC as a percentage of the AAQG.

10.6.1 Modelled Grid

Table 10.5 sets out the maximum concentrations predicted at any off-site point on land within the modelled 5km by 5km grid.

Table 10.5: Predicted Maximum Results at On-shore Grid Point Locations

Pollutant	Averaging Period	AAQG	Background concentration	PC	PC / AAQG	PEC	PEC / AAQG
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	%	($\mu g/m^3$)	%
Nitrogen dioxide (NO_2) *(EA method)*	Annual mean	40	27.2	10.0	24.9%	37.2	93.0%
	1 hour mean (maximum)	200	54.4	60.6	30.3%	115	57.5%
Nitrogen dioxide (NO_2) *(Janssen method)*	Annual mean	40	27.2	2.5	6.3%	29.7	74.3%
	1 hour mean (maximum)	200	54.4	55.5	27.7%	110	55.0%
Carbon monoxide (CO)	8 hour running mean (maximum)	10,000	140	0.02	0.0%	140	1.4%
Sulphur dioxide (SO_2)	24 hour mean (maximum)	125	6.3	54.2	43.4%	60.5	48.4%

	10 minute mean (maximum)	500	6.3	185.5	37.1%	192	38.4%
Particulate matter (PM_{10})	Annual mean	70	196.3	0.97	1.4%	197	282%
	24 hour mean (99th %ile)	150	392.6	3.55	2.4%	396	264.1%
Particulate matter ($PM_{2.5}$)	Annual mean	35	31.9	0.97	2.8%	32.8	93.9%
	24 hour mean (99th %ile)	75	63.8	3.55	4.7%	67.3	89.7%

There is no predicted exceedance of the relevant WHO AAQG values for the PECs of NO_2, CO and SO_2. The PC is less than 25% of the AAQG values for annual mean NO_2, which is in line with the requirement set out in the WBG EHS guidelines. Although the PC for the short-term concentrations of NO_2 and SO_2 are above 25% of the AAQG, it is considered that this is more relevant for long term mean concentrations as any subsequent development is highly unlikely to contribute significantly to the same one hour or daily mean peak concentration modelled for the proposed power plant and would vary both temporally and spatially. The predicted annual mean and 1 hour mean NO_2 concentrations are lower following the Janssen method than the EA method and represent more realistic concentrations (albeit still conservative) from the proposed power plant.

However, there are predicted exceedances of both the annual mean and 24 hour mean AAQG values for PM_{10} due to the high background concentration used for the assessment. This prediction is based on the average measured data received from surveys undertaken separately during the 'dry' and 'wet' season. The monitoring was of a limited duration for both survey periods and may not be fully representative. Although long term monitoring for particulates has not been conducted, the baseline concentrations measured at the site during project monitoring were high, therefore, the airshed designation for PM_{10} was regarded as degraded. There is no predicted exceedence of the annual mean or 24-hour mean AAQG for $PM_{2.5}$. The PCs of PM_{10} and $PM_{2.5}$ for the respective averaging periods is relatively low, approximately 1.4% to 4.7% of the AAQG values, and therefore represents only a fraction of the AAQG values. Therefore, the particulate matter (PM_{10} and $PM_{2.5}$) contribution from the plant is considered to be insignificant.

The contour plots presented in the Air Quality Technical Report show that the highest annual mean concentrations are predicted to occur approximately 0.9km east of the proposed stack location. The areas of highest annual mean concentration includes mixed land-use of industrial/commercial with some nearby residential use. This assessment will assume the maximum concentration occurs at a relevant exposure location, given the proximity of residential dwellings to the industrial/commercial area.

Contour plots of the PCs for NO_2, SO_2 and PM_{10}/$PM_{2.5}$ are provided within the Air Quality Technical Report, Appendix D (see Figures 3 to 10).

The predicted PC concentrations are compared against EC Directive limit values where they differ from the WHO AAQG values (for context) and are presented in Table 10.6.

Table 10.6: Maximum Predicted Results at On-shore Grid Point Locations compared against EC Directive Limit Values

Pollutant	Averaging Period	EC Directive Limit	Background concentration	PC	PC / EC Limit Value	PEC	PEC / EC Limit Value

		Values					
		(µg/m^3)	(µg/m^3)	(µg/m^3)	%	(µg/m^3)	%
Nitrogen dioxide (NO_2) *(EA method)*	1 hour mean (99.79th percentile)	200	54.4	48.0	24.0%	102	51.2%
Sulphur dioxide (SO_2)	1 hour mean (99.73rd percentile)	350	6.3	109	31.0%	115	32.8%
	24 hour mean (99.18th percentile)	125	6.3	44.0	35.2%	50.3	40.3%
Particulate matter (PM_{10})	Annual mean	40	196.3	0.97	2.4%	197	493%
	24 hour mean (90.41st percentile)	50	392.6	2.26	4.5%	395	790%
Particulate matter ($PM_{2.5}$)	Annual mean	25	31.9	0.97	3.9%	32.8	131%

The predicted percentage contribution from the project compared to the EC Directive Limit Values are generally lower than when compared to the WHO AAQG. Should the 25% threshold set out in the WBG EHS guidelines be considered to apply to short term averaging periods, then the 1 hour mean PC for NO_2 is compliant with the 25% threshold when compared to the EC Directive limit values. The percentage contribution for the 1-hour and 24 hour mean SO_2 concentrations would be considerably reduced for the EC Directive limit values compared to the equivalent short term WHO AAQGs.

Conversely, the EC Directive Limit Values are more stringent for particulates and the predicted process contributions are slightly higher as a percentage of the limit values. However, the PCs as a percentage of the limit values are between 2% and 5%, similar to the percentages achieved for the WHO AAQG and this equates to a fraction of the relevant limit values.

10.6.2 Ecological Results

Table 10.7 presents the maximum predicted process contributions for NO_x and SO_2 at the selected ecological receptors. In the absence of appropriate background concentrations at the various locations representing the ecological sites, the PC is compared to the AAQG value only to determine the likelihood of any significant effects.

10.6.2.1 Ambient Pollutant Concentrations

Table 10.7: Maximum Predicted Process Contribution at Sensitive Ecological Receptors

Receptor ID	NO_x Annual Mean PC	PC / AAQG	NO_x Max 24 Hour Mean PC	PC / AAQG	SO_2 Annual Mean PC	PC / AAQG
WHO Guideline value	30		75		20	
Unit	(µg/m^3)	%	(µg/m^3)	%	(µg/m^3)	%
E1-1	0.59	2.0	6.37	8.5	0.48	2.4
E1-2	0.86	2.9	7.60	10.1	0.69	3.4
E1-3	0.84	2.8	7.35	9.8	0.67	3.3
E1-4	0.83	2.8	7.14	9.5	0.67	3.3
E1-5	0.83	2.8	6.99	9.3	0.67	3.3
E2-1	1.02	3.4	9.63	12.8	0.82	4.1
E2-2	0.99	3.3	9.45	12.6	0.79	4.0
E2-3	1.10	3.7	8.06	10.7	0.88	4.4
E2-4	1.02	3.4	8.83	11.8	0.82	4.1
E2-5	1.05	3.5	8.41	11.2	0.84	4.2
E2-6	1.08	3.6	7.57	10.1	0.87	4.3
E3-1	2.36	7.9	15.87	21.2	1.89	9.5
E3-2	2.09	7.0	14.25	19.0	1.67	8.4
E3-3	2.22	7.4	15.42	20.6	1.78	8.9
E3-4	2.07	6.9	14.81	19.7	1.66	8.3
E3-5	1.97	6.6	14.08	18.8	1.58	7.9
E3-6	2.00	6.7	14.36	19.1	1.60	8.0
E3-7	2.13	7.1	10.45	13.9	1.70	8.5
E3-8	2.64	8.8	10.68	14.2	2.11	10.6
E3-9	3.05	10.2	9.62	12.8	2.45	12.2
E4-1	1.02	3.4	10.74	14.3	0.82	4.1
E5-1	1.47	4.9	35.58	47.4	1.17	5.9
E6-1	1.01	3.4	15.64	20.8	0.81	4.1
E6-2	1.01	3.4	14.81	19.7	0.81	4.1
E6-3	0.52	1.7	9.43	12.6	0.41	2.1

E6-4	0.72	2.4	12.72	17.0	0.58	2.9

The maximum predicted annual mean process contributions for NO_x and SO_2 occur at site E3-9, which is approximately 9.3 km east of the proposed site. The PCs are well below the WBG threshold of 25% of the AAQG value and are therefore unlikely to result in an exceedance of the air quality guideline or lead to any significant impacts. The exception being at site ID E5-1 for 24 hour mean NO_x and is discussed below.

The maximum predicted 24 hour process contribution occurs at site E5-1, which is approximately 450m north of the proposed site boundary. The PC is above 25% of the AAQG. However, as described in Section 5.5, mangrove habitat is absent or heavily degraded within 2 km of the site, and local deposition impacts are therefore unlikely to significantly reduce the ecological value of local mangroves or associated species. The ecological value of the mangrove habitat at this location is also unknown, but its proximity to coastal industrial and residential areas would suggest that its condition is potentially degraded and not used by wildfowl of interest.

The complete set of results for all years modelled is presented in the Air Quality Technical Report, Appendix D.

10.6.2.2 Nutrient Nitrogen Deposition

The maximum predicted nutrient nitrogen deposition at selected sensitive ecological receptors are presented in Table 10.8. In the absence of background deposition information, only the predicted deposition PCs in relation to critical loads (CLs) are presented.

Table 10.8: Maximum Predicted Nutrient Nitrogen Deposition Rates

Receptor ID	Habitat Type	CL	PC	PC / CL
		KgN/ha/yr		%
E1-1	Mangrove	20	0.12	0.6
E1-2	Mangrove	20	0.17	0.9
E1-3	Mangrove	20	0.17	0.8
E1-4	Mangrove	20	0.17	0.8
E1-5	Mangrove	20	0.17	0.8
E2-1	Mangrove	20	0.21	1.0
E2-2	Mangrove	20	0.20	1.0
E2-3	Mangrove	20	0.22	1.1
E2-4	Mangrove	20	0.21	1.0
E2-5	Mangrove	20	0.21	1.1
E2-6	Mangrove	20	0.22	1.1
E3-1	Mangrove	20	0.48	2.4
E3-2	Mangrove	20	0.42	2.1

E3-3	Mangrove	20	0.45	2.2
E3-4	Mangrove	20	0.42	2.1
E3-5	Mangrove	20	0.40	2.0
E3-6	Mangrove	20	0.40	2.0
E3-7	Mangrove	20	0.43	2.1
E3-8	Mangrove	20	0.53	2.7
E3-9	Mangrove	20	0.62	3.1
E4-1	Mangrove	20	0.21	1.0
E5-1	Mangrove	20	0.30	1.5
E6-1	Rainforest	10	0.20	2.0
E6-2	Rainforest	10	0.20	2.0
E6-3	Rainforest	10	0.10	1.0
E6-4	Rainforest	10	0.15	1.5

The maximum PC of 0.62 kgN/ha/yr occurs at receptor ID E3-9 and equates to 3.1% of the CL. This PC is a relatively small proportion of the adopted CL value and is a fraction of the WBG threshold of 25%. On this basis, one would expect no likely significant impact for mangrove habitat. The maximum predicted PC for the rainforest habitat is 0.2 kgN/ha/yr at receptor IDs E6-1 and E6-2. These also represent a small increase compared to the CL value and are well below the 25% threshold.

On this basis, there are no likely significant impacts likely for nutrient nitrogen deposition as a result of the proposed power plant.

10.6.2.3 Acid Deposition

As with the nitrogen deposition, in the absence of background acid deposition rates at the sensitive ecological habitat sites, only the acid deposition PCs are considered in relation to the CLs. The PCs were derived from the sulphur derived acid deposition as the CLs developed in the WHO guidelines (WHO, 2000) are based on sulphur acid deposition only. The results are presented in Table 10.9.

It is noted that mangrove habitat is inundated with water during high tides. As the pH of seawater ranges between 7.7 and 8.4 and has a high buffering capacity, the mangrove habitat will be very tolerant of pH fluctuations and is likely to be less sensitive to increases in acid deposition.

Table 10.9: Maximum Predicted Acid Deposition Rates

Receptor ID	Habitat	CL	PC	PC / CL
		Keq/ha/yr		%
E1-1	Mangrove	1.500	0.12	8.1
E1-2	Mangrove	1.500	0.18	11.7
E1-3	Mangrove	1.500	0.17	11.4

E1-4	Mangrove	1.500	0.17	11.3
E1-5	Mangrove	1.500	0.17	11.3
E2-1	Mangrove	1.500	0.21	13.8
E2-2	Mangrove	1.500	0.20	13.5
E2-3	Mangrove	1.500	0.22	15.0
E2-4	Mangrove	1.500	0.21	13.9
E2-5	Mangrove	1.500	0.21	14.2
E2-6	Mangrove	1.500	0.22	14.7
E3-1	Mangrove	1.500	0.48	32.1
E3-2	Mangrove	1.500	0.43	28.4
E3-3	Mangrove	1.500	0.45	30.1
E3-4	Mangrove	1.500	0.42	28.1
E3-5	Mangrove	1.500	0.40	26.8
E3-6	Mangrove	1.500	0.41	27.1
E3-7	Mangrove	1.500	0.43	28.9
E3-8	Mangrove	1.500	0.54	35.9
E3-9	Mangrove	1.500	0.62	41.5
E4-1	Mangrove	1.500	0.21	13.9
E5-1	Mangrove	1.500	0.30	19.9
E6-1	Rainforest	1.000	0.21	20.6
E6-2	Rainforest	1.000	0.21	20.7
E6-3	Rainforest	1.000	0.11	10.5
E6-4	Rainforest	1.000	0.15	14.8

The maximum predicted process contribution is 0.62 keq/ha/yr and occurs at site ID E3-9, which is mangrove wetland habitat. This concentration equates to 41.5 % of the maximum CL. Although this is above 25% of the adopted CL value, the high tolerance of the habitat to fluxes in pH would suggest that it is less sensitive to acid deposition and the predicted acid deposition due to emissions from the proposed power plant is unlikely to lead to a detrimental impact on the mangrove habitat.

The maximum predicted process contribution within rainforest habitat is 0.21 keq/ha/yr and occurs at sites ID E6-1 and E6-2. This is approximately 21% of the CL value and not considered to represent a significant impact. Furthermore, the maximum deposition rate is predicted at a section of the forest area which has a low density due to encroachment by human population. On this basis, the ecological value, and therefore, sensitivity, is likely to be low as a result. The predicted acid deposition rate at a section of the rainforest which is likely to be higher in ecological value (at site ID E6-3) is approximately 10.5% of the CL value, and likely to represent an insignificant increase in deposition.

On the above basis, it is unlikely that the proposed power plant will cause significant impacts to ecosystems at the proposed stack height and operating regime.

10.7 Mitigation Measures

10.7.1 Construction Phase

Though not considered quantitatively in this assessment, the risk appraisal undertaken indicates that there is the potential for dust emission caused by construction activities to potentially affect the nearest sensitive receptors, particularly those located downwind of the prevailing wind direction. The potential impact can be reduced to a minor residual impact providing appropriate mitigation measures are implemented.

Dust generation and dispersion during construction will be minimised through good construction practice and appropriate monitoring throughout the construction period. The mitigation measures will aim to prevent dust from being dispersed offsite and, thereby, protect nearby properties from significant dust impacts.

It is recommended that mitigation measures such as those listed below should be adopted where practicable and necessary during the construction phase:

- Plant and equipment will be designed and used in a manner which minimises dust generation;
- Water (or other suitable or some other environmentally benign dust-suppressant material) spray dampening of un-surfaced areas, soils and spoil may be undertaken to prevent dust blow during hot, dry weather conditions with relatively high wind speeds;
- Careful location, grading and management of stockpiles of soil and similar materials will be undertaken to prevent wind-blow;
- Sealing and / or re-vegetation of completed earthworks will be undertaken as soon as reasonably practicable;
- Where possible, site roads will be surfaced early in the construction programme – with vehicle speeds limited to an appropriately low speed to minimise re-suspension of dust from surfaced and un-surfaced roads;
- Regular cleaning of surfaced roads and maintenance of un-surfaced roads on site will be undertaken to reduce offsite transport of soils and to avoid dust generation;
- Lorries will be sheeted during transportation of friable construction materials and spoil and wheel wash facilities made available during adverse conditions;
- Drop heights will be minimised during material transfer activities, such as unloading of friable materials; and,
- Positioning and movement of construction equipment will be undertaken in a manner which minimises dust generation.

In addition, provision will be made in the CECA SL Stakeholder Engagement Plan (SEP) for receiving and resolving any local community complaints regarding nuisance dust via a grievance mechanism. .

With regard to combustion emissions from on-site plant and machinery, the following should be considered:

- Diesel powered construction equipment and vehicles will be well maintained to minimise exhaust emissions; and

- Idling reduction awareness activities for onsite diesel powered equipment and mobile vehicles.

It is anticipated that the specific mitigation measures would be agreed with the EPA-SL prior to construction and these would be incorporated into the CMP. The plan will include provision for on-site visual inspections/ monitoring and other measures to enable corrective or preventative actions to be implemented based on the outcome of the inspections/ monitoring or on receipt of complaints.

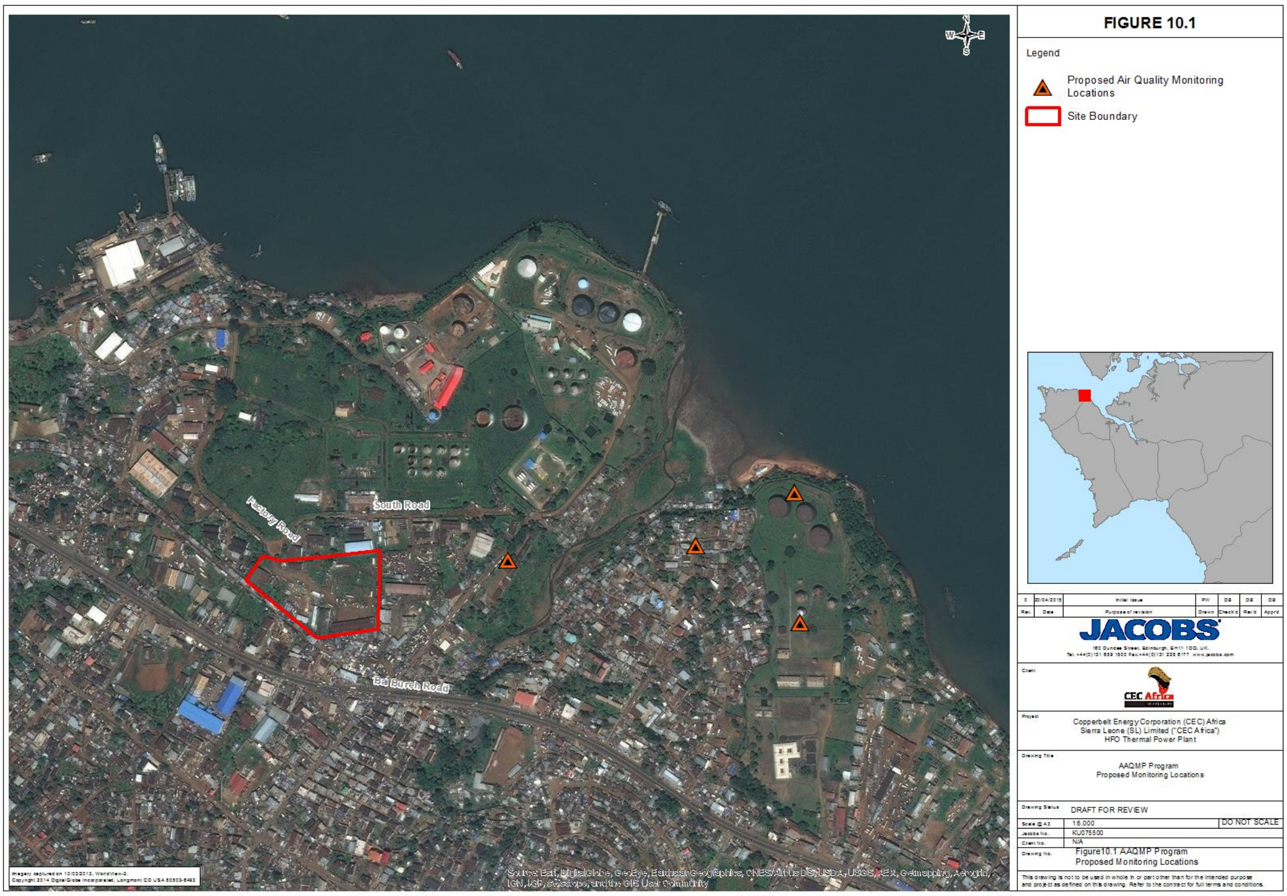
10.7.2 Operational Phase

The Plant will be designed to meet WBG standards for NO_x and SO_2. In order to ensure this, a number of mitigation measures will be integral to the design and operation of the proposed plant. These will include:

- The plant will need to comply with the relevant emissions guidelines, where appropriate.
- The use of modern combustion technology and effective combustion to minimise the generation of emissions to air.
- The maintenance of correct temperature control on the incinerator in order to avoid the generation of dioxins and will need to comply with the relevant emissions and operational guidelines.
- Appropriately designed stacks and stack height to ensure adequate dispersion of emissions to atmosphere. This ESHIA has identified that stack heights will need to be 65m during Phase I in order to appropriately manage the project's potential impacts on ambient air quality. During future phases of the project, additional stack height assessment would be required to ensure that emissions meet WBG/IFC requirements.

PM emissions still have the potential to exceed the WBG standards as the background concentrations measured as being high. However, PCs would be incrementally low and will be monitored to ensure that this is the case. Continuous Emissions Monitoring Systems (CEMS) will be installed on the engine exhaust stacks to monitor the emissions of the relevant pollutants and associated emissions parameters in accordance with the appropriate monitoring and reporting requirements of the EPA-SL and WBG. Provision shall be made for manual sampling of pollutants where required. Sampling points and safe access to the monitoring points shall be designed into the plant.

An ambient air quality monitoring program (AAQMP) will also be developed in consultation with the WBG and EPA-SL to monitor concentrations of NO_2, SO_2 and particulates (PM_{10} and $PM_{2.5}$) in the project vicinity during the operational phase of the project. Potential monitoring locations for NO_2 and SO_2 have been identified based upon the maximum annual mean and 24-hour mean concentration results presented in the Air Quality Technical Appendix report in Volume III, as illustrated in Figure 10.1. These measurements could be undertaken using passive diffusion tubes changed on a monthly basis, which is consistent with the measurements undertaken for the two baseline surveys. As the tubes are small and do not require any power, it is feasible for these long term monitoring locations to be outside of the project site boundary. With regard to particulates, it is unlikely that a permanent monitoring location outside of the project site boundary will be feasible as a continuous source of power is required and robust 24-hour security measures would need to be in place to protect the sophisticated equipment required for measuring particulates. The requirement and value of undertaking long term monitoring of particulates within the site boundary, where power and appropriate security measures are available, will be discussed in more detail with WBG and EPA-SL during the development of the AAQMP. The duration of the AAQMP and other specific details such as the number and location of monitoring locations will also be agreed with WBG and EPA-SL during the development of the AAQMP. It is anticipated that the AAQMP would be undertaken for at least a full year after operation of the project commences and the requirement for the AAQMP to continue beyond Year 1 would be dependent on the results of the monitoring, to be agreed in consultation with the WBG and EPA-SL.



10.7.3 Summary

This section has addressed the potential for long term and short term impacts on air quality arising from emissions of NO_2, CO, particulate matter (primarily PM_{10} and $PM_{2.5}$) and SO_2, from Phase 1 of the proposed project, and the shorter term impacts associated with emissions of dust from its construction.

For the operation of Phase 1 of the power plant, the predicted impact on air quality has been assessed against the relevant WHO ambient air quality guidelines and reference is made to the EC Directive for context. The results presented for Phase 1 show that the relevant ambient air quality guidelines are predicted to be complied with for all substances except PM_{10} and $PM_{2.5}$, where baseline concentrations in the project area have been measured as being high. The predicted process contributions comply with the WBG 25% of the AAQG threshold for all pollutants assessed with the exception of short term NO_2 and SO_2. It is very unlikely that neighbouring facilities' maximum short term concentration will occur at the same peak hour or 24 hour period for an exceedence of the AAQG to occur, and the 25% threshold is more relevant for long term averaging periods. Incidentally, applying the EC Directive Limit Values to 1 hour mean NO_2 concentrations would result in compliance of the 25% threshold.

For the purposes of this air quality assessment, the particulate concentrations included in the appended Air Quality Technical Appendix report are based upon the emission concentration of 100 mg/Nm^3. Based on the current fuel specification and predicted emission rates, the predicted process contributions from the proposed plant would result in small increases of particulates at the locations of the maximum.

In accordance with WBG PS3, control measures for reducing process contributions from particulate emissions have been considered. These included the potential to import low ash fuel versus high ash fuel and the installation of particulate filtration equipment. However, the difference in cost per year for low ash fuel would be approximately 2 to 2.5m USD, a significant amount for the Government of Sierra Leone. A proposed Electrostatic Precipitator (ESP) filtration system was also considered, but deemed to be infeasible due to its cost, which was estimated at approximately 3,120,000 Euros. In addition, the effectiveness of ESP systems in reducing particulate emissions is generally inconclusive.

Considering the small incremental increase in particulate emissions that the plant would generate, which equates to less than 5% of the short and long term AAQG, measures such as continuous monitoring and raising the stack height as needed, were considered sufficient, given the costs and benefits for a project of this scale. The use of emission concentrations above the WBG recommended limit results in predicted ground level concentrations which are considered to be insignificant, representing a fraction of the relevant air quality guidelines or limit values.

The large differences in the particulate concentrations measured in the short periods during the wet and dry season supports the need for ongoing ambient air quality monitoring to ensure that the project is assessed appropriately with regard to the WBG requirements for degraded airsheds (WBG, 2007). It is unlikely that the average concentration applied in this assessment accurately represents the ambient particulate concentrations and in reality concentrations may be lower than those presented. Elevated ‘spikes’ in the measured concentrations recorded during the wet season monitoring which were attributed to local events or sources may also have been present in the dry season monitoring but were not able to be identified. If the percentage increase in PCs for particulates changes significantly, consideration will be given to raising the stack height for future Phases.

The potential impact due to emissions from road traffic or mobile plant during the construction and operational phases is considered to be insignificant. With the use of mitigation measures outlined in this section, the impacts of dust generation on sensitive receptors in close proximity of the project site will be minimised and no significant impact is predicted during the construction phase. However, given the close proximity of sensitive areas adjacent to the project site, a high level of management will need to be employed to ensure best practice is continually adopted throughout the construction phase.

This ESHIA has identified that stack heights will need to be 65m in order to appropriately manage the project’s potential impacts on ambient air quality. This assessment uses the generally accepted approach for international ESHIAs of application of the WHO ambient air quality guidelines regarding acceptable impacts on human health and worst case operational scenario and assumptions. Use of the EU air quality limit values (which is permissible under the WBG EHS Guidelines) instead of the generally more stringent WHO ambient air quality guidelines has demonstrated a lower contribution for NO_2 averaging periods and 24 hour SO_2 in comparison to the air quality guidelines.

In addition, the application of the Janssen method for the NO_x to NO_2 conversion rate has demonstrated that lower, more realistic process contributions are achievable whilst still allowing appropriate protection of sensitive human receptors. For example, the conversion of annual mean NO_x to NO_2 was based on a factor of 70%, which is likely to be much higher than the actual conversion over the relatively short distances where the maximum concentrations occur (<1 km).

The stack height of 65m is shown to be an appropriate height for the plant at this stage. A summary of the air quality impacts pre mitigation is presented in Table 10.10.

Table 10.10: Summary of Impacts on Air Quality for Each Attribute during Each Phase (Prior to Mitigating Measures)

Attribute	Importance	Source of Effect	Effect Summary Description
All human health receptors – Air Quality	National	Emissions of NO_x (NO_2), SO_2, CO and Particulates (PM_{10} and $PM_{2.5}$) from construction / decommissioning vehicles and non-road mobile plant exhaust emissions	Construction and decommissioning Potential increases in the concentration pollutants at relevant exposure location potential for air quality guideline values exceeded.
	Local	Re-suspension of dust by construction related traffic on unsurfaced roads within or surrounding the proposed site and dust emissions from other onsite construction/decommissioning phase activities	Potential increase in dust emissions as result of construction activities and vehi on unsurfaced roads which could lead t nuisance dust impacts
	National	Emissions of NO_x (NO_2), SO_2, CO and Particulates (PM_{10} and $PM_{2.5}$) from the operation of the proposed power plant HFO engines	Operation Potential increases in the concentration pollutants at relevant exposure location potential for air quality guideline values exceeded.
	National	Emissions of NO_x (NO_2), SO_2, CO and Particulates (PM_{10} and $PM_{2.5}$) from road vehicles associated with the operation of the proposed power plant	Potential increases in the concentration pollutants at relevant exposure location potential for air quality guideline values exceeded.
SLRE – Air Quality	International	Re-suspension of dust by construction/ decommissioning related traffic on unsurfaced roads within or surrounding the proposed site and dust emissions from other onsite construction/decommissioning phase activities	Construction and decommissioning Potential increase in dust emissions as result of construction activities and vehi on unsurfaced roads which could lead t impacts on vegetation
		Emissions of NO_x (NO_2) and SO_2, from the operation of the proposed power plant HFO engines	Operation Potential increases in the concentration pollutants which could lead to impacts c vegetation Potential for additional of nutrient nitrog and acid deposition causing an impact ecosystems and vegetation
WAPNP – Air Quality	National	Re-suspension of dust by construction/ decommissioning related traffic on unsurfaced roads within or surrounding the proposed site and dust emissions from other onsite construction/decommissioning phase activities	Construction and decommissioning Potential increase in dust emissions as result of construction activities and vehi on unsurfaced roads which could lead t impacts on vegetation

		Emissions of NO_x (NO_2) and SO_2, from the operation of the proposed power plant HFO engines	Operation Potential increases in the concentration pollutants which could lead to impacts c vegetation Potential for additional of nutrient nitrog and acid deposition causing an impact c ecosystems and vegetation

10.8 Residual Impacts

The residual impacts associated with the proposed project after implementation of the mandatory mitigation measures during the construction & *decommissioning* phase are detailed in Table 10.11.

Table 10.11: Residual Impact after Mitigation Measures for Construction and Decommissioning

Attribute	Importance	Significance pre mitigation	Significance post mitigation
All human health receptors – Air Quality	Local	Moderate	Negligible / Minor
SLRE – Air Quality	International	No impact	No impact
WAPNP – Air Quality	National	No impact	No impact

The residual impacts associated with the proposed project after implementation of the mandatory mitigation measures during the operation phase are detailed in Table 10.12.

Table 10.12: Residual Impact after Mitigation Measures for Operation

Attribute	Importance	Significance pre mitigation	Significance post mitigation
All human health receptors – Air Quality	National	Moderate	Minor / Moderate
SLRE – Air Quality	International	Minor	Minor
WAPNP – Air Quality	National	Minor	Minor

10.9 Cumulative Impacts

Under current conditions, the impacts associated with cumulative air emissions are likely to be minor due to the recent Ebola risk conditions. However, future cumulative construction and operational particulate emissions should be carefully monitored in the project area and proper mitigation measures proposed to ensure that impacts do not become more significant.

10.10 References

- EC, 2008 – European Commission, Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.
- EA, 2010: Environment Agency: Air Quality Modelling and Assessment Unit, Frequently asked questions and further guidance, Conversion Ratios for NO_x and NO_2 accessed at www.environment-agency.gov.uk, October 2010.
- IAQM, 2014 – Institute of Air Quality Management: Guidance on the Assessment of Dust from Demolition and Construction, February 2014.
- Janssen, 1988 - L.H.J.M. Janssen, J.H.A. Van Wakeren, H. Van Duuren and A.J. Elshout, A Classification of NO Oxidation Rates in Power Plant Plumes Based on Atmospheric Conditions, Atmospheric Environment Vol. 22, No. 1, pp. 43 – 53. 1988.

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- WBG, 2007 – World Bank Group (WBG) Environmental, Health and safety Guidelines - General EHS Guidelines: Environmental – Air Emissions and Ambient Air Quality, April 30, 2007.
- WBG, 2008 – World Bank Group (WBG) Environmental, Health and safety (EHS) Guidelines for Thermal Power Plants, December 19, 2008.
- WHO, 2000 – World Health Organisation – Air Quality Guidelines for Europe, 2nd Edition, WHO Regional Publications, European Series, No.91

11. Soils, Geology, Hydrogeology and Hydrology

11.1 Introduction

This section assesses the potential impacts on hydrology, hydrogeology and geology such as quantity and quality and assesses the flood risk implications of the proposed project during the construction operational and decommissioning phases.

11.2 Discharge Standards

There are no discharge standards specified within the Environment Protection Agency (EPA) Act, 2008 (No. 11 of 2008) as amended in 2010 therefore the Environmental, Health, and Safety (EHS) Guidelines, World Bank/IFC will be applied ("the EHS Guidelines"), specifically:

- EHS Guidelines General: Section 1.3 Environmental Wastewater and Ambient Water Quality;
- EHS Guidelines General: Section 1.4 Environmental Water Conservation ;and
- EHS Guidelines for Thermal Power Plants.

Table 11.1 details the effluent discharge requirement from thermal power plants that are to be applied to the proposed project.

Table 11.1: Guideline values for process emissions and effluents from Thermal Power Plants

Parameter	Mg/L (except pH and temperature)
pH	6 – 9
TSS	50
Oil and grease	10
Total residual chlorine	0.2
Chromium - Total	0.5
Copper	0.5
Iron	1.0
Zinc	1.0
Lead	0.5
Cadmium	0.1
Mercury	0.005
Arsenic	0.5
Temperature	• 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.

Table 11.2 details the effluent from standards that are to be applied in relation to sanitary discharges for the proposed project.

Table 11.2: Guideline values for Sanitary Sewer Discharges

Pollutants	Units	Guideline Value
pH	pH	6-9
BOD	mg/l	30
COD	mg/l	125
Total Nitrogen	mg/l	10
Total phosphorous	mg/l	2
Oil and grease	mg/l	10
TSS	mg/l	50
Total coliform bacteria	MPN/10ml	400

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.

11.3 Sensitive Receptors

11.3.1 Soils – Geology

Table 11.3 summarises the importance of the geological attributes/receptors within the study area.

Table 11.3: Geological Attribute Importance (Quality) within the Study Area

Receptor/ Attribute	Importance	Rationale
Construction workers	Local	Exposure to contamination in soils during construction activities on site
Future site users	Local	Exposure to contamination in soils on site
Surrounding land	Local	Local migration of contamination to surrounding land

11.3.2 Hydrogeology

Table 11.4 summarises the importance of the groundwater attributes/receptors within the study area.

Table 11.4: Groundwater Attribute Importance (Quality) within the Study Area

Receptor	Importance	Rationale
Boreholes in surrounding area	Local	Groundwater use by the local population from small boreholes
Onsite borehole	Local	Value to onsite operations
Municipal Water Supply – GVWC	Regional	Value on a regional scale as this is the only water supply which is currently constrained.
Sierra Leone River Estuary (SLRE)	International	Designated as a Ramsar Site

Wellington Stream or Creek	Regional	Value on a regional scale due to connectivity with the wider Sierra Leone River Estuary which is designated as a Ramsar Site
Old Railway Road Stream	District	Value on a local scale

11.3.3 Hydrology

Table 11.5 summarises the importance of the surface water attributes/receptors within the study area based on the ESHIA methodology set out in Section 6.

Table 11.5: Surface Water Attributes Importance within the Study Area

Attribute	Importance	Rationale
Sierra Leone River Estuary (SLRE) Water Quality	International	Designated as a Ramsar Site
Wellington Stream Water Quality	Regional	Value on a regional scale due to connectivity with the wider SLRE which is designated as a Ramsar Site and its importance to Freetown (drainage)
Old Railway Road Stream Water Quality	District	Value on a local scale due to importance to eastern Freetown and Kissy Docks area drainage system
Drainage Network Water Quality	Local	Value on a local scale (drainage)
Commercial Fishery Resources	Regional	Value on a regional scale
Local Municipal Water Supply	Regional	Value on a regional scale as this is the only municipal water supply which is currently constrained
Flood Risk	Local	Value on a local scale due to importance to eastern Freetown and Kissy Docks area (drainage)

11.4 Soils and Human Health Impact Assessment

This section considers and assesses the impact of the proposed development with regards to soil quality during the construction, operation and decommissioning phases - these are summarised in Table 11.6.

11.4.1 Construction Phase Impacts

Based on available information, no significant soil contamination has been identified on site with no obvious signs of surface contamination and the majority of contaminants in borehole soil samples below screening criteria for commercial land use. Non-asbestos fibres were detected in two soil samples. It is important to note that the soil samples taken in the ground investigation are from targeted borehole locations on site and whilst they give an indication of the likely contamination levels on site they do not represent the entire site. Therefore it is possible for further existing contamination to be uncovered during construction activities, in particular the area of the old fuel pump. It should also be anticipated that further non-asbestos fibres may be encountered during construction activities on the site, however the risk is considered low.

There is the potential for further contamination of soils from any spills of hazardous materials during construction activities including fuel and oils. Risks to human health include exposure of construction workers to any existing or construction made soil contamination as potential contamination pathways are opened up during construction activities.

11.4.2 Operational Phase Impacts

Risks to human health will be limited during the operational phase unless any major spills or contamination events occur. The majority of the site will be hard standing therefore there will be limited pathways for contact with potential contamination in the unlikely event that any previously unidentified contamination remains present.

There is the potential for health risks to site users if additional contamination events occur, in particular spills of hazardous materials such as fuel. In these instances it is likely that any health risks are limited to those in the immediate vicinity of the spill and to any workers involved in the cleaning up of the materials.

11.4.3 Decommissioning Phase Impacts

Decommissioning phase impacts are similar to construction phase impacts. There is the potential for any existing contamination to migrate as a result of decommissioning activities. There is also the potential for exposure to workers as soil is exposed during decommissioning activities. This may present a health risk to these workers if any contaminated soils are exposed. Further contamination of soils during decommissioning activities is possible, particularly spills of hazardous materials. In this instance health impacts to workers may be possible along with the migration of contaminants to offsite soils depending on the location of the spill and the likelihood of it impacting groundwater.

Table 11.6: Summary of Impacts on Soils and Human Health for Each Attribute during Each Phase (Prior to Mitigating Measures)

Attribute	Importance	Source of Effect	Effect Summary Description
Construction workers	Local	Potential exposure of construction workers to any contamination of soils on site during construction activities.	<u>Construction</u> Potential for existing on-site soil contamination to be mobilised during construction, resulting in exposure of contamination to construction workers.
			<u>Operation</u> Potential for pollution from spills or other accidents from hazardous materials used during construction, including oils and fuels.
			<u>Decommissioning</u> Potential for pollution from spills or other accidents from hazardous materials used during decommissioning, including oils and fuels.
Future site users	Local	Potential exposure of future site users to any contamination of soils on site.	<u>Construction</u> Potential for pollution from spills or other accidents from hazardous materials used during construction, including oils and fuels.
			<u>Operation</u> Potential for exposure of future site users from contamination of soil in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).
			<u>Decommissioning</u> Potential for exposure to future site users of pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.

Surrounding land	Local	Contamination of soils resulting in potential pollution of groundwater impacting water quality abstracted by offsite boreholes.	Construction Potential for existing on-site soil contamination to be mobilised during construction, resulting in migration of contamination to offsite soils.
			Operation Potential for migration and contamination of offsite soils in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).
			Decommissioning Potential for migration and contamination for spills or other accidents from hazardous materials used during construction, including oils and fuels.

11.5 Hydrogeology Impact Assessment

This section assesses the potential impacts on both the quantity and quality of groundwater beneath the site and in the surrounding area. This includes consideration of the use of groundwater as a water supply both for the site and by the local population.

11.5.1 Construction Phase Impacts

This section considers and assesses the impact of the construction phase of the proposed development with regards to groundwater quality and groundwater supply, with potential impacts to receptors that are linked to groundwater in the local area, including groundwater abstractions from boreholes, and surface water features such as the Sierra Leone River Estuary. These are summarised in Table 11.7.

11.5.1.1 Groundwater Quality

Results of the site investigation indicate that the soils beneath the site are permeable and vulnerable to contamination. During the construction phase there is the potential that any existing contamination within the soil, due to current/historical use of the site, will be mobilised as a result of earthworks and excavations within the site. This mobilised contamination would have the potential to infiltrate to groundwater causing a deterioration of the groundwater quality, and could be transported in groundwater. This therefore has the potential to impact water abstracted from the existing onsite borehole, or any offsite boreholes in the surrounding area.

In addition, there is the potential for the contamination of groundwater during construction process as a result of spills of hazardous materials during construction which may also impact groundwater quality in the local area and on site.

It is understood that groundwater in the area is used by the local population as a water source, with boreholes in the surrounding area used to abstract the water. Such water is also used for farming activities including those on or near to the site. Therefore there are potential health risks to the local population if contaminated groundwater is used as drinking water supply or for watering of crops.

Potential risks to the onsite abstraction borehole for contaminated groundwater could also impact the use of this borehole both during construction and the operation of the site. Water quality samples from this borehole during the pumping test will confirm the existing quality of groundwater from this borehole which will further inform the potential risks.

Groundwater flow beneath the site is understood to be northwards, towards the Sierra Leone River Estuary. There is the potential that groundwater discharges to the SLRE and therefore contamination of the groundwater as a result of the construction phase could potentially be transported to the SLRE.

Other watercourses in the surrounding area also have the potential to be in hydraulic continuity with groundwater, including the Wellington Creek, located 200 m to the east of the project site, and Old Railway Road Stream, located to south of the site. The fractured nature of the geology beneath the site means that groundwater flow patterns may be complex and as a result there are potential contamination pathways from groundwater to these water courses.

The site investigation indicates that no significant contamination has currently been identified on site, though some elevated total petroleum hydrocarbons were identified in groundwater in the vicinity of the fuel pump area. Therefore the risks of significant impacts to the groundwater quality, and any of the identified receptors, are likely to be low. Any significant contamination sources identified during the site construction will be either removed from site or treated as appropriate to reduce potential risks of associated contamination of groundwater.

Any hazardous materials and wastes used as part of the construction of the site will be appropriately stored (e.g. on areas of fully bunded hard standing, as necessary). Appropriate accident and spill response plans will be required to manage any spills that might occur during the construction of the plant.

11.5.1.2 Groundwater Supply

It is proposed that the existing onsite abstraction borehole will be used to provide all or part of the water supply required during the construction and operation of the plant. The abstraction of significant quantities of groundwater has the potential to reduce groundwater resources available in the aquifer underlying the site and in the surrounding area, and as a result impacting the availability of groundwater at boreholes in the surrounding area.

Construction sites need relatively limited supplies of water for cement manufacture, damping down for dust control and messing purposes, therefore this effect should be limited during the construction phase.

In addition, the pumping test results performed during the site investigation indicates that the existing abstraction borehole has a low efficiency, limiting the volumes of water that can be abstracted to between 4.0 and 4.5 m^3/hour (100 to 110 m^3/day). A groundwater abstraction of this magnitude is unlikely to have a significant impact on groundwater levels in the local area and therefore any impacts to offsite boreholes are likely to be limited. The locations of any offsite boreholes will be determined through a survey prior to updating the ESIA. This impact assessment will be amended accordingly.

The pumping test results indicate that a greater yield may be obtained from a more fit-for-purpose abstraction borehole, and the potential impacts on any such abstraction would have to be assessed if this was considered to be required.

11.5.2 Operational Phase Impacts

This section considers and assesses the impact of the operational phase of the proposed development with regards to groundwater quality and groundwater supply. Again potential impacts to receptors that are linked to groundwater in the local area, including groundwater abstractions from boreholes, and surface water features such as the Sierra Leone River Estuary, are also considered. These are summarised in *Table 8.1.*

11.5.2.1 Ground Water Quality

The main risk to groundwater quality is from potential contamination of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during operation. This includes the proposed HFO and diesel tanks, oils, lubricants and other hazardous materials. Any potential spills or leaks from the HFO or diesel tanks have the potential to see significant volumes of contamination infiltrate into the ground and the groundwater beneath the site.

As with the construction impacts, pollution of groundwater beneath the site has the potential to impact groundwater quality in the surrounding area and affect the quality of groundwater abstracted from any nearby boreholes used by the local population as a water supply. Therefore there are potential health risks to the local population if contaminated groundwater is used as drinking water supply.

As outlined in more detail below, it is proposed that the existing borehole onsite will be used to provide part of the water supply required for the operation of the site, with some water to be used for potable water. Any contamination of the groundwater abstracted from the borehole could present a health risk to anyone drinking this water. Therefore the water quality of the water abstracted should be regularly tested to ensure the suitability for drinking.

Contaminated groundwater could also impact the water quality of surface water that is connected to groundwater, including the Sierra Leone River Estuary (SLRE), the Wellington Creek and the Old Railway

Road Stream. The fractured nature of the geology beneath the site means that groundwater flow patterns may be complex and as a result there are potential contamination pathways from groundwater to these water courses.

Hazardous materials and wastes should be appropriately stored (e.g. on areas of fully bunded hard standing, as necessary). Appropriate accident and spill response plans will be required to manage any spills that might occur during the operation of the plant.

11.5.2.2 Ground Water Supply

It is proposed that the existing onsite abstraction borehole would be used to provide part of the water supply required during the construction and operation of the plant. As the power plant is air cooled, limited water volumes only are required for radiator makeup water, wash down and sanitary/domestic use.

It is understood that a total daily volume of 210 m^3/day is anticipated to be needed during the operation of the plant. This is based on the following requirements:

- Potable water: 10 m3/day
- Service Water: 8 m3/day
- Demin Water: 192 m3/day

In addition, a peak instantaneous flow rate of 55 m^3/hour would be required for fire water (beyond the existing capacity provided in the fire water tank).

The pumping tests performed on the existing onsite abstraction borehole indicates that it has poor efficiency, which limits the volumes of water that can be abstracted to a maximum of 4.0 to 4.5 m^3/hour (100 to 110 m^3/day). This volume would not be able to fully meet the anticipated water supply requirements during the operation of the plant. However, the results of the test pumping exercise indicated that a new borehole designed to good international industry practice may provide greater yields. Results of the test pumping are included in Appendix F. CECASL has confirmed that an additional borehole or boreholes will be drilled to supply water for the project in addition to that obtained through rainwater harvesting. Purchase of water from GVWC will also be considered as a supplemental source where required. If GVWC water is required, an assessment of potential impacts on water availability to other water users on the network will be undertaken at that time.

The abstraction of significant quantities of groundwater has the potential to reduce groundwater resources available in the aquifer underlying the site and in the surrounding area, and as a result impacting the groundwater that can be abstracted from boreholes in the surrounding area. A groundwater abstraction of this magnitude is unlikely to have a significant impact on groundwater levels in the local area and therefore any impacts to other offsite boreholes are likely to be limited. However, as part of the forthcoming update to the ESIA, a borehole survey will be undertaken to identify the location of any nearby boreholes and results of this assessment will be updated to reflect this.

Water supply requirements for the project are relatively small and are expected to be sufficiently supplied by borehole(s) and rainwater capture. GVWC municipal supply connection to the site would only be utilised if there are unpredictable interruptions to borehole water supply. As such, water supply impacts are considered to be minor adverse and of a low magnitude.

11.5.3 Decommissioning Phase Impacts

The main decommissioning impacts will be similar to those for the construction phase, however additional impacts specifically for decommissioning are detailed below.

11.5.3.1 Ground Water Quality

There is the potential for pollution for spills or other accidents from hazardous materials used during decommissioning, including oils and fuels, particularly from the HFO and diesel fuel storage tanks and leakage of and residual hazardous materials in these tanks. This could impact both the onsite borehole and surrounding water quality and have health impacts for both site workers and the local population of groundwater is used for drinking purposes.

11.5.3.2 Ground Water Supply

Decommissioning of the site likely to need limited supplies of water for damping down for dust control and messing purposes. It is unlikely that the local water supply will be overused for decommissioning activities.

11.5.3.3 Sierra Leone River Estuary (SLRE)

There is the potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels. Due to groundwater flow across the site these may impact the SLRE.

11.5.3.4 Wellington Creek and Old Railway Road Stream

There is the potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.

Table11.7: Summary of Impacts on Groundwater Quality for Each Attribute during Each Phase (Prior to Mitigating Measures)

Attribute	Importance	Source of Effect	Effect Summary Description	Pot Mag
Groundwater supply - Boreholes in surrounding area	Local	Potential overuse of groundwater from abstraction from onsite borehole with potential to restrict water availability to existing users, including boreholes in the surrounding area used by local population or artisanal farmers (if using groundwater for farming purposes).	<u>Construction</u> Construction sites need relatively limited supplies of water for cement manufacture, damping down for dust control and messing purposes.	
			<u>Operation</u> Power plant is air cooled, limited water volumes only are required for radiator makeup water, wash down and sanitary/domestic use.	
			<u>Decommissioning</u> Decommissioning of the site likely to need limited supplies of water for damping down for dust control and messing purposes.	
Groundwater quality - Boreholes in surrounding area	Local	Potential pollution of groundwater impacting water quality to existing users in local area, including boreholes used by local population or artisanal farmers (if using groundwater for farming purposes). Potential health risks to local population if use polluted water for drinking supply and possible restrictions on water availability.	<u>Construction</u> Potential for existing on-site soil contamination to be mobilised during construction, resulting in contamination of groundwater abstracted by local boreholes. Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
			<u>Operation</u> Potential contamination of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).	M
			<u>Decommissioning</u> Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
Groundwater quality - Onsite borehole	Local	Potential pollution of groundwater impacting water quality abstracted by onsite borehole.	<u>Construction</u> Potential for existing on-site soil contamination to be mobilised during construction, resulting in contamination of groundwater abstracted by onsite borehole.	

			Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
			<u>Operation</u> Potential contamination of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).	M
			<u>Decommissioning</u> Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
Groundwater supply - Municipal Water Supply - GVWC	Regional	Reliance and overuse of municipal supply with potential to restrict water availability to existing users. Potential groundwater contamination restricts the use of the onsite borehole as water supply, resulting in reliance on municipal supply.	<u>Construction</u> Construction sites need relatively limited supplies of water for cement manufacture, damping down for dust control and messing purposes.	
			<u>Operation</u> Power plant is air cooled, limited water volumes only are required for radiator makeup water, wash down and sanitary/domestic use.	M
			<u>Decommissioning</u> Decommissioning of the site likely to need limited supplies of water for damping down for dust control and messing purposes.	
Groundwater quality - Sierra Leone River Estuary (SLRE)	National	Groundwater flow beneath the site to the north, towards the SLRE – therefore potential that SLRE is in hydraulic continuity with groundwater. Potential pollution at the site could be transported through groundwater to SLRE.	<u>Construction</u> Potential for existing on-site soil contamination to be mobilised during construction, resulting in contamination of groundwater. Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
			<u>Operation</u> Potential contamination of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).	M
			<u>Decommissioning</u> Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	

Groundwater quality - Wellington Creek	Regional	Potential pollution at the site could be transported through groundwater to Wellington Creek, located 200m to the east of the project site. The likely fractured geology means that groundwater flow patterns may be complex and may not necessarily be towards the north.	<u>Construction</u> Potential for existing on-site soil contamination to be mobilised during construction, resulting in contamination of groundwater. Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
			<u>Operation</u> Potential contamination of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).	
			<u>Decommissioning</u> Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	
Groundwater quality - Old Railway Road Stream	District	Potential pollution at the site could be transported through groundwater to Old Railway Road Stream, located to south of the site.	<u>Construction</u> Potential for existing on-site soil contamination to be mobilised during construction, resulting in contamination of groundwater. Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	N an
			<u>Operation</u> Potential contamination of groundwater in the event of a spill or other type of accident from hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials).	N an
			<u>Decommissioning</u> Potential for pollution for spills or other accidents from hazardous materials used during construction, including oils and fuels.	N an

11.6 Hydrology Impact Assessment

11.6.1 Construction Phase Impacts

This section considers and assesses the impact of the construction phase of the proposed project with regards to surface water quality, water supply and flooding; these are summarised in Table 11.8.

11.6.1.1 Surface Water Quality

During the construction phase there is the potential for pollution of surface water features due to sediment loading as a result of surface water runoff. In addition a variety of construction materials and chemicals are likely to be used during works which could have varying polluting potential if spilled adjacent to or within a watercourse. Accidental spills and leaks may include seepage if storage locations were poorly protected, fuel spillages, lubricants spills and leaks/discharges from vehicles. Potential pollution sources during the construction phase of the proposed project include:

- Construction works within and adjacent to watercourses such as drainage ditches and streams;
- Excavations including those associated with the provision of drainage works;
- Site clearance works;
- Stockpiling of materials;
- Accidental spillage of polluting substances in or adjacent to watercourses;
- Construction plant and vehicle washing; and
- Liquid effluent including domestic wastewater/ sewage.

No significant construction works will be undertaken within or immediately adjacent the SLRE, however there is the potential for works to be undertaken within and adjacent to streams and/or drainage channels that are hydraulically connected to the SLRE therefore, there is a potential for indirect impacts to the water quality of the SLRE. The importance (international) of the receptor, combined with the low magnitude of the effect (short-term, minor damage) would result in an impact to the water quality of the SLRE from the construction works as indirect (runoff, spills), temporary, negative, and of medium significance prior to mitigation.

No construction works will be undertaken within or adjacent to Wellington Stream, however there is the potential for works to be undertaken within and adjacent to streams and/or drainage channels that are hydraulically connected to this watercourse therefore there is a potential for indirect impacts to the water quality of the Wellington Stream. The importance (regional) of the receptor, combined with the low magnitude of the effect (short-term, minor damage) would result in an impact to the water quality of the Wellington Creek from the construction works as indirect (runoff, spills), temporary, negative, and of medium significance prior to mitigation.

There is a potential for construction works to be undertaken within or adjacent to the Old Railway Road Stream therefore there is a potential for direct and indirect impacts to the water quality of this watercourse. The importance (district) of the receptor, combined with the low magnitude of the effect (short-term, minor damage) would result in an impact to the water quality of the Old Railway Road Stream from the construction works as direct (construction of drainage connections/culverts) and indirect (runoff, spills), temporary, negative, and of minor significance prior to mitigation. However, it is noted that this watercourse does run through the grounds of the Winston Churchill Secondary School. At this time it is not known if the children have access to the water and/or the existing water quality. The EPC contractor should confirm the access to this watercourse and confirm the assessment of this impact as required.

Construction works are likely to be undertaken within or adjacent to the existing drainage network in and around the site therefore there is a potential for direct and indirect impacts to the water quality of the drainage network. The importance (local) of the receptor, combined with the low magnitude of the effect (short-term, minor damage) would result in an impact to the water quality of the existing drainage network from the construction works as direct (construction of drainage connections/culverts) and indirect (runoff, spills), temporary, negative, and of negligible significance prior to mitigation.

Commercial and artisanal fishery resources may theoretically be impacted by any decrease in the water quality of the SLRE during the construction activities as a result of accidental discharges or contamination from the site entering the SLRE via the streams or storm water. The importance (regional) of the receptor combined with the low magnitude of the effect (short-term, minor damage) and the distance of fishery activities from Kissy Bay would result in an impact the this resource from the construction works as indirect (runoff, spills), temporary, negative, and of minor significance prior to mitigation.

11.6.1.2 Water Supply

Water volumes associated with construction activities are unknown at present, but as no water-intensive construction activities are anticipated, the associated volumes required will not be significant. The construction sites will need relatively limited supplies of water for cement manufacture, damping down for dust control and messing purposes. Water requirements during construction will be the responsibility of the EPC contractor and it is anticipated that this will be delivered to site via tankers until infrastructure is in place to supply the site (borehole, see Section: Hydrogeology). Potable water will also be provided in bottles/drums and delivered to site via trucks.

There is also a risk that construction activities could disrupt or accidentally cut off the existing local water supply. The importance (regional) of the receptor combined with the low magnitude of the effect (short-term, minor damage) would result in an impact on the municipal water supply from the construction works as direct (disruption), temporary, negative, and medium significance prior to mitigation.

11.6.1.3 Flooding

The change in land use at the site from brownfield use to include laydown areas and other construction activities associated with the site development has the potential to increase the volume of surface runoff that discharges into the surface drainage network due to a reduction in the available permeable areas. This is in addition to the existing context of significant high intensity rainfall events throughout the wet season which results in very rapid overwhelming of soil infiltration capacity and surface flooding.

The importance (local) of the receptor combined with the low magnitude of the effect (short-term, minor damage) would result in an impact on flooding from the construction works as direct (increase in surface runoff), temporary, negative, and minor significance prior to mitigation.

11.6.2 Operational Phase Impacts

Specific potential impacts on surface water receptors expected due to the proposed operational phase are described below and summarised in Table 11.8.

11.6.2.1 Surface Water Quality

Potential discharges from the operational plant will include:

- Sewage plant effluent;
- Industrial wastewater (IWW - including wash down water and separated water from the Oil/Water separator); and

- Potentially contaminated & clean storm water.

All domestic wastewater will be sent to either an onsite septic tank for storage and disposal or to an onsite effluent treatment plant, depending on the final design. In the event that a treatment plant is required , discharges will be required to meet the WBG EHS Guidelines before discharge to any watercourse.

IWW generation resulting from the oily water treatment and effluent from the operation of the proposed project is anticipated to be small. Details of the treatment of this effluent are not finalised however all waste water generated on site will be adequately treated, to be in line with WBG EHS Guidelines.

The final discharge point(s) for the plant has not been established, but is likely to be the local stream (the old Railway Road Stream) or alternatively, adjacent storm water drains may be used. The risk of each option will be weighed and discussed with EPA-SL and the project will deigned to ensure that WBG and national standards for wastewater are met.

A storm water drainage system will drain areas of hard standing unlikely to be contaminated by the project's processes. The majority of the rainwater drainage will be uncontaminated and drain to the local storm drainage system.

Areas of hard standing with the potential to be contaminated by process will be constructed with kerbs to direct any accidental spills and potentially contaminated storm water to an oil/water separator. Oil from the oil/water separator will be recycled or disposed of in the incinerator. Water from the oil/water separator will be treated prior to discharge to WBG EHS Guidelines (WBG, 2007).

Potential impacts from the operation of the proposed project in the absence of mitigation measures but with the assumption that IFC standards will be met are described below.

There will be no direct discharges to the SLRE, however there is the potential indirect via streams and/or drainage channels that are hydraulically connected to the SLRE therefore there is a potential for indirect impacts to the water quality of the SLRE. Considering that all discharges will be required to meet IFC discharge standards and given the importance (international) of the receptor, combined with the low magnitude of the effect (compliance with legal requirements) impacts to the water quality of the SLRE from operational discharges are considered to be indirect, long term, negative, and minor.

There will be no direct discharges to the Wellington Stream, however there is the potential for indirect discharges via streams and/or drainage channels that are hydraulically connected to the Wellington Creek. Considering that all discharges will be required to meet IFC discharge standards and given the importance (regional) of the receptor, combined with the low magnitude of the effect (compliance with legal requirements) impacts to the water quality of the Wellington Stream from operational discharges are considered to be indirect, long term, negative, and minor.

There is a potential for direct discharges to the Old Railway Road Stream therefore there is a potential for direct impacts to the water quality of the Old Railway Road Stream. Considering that all discharges will be required to meet IFC discharge standards and given the importance (District) of the receptor, combined with the low magnitude of the effect (compliance with legal requirements) impacts to the water quality of the Old Railway Road Stream from operational discharges are considered to be indirect, long term, negative, and minor. However, it is noted that this watercourse does run through the grounds of the Winston Churchill Secondary School. At this time it is not known if the children have access to the water and/or the existing water quality. The EPC contractor should confirm the access to this watercourse and confirm the assessment of this impact as required.

There is a potential for direct discharges to the existing drainage network therefore there is a potential for direct impacts to the water quality of the existing drainage network. Considering that all discharges will be required to meet IFC discharge standards and given the importance (local) of the receptor, combined with the low magnitude of the effect (compliance with legal requirements) impacts to the water quality of the existing drainage network from operational discharges are considered to be indirect, long term, negative, and negligible.

Commercial and artisanal fishery resources may be impacted by any decrease in the water quality of the SLRE from operation discharges. Considering that all discharges will be required to meet IFC discharge standards and given the importance (regional) of the receptor combined with the low magnitude of the effect (compliance with legal requirements) and the distance of fishery activities would result in an impact to this resource as indirect (runoff, spills), temporary, negative, and of minor significance prior to mitigation

11.6.2.2 Water Supply

As the power plant is air cooled, limited water volumes only are required for radiator makeup water, wash down and sanitary/domestic use. It is envisaged that the operational water supply will be taken from the onsite borehole therefore there will be no impacts on the local municipal water supply from the operational phase; resource impacts to the groundwater regime are considered in Section 11.5 (Hydrogeology).

Water used for the purpose of drinking shall be treated to World Health Organisation (WHO) Standards as specified in the Guidelines for Drinking-water Quality. Water treatment will need to consider the potential contaminants identified in Section 11.4 above and the results of the water quality analysis conducted as part of the test pumping exercise, when this is available. Further groundwater quality testing should be undertaken during construction and prior to operation to ensure that any potential contaminants are identified and the proposed water treatment is appropriate.

11.6.2.3 Flooding

The change in land use at the site to include new buildings, access roads, hard standing that have the potential to increase the volume of surface water runoff that discharges into the surface drainage network. The importance (local) of the receptor combined with the high magnitude of the effect would result in an impact on flooding from the operation of the plant as direct long term, negative, and medium significance prior to mitigation.

It is also noted that there is the potential for wet season rainfall-related flooding to be exacerbated by the impacts of climate change and mitigation through increased storm drainage capacity is included in the design to address this.

11.6.3 Decommissioning Phase Impacts

The impacts on surface waters attributes during the decommissioning stage are expected to be equivalent to (or less than) the impacts that would affect surface waters attributes during the construction stage.

Table 11.8: Summary of Impacts on water quality for each attribute during each phase (prior to mitigating measures)

Attribute	Importance	Source of Effect	Effect Summary Description
RE - Water Quality	ernational	Indirect impacts associated with the transport of sediment or accidental release during construction. Discharge of effluent from operations Indirect impacts associated with the transport of sediment or accidental release during decommissioning.	Construction Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during construction works. Operation Potential for pollutants to be transported to water environment via the drainage system. However, discharges will be required to meet the IFC EHS Guideline values. Decommissioning Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during decommissioning works.
ıter Quality	ernational	Accidental Spills	Operation Potential accidental spills during HFO transfer during operations which could also affect the local RAMSAR site.
ngton Creek - Water Quality	Regional	Indirect impacts associated with the transport of sediment or accidental release during construction. Discharge of effluent from operation Indirect impacts associated with the transport of sediment or accidental release during decommissioning.	Construction Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during construction works. Operation Potential for pollutants to be transported to water environment via the drainage system. However, discharges will be required to meet the IFC EHS Guideline values. Decommissioning Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during decommissioning works.

ailway Road Stream - Water Quality	District	Direct impact on the watercourse from construction work in and within closed proximity and indirect impacts associated with the transport of sediment or accidental release during construction. Discharge of effluent from operation. Direct impact on watercourse from decommissioning work in and within closed proximity and indirect impacts associated with the transport of sediment or accidental release during decommissioning.	<u>Construction</u> Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during construction works. <u>Operation</u> Potential for pollutants to be transported to water environment via the drainage system. However, discharges will be required to meet the IFC EHS Guideline values. <u>Decommissioning</u> Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during decommissioning works.
age Network - Water Quality	Local	Direct impact on the watercourse from construction work in and within closed proximity and indirect impacts associated with the transport of sediment or accidental release during construction. Discharge of effluent from operation. Direct impact on watercourse from decommissioning work in and within closed proximity and indirect impacts associated with the transport of sediment or accidental release during decommissioning.	<u>Construction</u> Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during construction works. <u>Operation</u> Potential for pollutants to be transported to water environment via the drainage system. However, discharges will be required to meet the WBG EHS Guideline values. <u>Decommissioning</u> Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during decommissioning works.
ercial Fishery Resources - Water Quality	Regional	Indirect impacts associated with the transport of sediment or accidental release during construction. Discharge of effluent from operation. Potential accidental spills.. Indirect impacts associated with the transport of sediment or accidental release during decommissioning.	<u>Construction</u> Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during construction works. <u>Operation</u> Potential for pollutants to be transported to water environment via the drainage system. However, discharges will be required to meet the IFC EHS Guideline values. Potential spills during HFO transfer during operations which could result in contamination. <u>Decommissioning</u> Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during decommissioning works.

Municipal Water Supply	Regional	Disruption of resource.	<u>Construction & Decommissioning</u> There will be no tie in to the municipal water supply during these stages however, construction and/or decommissioning activities could disrupt or accidentally cut off the water supply.
			<u>Operation</u> There will be no tie in to the municipal water supply .
Flooding	Regional	Increase the risk or magnitude of flooding.	<u>Construction & Decommissioning</u> Change in land use at the site has the potential to increase the volume of surface runoff that discharges into the surface drainage network.
			<u>Operation</u> Change in land use at the site has the potential to increase the volume of surface runoff that discharges into the surface drainage network

11.6.4 Construction Phase Mitigation

The specific mitigation measures to be implemented for the proposed project during the construction phase are detailed below.

11.6.4.1 Contamination

All construction works will be completed in line with the recommendations of the IFC PS and WBG EHS Guidelines and the following good international industry practice (GIIP) guidelines as applicable:

- Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors' (CIRIA, 2001): and
- Environment Agency (EA) UK:
    - Pollution Prevention Guidelines (PPG) 5: Works and Maintenance in/ or near Water;
    - PPG21: Incident Response Planning;
    - PPG22: Dealing with Spills; and
    - PPG26: Drums and Intermediate Bulk Containers.
- Environmental Protection Agency (EPA) US:
    - Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites.

The EPC Contractor will be required to prepare the following management plans that are relevant to the water environment. The Management Plans will include assignment of responsibilities and a full list of EPC management plan requirements is included in Volume II (ESMP):

- Construction Management Plan;
- Health and Safety Plan;
- Emergency Response Plan, including a Spill Response Plan);
- Community Safety Plan (including traffic management plan);
- Monitoring and Reporting Plan; and
- Waste Management Plan.

The following specific pollution prevention measures are required to be implemented by the EPC contractor to prevent impact to water quality receptors in the area, these measures will be included in the relevant management plan:

- During the construction period, the EPC contractor will be responsible for providing adequate sanitary facilities and maintenance of these in a clean and hygienic state for use by all persons employed by the Employer, Engineer, Contractor or other contractors on the Site. The EPC contractor will ensure that any sewage effluent generated is disposed of appropriately and not discharged untreated to the environment. All sanitary discharges will be required to meet the WBG EHS Guidelines. If this effluent is to be disposed offsite the Contractor will inspect the vehicles/sub-contractors used to transfer the sanitary wastewater from any collection system and the EPC contractor will request a waste transfer record to ensure that this is disposed of appropriately;
- Potentially contaminated wastewater arising from construction activities such as, but not limited to, concrete washes (high alkaline) and equipment/vehicle cleaning activities (potentially containing

detergents) is shall be contained, stored and disposed of appropriately. The EPC contractor will ensure that any construction related effluent generated is disposed of appropriately and not discharged untreated to the environment. All discharges will be required to meet the WBG EHS Guidelines before discharge to any watercourse. If this effluent is to be disposed offsite the Contractor will inspect the vehicles/sub-contractors used to transfer the wastewater from any collection system and the EPC contractor will request a waste transfer record to ensure that this is disposed of appropriately;

- Where possible, stockpiles will not be sited close to the watercourse or drainage ditches. If unavoidable, stockpiles will be sloped appropriately and covered with sheeting;
- Designated refuelling and vehicle maintenance areas will be constructed. These will comprise bunded and sealed areas and all scheduled refuelling and maintenance of construction and transportation vehicles will be undertaken within these designated areas;
- All vehicles used on site will be serviced and maintained and records kept of maintenance undertaken;
- Spill Response Procedures within the Emergency Response Plan will be developed by the EPC contractor and implemented following any accidental release of hazardous substances e.g. during refuelling, and this plan shall include details of measures to be adopted to stop, contain as far as practical on site, and clean up spills, and to inform the relevant authorities in the event that a spill migrates (or occurs) offsite;
- Hazardous material storage tanks, including for fuels, will be located within appropriately protected areas such as prefabricated skids or bunded and hard surfaced areas with adequate capacity for the volume of hazardous materials stored within;
- An adequate quantity of drip trays and spill kits/mitigation materials will be provided to contain and recover potential releases of hazardous substances;
- Pollution spill kits will be held at strategic locations on site and site personnel will be trained in their use;
- Lines of communication in the event of an emergency will be established, documented within the Emergency Response Plan and communicated to site personnel prior to commencement of works;
- Any accidental spill / leak will be fully cleaned immediately, and if required polluted soil / sand will be excavated and removed from site. Any accidental spill / leak will be recorded;
- Hazardous effluents such as used oils will either be incinerated during construction using temporary facilities or stored and incinerated once the main incinerator is operational;
- Storage tanks and area will be maintained and inspected regularly; and,
- Records will be kept of all liquids/ tanks / containers on site.

Daily visual inspections of the surface drainage and sediment control measures and the watercourses will be undertaken by the EPC Contractor. Indicators that water pollution may have occurred include the following:

- Change in water colour;
- Change in water transparency;
- Increases in the level of silt in the water;
- Oily sheen to water surface;
- Floating detritus; or
- Scums and foams.

These inspections shall be recorded on an inspection log. In the event that such indicators are observed, an investigation will be undertaken to ascertain the likely cause and measures shall be put in place to address.

11.6.4.2 Water Supply

Water supply pipes will be appropriately identified, marked and protected. Specific mitigation measures to avoid disruption or accidentally cutting off the water supply will be specified by the EPC contractor in consultation with GVWC.

11.6.4.3 Flooding

The drainage system employed during construction will be designed to ensure that the proposed project does not increase flood risk to the surrounding area and that it manages flood risk at the site. It will be designed to control drainage of both the proposed development areas and any associated temporary laydown areas.

11.6.5 Operational Phase Mitigation

The specific mitigation measures to be implemented for the proposed project during the operational phase are detailed below.

11.6.5.1 Contamination

The proposed project is described in detail in Section 2, however, it is noted that there are limited details of the proposed project wastewater treatment methods and drainage design. All discharges will be in accordance with the Environmental, Health, and Safety Guidelines, World Bank/IFC have been applied ("the EHS Guidelines"), specifically:

- EHS Guidelines General: Environmental Wastewater and Ambient Water Quality;
- EHS Guidelines General: Environmental Water Conservation; and
- EHS Guidelines for Thermal Power Plants.

The EPC contractor shall install effluent management or treatment systems at the facility to ensure that all wastewater discharge meets the IFC EHS standards. This will include the use of appropriate runoff interceptors and oil/water separators, sewage and effluent treatment. The following specific pollution prevention measures are required to be implemented by the EPC contractor to prevent impact to water quality receptors in the area:

- There will be no direct discharge to the SLRE;
- Water use shall be minimized and waste water reused/recycled wherever practicable;
- Sanitary wastewater shall not be commingled with industrial wastewater or the storm water collection systems;
- The operator shall not dilute the industrial wastewater discharge with potable, seawater or firewater;
- Monitoring of discharges will be in accordance with IFC requirements;
- A Spill Response Plan will be implemented as part of the Emergency Response Plan which will include procedures for the handling and storage of dangerous materials and measures for implementation in the case of an accident or spillage;
- The water quality of the abstraction boreholes(s) will should be tested to ensure the suitability for drinking.

11.6.5.2 Flooding

Once more detail on the existing drainage network and the proposed design is available a detailed flood risk assessment will be carried out by the EPC contractor. The proposed project drainage design will be of appropriate capacity to deal with rain water generated during the rainy season. The design will also include additional capacity to build in resilience against effects of climate change and as regards increased incidence of heavy rainfall and extreme flood events.

11.6.6 Decommissioning Phase Mitigation

The mitigation measures during the decommissioning stage are expected to be similar to those during the construction stage. These mitigation measures are described in detail in Section 11.6.4 Mitigation during Construction.

11.7 Residual Impacts

The residual impacts associated with the proposed project after implementation of the mandatory mitigation measures during the all project phases are detailed in Tables 11.9 – 11.14

Table 11.9: Soils – Geology: Residual Impact after Mitigation Measures for Construction and Decommissioning

Attribute	Importance	Significance pre mitigation	Significance post mitigation
Construction Workers	Local	Minor	Negligible
Future site users	Local	Minor	Negligible
Surrounding land	Local	Minor	Negligible

Table 11.10: Soils – Geology: Residual Impact after Mitigation Measures for Operation

Attribute	Importance	Significance pre mitigation	Significance post mitigation
Construction Workers	Local	Minor	Negligible
Future site users	Local	Minor	Negligible
Surrounding land	Local	Minor / Moderate	Negligible

Table 11.11: Hydrogeology: Residual Impact after Mitigation Measures for Construction and Decommissioning

Attribute	Importance	Significance pre mitigation	Significance post mitigation
Boreholes in surrounding area	Local	Minor	Negligible
Onsite borehole	Local	Minor	Negligible
Municipal Water Supply – GVWC	Regional	Minor	Minor
Sierra Leone River Estuary (SLRE)	International	Minor	Minor

Wellington Stream or Creek	Regional	Minor	Negligible
Old Railway Road Stream	Distinct	Minor	Negligible

Table 11.12: Hydrogeology: Residual Impact after Mitigation Measures for Operation

Attribute	Importance	Significance pre mitigation	Significance post mitigation
Boreholes in surrounding area	Local	Minor/Moderate	Negligible
Onsite borehole	Local	Minor/Moderate	Negligible
Municipal Water Supply – GVWC	Regional	Moderate	Negligible
Sierra Leone River Estuary (SLRE)	International	Moderate	Negligible
Wellington Stream or Creek	Regional	Minor	Negligible
Old Railway Road Stream	Distinct	Negligible	Negligible

Table 11.13: Hydrology: Residual Impact after Mitigation Measures for Construction and Decommissioning

Attribute	Importance	Significance pre mitigation	Significance post mitigation
SLRE	International	Moderate	Negligible
Wellington Creek - Water Quality	Regional	Minor	Negligible
Old Railway Road Stream - Water Quality	District	Minor	Negligible
Drainage Network - Water Quality	Local	Negligible	Negligible
Commercial Fishery Resources - Water Quality	Regional	Minor	Negligible
Municipal Water Supply	Regional	Minor	Negligible
Flooding	District	Minor	Negligible

Table 11.14: Hydrology: Residual Impact after Mitigation Measures for Operation

Attribute	Importance	Significance pre mitigation	Significance post mitigation
SLRE	International	Moderate	Negligible
Wellington Creek - Water Quality	Regional	Minor	Negligible

Old Railway Road Stream - Water Quality	District	Minor	Negligible
Drainage Network - Water Quality	Local	Negligible	Negligible
Commercial Fishery Resources - Water Quality	Regional	Minor	Negligible
Municipal Water Supply	Regional	No Impact	No Impact
Flooding	District	Major	Negligible

11.8 Cumulative impacts (if relevant developments are confirmed)

Other projects within the vicinity of the proposed project (such as the Addax Petrojetty) could potentially result in cumulative impacts during the construction phase if these projects were to run concurrently. However, any new project will be subject to planning requirements and, where required, EIA to address the impacts.

CECASL will liaise with the developers of the Addax Petrojetty throughout its development and operation (as the jetty is the planned source of HFO delivery for the CECASL project). The associated ESIA has been reviewed as part of this ESIA process. The ESMP includes an action for the implementation of a Spill Response Plan as part of the Emergency Response Plan in the operational phase which will include procedures for the handling and storage of dangerous materials and measures for implementation in the case of an accident or spillage.

11.9 References

- European Commission (2006) Country Environment Profile (CEP) - Sierra Leone.
- Action Aid International (2010) Unjust waters Climate change, flooding and the protection of poor urban communities: experiences from six African cities.
- S.K Sankoh; J.A.S Redwood-Sawyerr; A.B. Karim and E. T. Ndomahina (2009) Report prepared for the waste management in Sierra Leone.
- CEC Africa (Sierra Leone) Limited (2014) CECASL HFO Project, Freetown - Project Description for Environmental and Social Impact Assessment.
- World Health Organisation (WHO) Guidelines for Drinking-water Quality, Fourth Edition.

12. Ecology

This section evaluates the ecology of the proposed project site and discusses the potential impacts in the context of the proposed project. It presents an assessment of the significance of impacts on sensitive ecological receptors and mitigation measures that will be incorporated into the scheme design.

The section is based on a desk study review of existing ecological information for the site and local area.

12.1 Relevant Legislation, Conventions and Standards

This assessment has been undertaken with reference to the following legislation;

- The National Environmental Policy, 1994.
- Environment Protection Act, 2008 (as amended).
- Fisheries Management and Development Act, 1988.

Sierra Leone is also a signatory to the following international conventions and standards that are relevant to this assessment:

- Abidjan Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the West and Central African Region.
- Convention on the Conservation of Migratory Species of Wildlife.
- Ramsar Convention on Wetlands of International Importance.
- Convention on the Trade in Endangered Species.
- African Convention on the Conservation of Nature and Natural Resources.
- Convention on Biological Diversity, as interpreted by the IFC Performance Standards on Social and Environmental Sustainability ("the IFC standards") (IFC, 2012).

The National Biodiversity Strategy Action Plan (2004-2010) (Government of Sierra Leone, 2004) is the primary document identifying conservation priorities in Sierra Leone. The plan outlines 19 priority projects, of which the following have the greatest relevance to the project area:

- Post-conflict reconstruction and management of protected areas;
- National reforestation and rehabilitation of degraded forest resources ;
- Nationwide forest inventory to restore and redefine the forest estate after the civil conflict;
- National marine biodiversity and museum for Sierra Leone;
- Assessment of the marine finfish and shellfish stocks of the inshore coastal waters of the continental shelf; and
- Studies on the biodiversity of major estuarine systems.

Additional detail on the methodology used to determine the sensitivity of ecological receptors is presented in Appendix H of this ESHIA.

12.2 Potential Impacts

12.2.1 Sensitive Receptors

12.2.1.1 Designated Sites

As a Ramsar Wetland and IBA, the Sierra Leone River Estuary and its designated habitat and bird interest features are considered to be of international value. There is ongoing degradation of interest features within the Ramsar Wetland and IBA, but the relatively intact mangroves and coastal habitats within the designated site, especially away from the Freetown area, are considered Natural habitats with respect to the IFC classification (IFC, 2012). Mangroves serve as important refugia, foraging habitat and spawning grounds for marine and freshwater fish species and may be critical for several such species. Mangroves also qualify as a highly threatened ecosystem with respect to IFC Criterion 4 (see Appendix H), with an estimated global reduction of 30-50% in aerial cover between 1980 and 2005 (Food and Agriculture Organization, 2007). In addition, mangroves may locally serve as traditional fishing grounds for local people and are also likely to provide ecosystem services through provision of timber as well as through carbon storage and sequestration.

As a designated National Park, the Western Area Peninsula National Park is considered to be of national value. The rare species within this National Park, notably white-necked rockfowl, green-tailed bristlebill, western chimpanzee, red colobus, western black-and-white colobus, sooty mangabey and Diana monkey, leopard, Jentinks duiker, black duiker and Maxwell duiker are considered of national value. The toad *Cardioglosus aureolli* and the Freetown long-fingered frog as assumed to be of value at the regional value. The National Biodiversity Strategy Action Plan includes recommendations to develop guidelines on the conservation of threatened and endangered species (Government of Sierra Leone, 2004), but strict protection of such species is not currently proposed.

Habitats

All habitats within the project site are concluded to be modified with respect to the IFC classification (IFC, 2012). They are common and widespread habitats in Western Sierra Leone and are not of conservation concern in their own right. They are not critical habitats with respect to the IFC Criteria (see Appendix H). The artisanal vegetable plots provide some Ecosystem Services to local people through the provision of food, but given their small scale, they are considered of value at the local level only.

All habitats in the wider area within 2 km of the project site are also concluded to be Modified with respect to the IFC classification. Apart from habitats within the designated sites, only the watercourses are considered to provide some value for native species of plants and animals. However, given their condition the watercourses are concluded not to be Critical habitats with respect to the IFC Criteria, and they are assigned a local value only. Urban gardens in the local area also include vegetable plots, which provide an Ecosystem Service to local people through the provision of food, but considering their small scale, they are considered of value at the local level only. Apart from those included within the designated sites, all other habitats within 2 km of the site are considered of value at the less than local level.

The degraded nature of the mangroves and costal habitats within 2 km of the project site means that they are unlikely to support species of conservation concern. Nor are they used for fishing or foraging by local people. Being designated features in the Ramsar Wetland, these habitat areas have an international value, although being so fragmented and degraded they are unlikely to significantly contribute to the integrity of the designated site. The National Biodiversity Strategy Action Plan (Government of Sierra Leone, 2004) includes recommendations to support and promote the conservation and rehabilitation of mangroves and promote policies that reduce the infrastructural development of mangroves, coastal areas and the marine environment. However, such measures are unlikely to rehabilitate habitats within 2 km of the project site, because these comprise very small and fragmented patches with little or no room for expansion. It will be more cost effective to focus efforts on less degraded and larger and more contiguous areas of mangrove and coastal habitats away from Freetown that have fewer pressures from pollution and disturbance and which provide a better potential to support the species and processes associated with high-quality mangroves.

Similarly, although areas within the National Park close to Freetown, within 2 km of the project site, are degraded and although none of the Park's species of conservation interest are likely to occur within this distance, they have a national value by default. The habitats within the 2 km distance might act as a buffer between the high-density forest habitat in the centre of the National Park and surrounding land uses, notably the urban sprawl in the north, although they are unlikely to significantly contribute to the integrity of the National Park.

Fauna

The species recorded on the project site and in the local area are mainly common and widespread species of little conservation interest. The only exceptions include Western reef heron, which is an assemblage species in Sierra Leone River Estuary Ramsar Wetland and IBA, and hooded vulture which IUCN considers to be endangered. Neither species was reported to be breeding in the local area, but they may occasionally forage on or near the site. In the absence of abundance data for the two species in the local area, they are each assigned a district value.

The two butterflies listed in Section 5.5.3 are endemic to West Africa but are not species of conservation concern.

Nile monitor is listed on CITES Appendix II, which lists species that are not necessarily threatened with extinction at the present time but may become so unless trade is closely controlled. The five turtle species are listed on CITES Appendix I and are, as such, threatened with extinction. They do not appear to breed on local beaches, but could occur in local waters. Taking a conservative approach in the absence of abundance data for the six reptile species in the local area, they are each assigned a district value.

12.2.2 Receptors taken forward for assessment

This section characterises and evaluates the significance of potential impacts of the scheme on valued ecological receptors, in the absence of mitigation. The following applies to all the ecological receptors brought forward to the detailed ecological impact assessment stage;

- Their value is assessed as being important at a district level or higher (and/or they are subject to some form of legal protection); and
- They are potentially vulnerable to significant impacts from the proposed development.

Nile monitor is usually found in woodland, savannah, scrub, evergreen thickets and swamps near rivers and lakes. As such they are unlikely to occur within the project site or in nearby estuarine habitats, where impacts from the development may be possible. Detailed assessment is therefore not considered necessary for this species.

Based on the above and consideration of available baseline information, ecological receptors subject to detailed assessment include the following:

Designated sites:

- Sierra Leone River Estuary Ramsar Wetland and IBA
- Western Area Peninsula National Park

Avifauna:

- Western reef heron (considered with the Ramsar Wetland and IBA above)

- Hooded vulture

Marine turtles:

- Olive ridley
- Loggerhead
- Leatherback
- Green sea turtle
- Hawksbill

12.3 Construction Phase Impacts

The brownfield site and pipeline route will be cleared as part of the development works, and only minor losses of vegetation will occur within the site and potentially along new sections of the pipeline. During this process and the subsequent construction of the facility, habitats and species adjacent to the site have the potential to be disturbed and displaced.

Sierra Leone River Estuary Ramsar Wetland and IBA: Sierra Leone River Estuary is located c.400 m north of the project site. The pipeline route will follow a road within the NP Facility until it turns northwards across the coastal zone to the Addax jetty. There will be no direct loss of designated habitat within the Ramsar Wetland / IBA. Confidence in this prediction is considered near-certain.

Indirect construction impacts on the estuary are possible, for example from surface runoff and accidental spills. Spillages may locally destroy conditions for shoreline organisms and species feeding on those. Given the existing level of degradation, including relatively high sedimentation and pollution levels, the magnitude of this effect is likely to be Low, and it is uncertain if construction impacts would significantly impact on the local habitats within the Ramsar Wetland and IBA. Nevertheless, taking a precautionary approach, in the absence of any mitigation, the magnitude of the effect is considered Medium, and the significance of the impacts is also considered Medium. Confidence in this prediction is probable only, owing to the precautionary approach being taken.

Disturbance impacts from construction machinery and people have the potential to result in temporary displacement of any bird species roosting or feeding in the local area, although because construction at the project site and HFO pipeline will be set back from the coast, this is likely to occur only when working on or adjacent to the jetty. However, with the exception of Western reef heron, the local area is unlikely to consistently support qualifying bird species, in parts owing to the existing high levels of disturbance from industry and maritime traffic. The magnitude of construction disturbance on qualifying bird species is therefore concluded to be Low, and the significance of the effect is concluded to be Minor. Confidence in this prediction is considered near-certain.

Western Area Peninsula National Park: No pathway for significant impacts on the National Park during construction has been identified. Confidence in this prediction is considered near-certain.

Hooded vulture: Hooded vulture is unlikely to breed on the project site or in adjacent areas but may occasionally enter the area to roost or forage. Individual birds are likely to avoid any construction impacts, notably visual or noise disturbance, by simply moving out of the zone of impact. The magnitude of effect is therefore concluded to be Low, and the significance of the effect is concluded to be Minor. Confidence in this prediction is considered certain/near certain.

Marine turtles: Disturbance impacts from construction machinery and people have the potential to result in temporary displacement of any marine turtle present in the open water or on the coast in the local area, although because construction at the project site and HFO pipeline will be set back from the coast, impacts are only potentially possible during works adjacent to the jetty. Impacted animals could suffer reduced fitness as a result. However, given the existing high levels of disturbance from industry and maritime traffic, the degraded nature of local habitats and the relatively recent site disturbance associated with construction of the jetty itself, marine turtles are unlikely to be present near the zone of impact in any significant numbers. Any individuals present in the zone of impact are likely to simply move away from the zone, and the magnitude of the effect is concluded to be Low. The significance of the effect is therefore concluded to be Minor. Confidence in this prediction is considered near-certain.

Indirect construction impacts from accidental spills could impact marine turtles, although because turtles do not appear to be breeding on local beaches, the impact would be on individuals swimming in the water. Accidental hydrocarbon spills into the estuary may have a significant effect on marine turtles, both through chemical exposure from contaminated food but also from swimming in the fuel itself (Vargo et al., 1986). Oil on a turtle's skin may result in skin and eye problems and increased potential for infection, and fumes inhaled when a turtle comes to the surface to breathe may also result in irritation of the turtle’s eyes or mouth and cause internal damage, such as irritation to the respiratory system, injured tissues or pneumonia. Owing to the small disturbance zone and the likely very limited extent of any spillage, the magnitude of the effect is concluded to be Low, and the effect of spillages on the five turtle species is therefore concluded to be Minor. Confidence in this prediction is considered near-certain

12.4 Operational Phase Impacts

During operation the most likely potential impacts include accidental HFO spills on the estuary as well as air pollution effects on habitats and species.

Sierra Leone River Estuary Ramsar Wetland and IBA: The main potential for significant impacts on the Ramsar Wetland and IBA during operation of the plant relates to accidental, large fuel spillages into the estuary. Spillages may destroy conditions for shoreline organisms and bird species feeding on those, but they may also affect birds directly (UNEP, no date). When oil sticks to feathers, it causes them to mat and separate, impairing waterproofing and exposing the animal's skin to extremes in temperature. Birds may try to remove the oil by preening, which may result in the birds ingesting the oil, which can result in severe damage to internal organs. The preening may override other behaviours, such as evading predators and feeding, thereby making birds more vulnerable. In the absence of any mitigation, operational impacts from spillages are likely to be Low given the low likelihood of qualifying species being present near the jetty in significant numbers. However, taking a precautionary approach the significance of the effect is considered Medium. Confidence in this prediction is considered probable only, owing to the precautionary approach taken.

Given the existing high levels of activity in the area, and the fact that the project site itself is set back from the coast, disturbance impacts on qualifying species from machinery, ships and people are likely to be Low, and the significance of the effect is considered Minor. Confidence in this prediction is considered near-certain.

As described in Section 8: Air Quality, for significant air deposition impacts on mangrove habitats to occur, process contributions must exceed 25% of the applicable air quality guidelines, but this will not be the case. For example, the maximum predicted NOx contribution at AQ location E3-9 (which is located between Bunce River and Tumbu) is 2.97 ug/m^3, which equates to c.10% of the WHO Air quality guidelines (30 ug/m^3). Thresholds will not be exceeded when combined with existing concentrations. With regard to SO_2 concentrations, the maximum annual mean concentration is 2.38 ug/m^3 which is approximately 12% of the WHO air quality guideline value of 20 ug/m^3, and guideline thresholds will not be exceeded when combined with existing concentrations. The magnitude of effects is therefore predicted to be Low and the significance of the effect concluded to be Minor. Confidence in this prediction is considered near-certain.

The highest nitrogen deposition is 0.6 kgN/ha/yr, again at location E3-9. This is just 3% of the critical load for mangrove habitat and is not a significant increase. The highest acid deposition from the power station will be 0.6 keq/ha/yr, also at receptor E3-9. This corresponds to 40% of the critical load value calculated for mangrove habitat. Existing deposition rates for nitrogen and sulphur are not known, and it is therefore not known if the process contribution will lead to thresholds being exceeded. However, it is possible that the threshold itself is set too low: Although there may be a deficiency of data on the topic, acid deposition does not appear to constitute a significant threat on this habitat (e.g. Maiti and Chowdhury, 2013). The tidal exchange means that mudflats and foreshore habitats are unlikely to suffer significant impacts from nitrogen or acid deposition. The magnitude of effects is therefore predicted to be Low and the significance of the effects is concluded to be Minor. Confidence in these predictions is considered probable only, owing to uncertainty over background deposition rates.

Western Area Peninsula National Park: As described in Section 8, Air Quality, the predicted acid deposition within the National Park (at receptors E6-1, E6-2, E6-3 and E6-4) ranges from 5.5% to 13.9% of the Critical Load. Receptor E6.3 is the southernmost of the four receptors and is located near the actual rainforest boundary within the National Park, and it is this receptor which has the lowest predicted process contribution of 5.5% of the Critical Load (corresponding to a Process Contribution of 0.06 keq/ha/yr). Although no data are available on background deposition rates, owing to the distance of the rainforest to industrial areas guideline thresholds are unlikely to be exceeded even when combined with existing concentrations. As such, the magnitude of effects is predicted to be Low and the significance of the effect concluded to be Minor. Confidence in this prediction is considered probable, owing to the lack of background deposition rates.

The predicted Nitrogen deposition within the National Park (at receptors E6-1, E6-2, E6-3 and E6-4) ranges from 1.01% to 1.99% of the Critical Load. As before receptor E6.3 has the lowest predicted process contribution of 1.01% of the Critical Load (corresponding to a Process Contribution of 0.1 kqN/ha/yr). Although no data are available on background deposition rates, owing to the distance of the rainforest to industrial areas, guideline thresholds are unlikely to be exceeded even when combined with existing concentrations. As such, the magnitude of effects is predicted to be Low and the significance of the effect concluded to be Minor. Confidence in this prediction is considered probable, owing to the lack of background deposition rates.

Hooded vulture: During operation, there is a potential for impacts on hooded vultures from noise and visual disturbance. However, the magnitude of this effect is likely to be Low, because any vultures currently present will be at least partially habituated to disturbance impacts from existing developments in the local area. As such, the significance of the effect is concluded to be Minor. Confidence in this prediction is considered near-certain.

Marine turtles: Disturbance impacts from ship traffic and jetty operations have the potential to result in displacement of any marine turtles present in the open water or on the coast in the local area. However, given the existing high levels of industrial disturbance in the area, and the degraded nature of local habitats, marine turtles will be unlikely to be present near the jetty and the magnitude of the effect is likely to be Low. The significance of the effect is therefore concluded to be Minor. Confidence in this prediction is considered near-certain.

However, as described for potential spills during the construction phase, accidental fuel spills into the estuary may have a significant effect on marine turtles, both through chemical exposure from contaminated food but also from swimming in the fuel itself. Oil on a turtle's skin may result in skin and eye problems and increased potential for infection, and fumes inhaled when a turtle comes to the surface to breathe may also result in irritation of the turtle’s eyes or mouth and cause internal damage, such as irritation to the respiratory system, injured tissues or pneumonia. Larger spills pose an immediate problem for marine turtles, but continuous exposure over time may also weaken their overall health. The effect on marine turtle numbers could last several years, and the magnitude of the effect is therefore concluded to be Medium. In the absence of any mitigation, from the significance of the effect of spillages on the five turtle species is concluded to be Medium. Confidence in this prediction is considered near-certain.

12.4.1 Decommissioning phase impacts

The power plant will have an operational life of at least 25 years, after which it will be decommissioned and the site reinstated as agreed with the relevant authorities. It is difficult to predict impacts which would arise from decommissioning because of the length of the operational period and the likelihood for changes to have occurred to habitats and species populations during this time. As such, the confidence in all predictions is considered to be probable or uncertain.

The decommissioning activities are likely to be similar to the construction phase. In the absence of mitigation, decommissioning could cause short-term impacts through sedimentation, spillages and disturbance, similar to those predicted during the construction period.

Negative impacts for those habitats and species present at the time of decommissioning are likely to be relatively short-term and relate mainly to decommissioning of the jetty and HFO pipeline. Because the impacts are predicted to be similar to those predicted during construction albeit without any habitat loss and because they will occur on a busy operational site, they are not anticipated to be significant.

An assessment will be undertaken prior to decommissioning to inform an up-to-date evaluation of potential impacts on valued ecological receptors, and mitigation measures will be implemented as appropriate.

12.4.2 Summary of impacts

Table 12.1 provides a summary of the predicted effects during each of the construction, operation and decommission phases, respectively, and in the absence of any mitigation.

Table 12.1: Summary of Predicted Effects in the Absence of Any Mitigation

Topic	Importance	Source of Effect	Effect Summary Description
Sierra Leone River Estuary Ramsar Wetland and IBA	International	<u>Construction</u>	
		Potential increased siltation, release of suspended solids, and spillage of contaminants in general area during construction works	Reduced abundance of organisms at the bottom of food chain as food base for qualifying species
		Disturbance from construction machinery and people	Displacement of qualifying species resulting in poor fitness
		<u>Operation</u>	
		Large fuel spillage	Reduced abundance of organisms at the bottom of food chain as food base for qualifying species Direct toxicity, poor feeding and increased predation
		Disturbance from construction machinery and people	Displacement of qualifying species resulting in poor fitness
		Air deposition	Deposition leading to dieback or changed habitat structure
		<u>Decommissioning</u>	
		N/A	N/A
Western Area Peninsula National Park	National	<u>Construction</u>	
		N/A	N/A
		<u>Operation</u> <u>N/A</u>	N/A
		<u>Decommissioning</u>	
		N/A	N/A
Hooded vulture	District	<u>Construction</u>	
		Disturbance from construction machinery and people	Displacement resulting in poor fitness
		<u>Operation</u>	
		Disturbance from machinery and people	Displacement resulting in poor fitness
		<u>Decommissioning</u>	

		N/A	N/A	N
Marine turtles	Local	Construction		
		Disturbance from construction machinery and people	Displacement resulting in poor fitness	L
		Potential hydrocarbon spillage during construction works	Direct toxicity	L
		Operation		
		Disturbance from machinery and people	Displacement resulting in poor fitness	L

12.5 Mitigation

This section describes the measures which will be implemented to reduce significant impacts on sensitive ecological receptors as part of the development.

The measures described will be collated in the ESMP which provides the management framework needed to implement the proposed strategies. The draft ESMP is presented in Volume II of this submission. The ESMP will describe actions to be taken to eliminate or reduce key identified impacts related to ecological receptors to acceptable levels, as well as considering other biophysical, socioeconomic and health issues. It will also stipulate monitoring regimes required to track these. The ESMP will be a live document that will last the lifetime of the project and will be updated regularly as the project proceeds.

12.5.1 Construction Phase

The following mitigation measures will be employed during the construction phase:

- Minimising direct impacts on intertidal and coastal habitats (in the event that any works are required in such areas):
    - Use temporary fencing to prevent inadvertent damage to mudflat, mangrove and coastal habitats adjacent to the construction zone;
    - Ensure the way-leave area width is at its minimum for least removal of vegetation; and,
    - Site temporary works areas away from coastal habitats where practicable;
- Minimising indirect habitat impacts:
    - Minimise potential for pollutants and surface water runoff to migrate offsite through use of silt traps or similar measures and adherence GIIP regarding pollution prevention guidelines;
    - Carry out tool-box talk to educate site staff about the sensitivity of coastal and intertidal habitats; and
    - Re-plant areas left undeveloped with native vegetation to prevent the incursion of opportunistic invasive species;
- Minimising impacts on species:
    - Adherence to pollution prevention guidelines;
    - Carry out tool-box talk to educate site staff about the sensitivity of threatened species and their protection; and
    - Use floating barriers to contain any spillages and deter species from moving into work zone;

12.5.2 Operation phase

The following mitigation measures will be employed during the operation phase:

- Treatment of discharge to IFC Water Quality Discharge Standards prior to release to remove pollutants.
- Fuel spillage mitigation.

12.5.3 Decommissioning Phase

The need for mitigation relating to decommissioning impacts will be determined nearer the time of decommissioning, in light of the updated assessment. However, impacts tend to be similar to the construction phase due to the similar nature of decommissioning and construction activities.

12.6 Cumulative Impacts

PETROJETTY (CEMMATS Group Ltd, 2013) plans to construct a new jetty close to the existing jetty at Kissy, north of the project site, which dates from 1979 and is in a poor condition. The new jetty will allow the berthing of tankers of up 55,000 tons water displacement.

The potential for significant in-combination impacts from the two developments relates to disturbance of birds and spillages in the estuarine environment, but major construction works in the coastal zone will not be overlapping, as the basic jetty structure must be in place before the HFO pipeline can be constructed.

Disturbance impacts from construction machinery and people have the potential to result in temporary displacement of any bird species roosting or feeding in the local area, although because construction at the project site and HFO pipeline will be set back from the coast, and because HFO-related work on the jetty will occur only once major construction works on the jetty are complete, this is unlikely to be significant. In addition, with the exception of Western reef heron, the local area is unlikely to consistently support qualifying Ramsar Wetland / IBA bird species, in parts owing to the existing high levels of disturbance from industry and maritime traffic. Cumulative disturbance impacts are therefore unlikely to be significant.

Spillages may locally destroy conditions for shoreline organisms and the species feeding on those and, as described earlier, spillages can directly affect marine turtles and Western reef heron. However, both developments include a range of mitigation measures to contain spillages. These include an Emergency Response Plan, which will be prepared to deal with spillages, and spill containment and clean-up materials will be available on permanent standby at the jetty. Waste disposal plans will also be in place relating to the safe disposal of recovered oil and used clean-up materials. Implementation of these measures makes it unlikely that spillages will have significant impacts on birds and turtles in the estuary.

12.7 Residual Impacts / Conclusions

Provided that the mitigation measures described in the previous section are implemented, all residual negative impacts on valued ecological features will not be significant. Confidence in this prediction is considered certain/near-certain.

12.8 References

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13. Waste

This Section presents an evaluation of the potential impacts resulting from the generation of wastes, their storage, treatment and/or or disposal and the associated management activities during the lifetime of the CEC HFO Power Plant.

The WBG EHS Guidelines on Waste Management define waste as "any solid, liquid or contained gaseous material that is being discarded by disposal, recycling, burning or incineration. It can be by-product of a manufacturing process or an obsolete commercial product that can no longer be used for intended purpose and requires disposal"

Waste management is recognised as in integral and critical component of the ESHIA. A meeting was held with the sole body responsible for all waste handling in Freetown, Masada Waste Management Company ('Masada') as part of the baseline survey, to determine the status of treatment technologies and waste disposal options in Sierra Leone.

Information relating to expected waste generation has been used to assess potential environmental impacts resulting from waste generation, storage, treatment and disposal during the construction and operation phases of the proposed development.

13.1 Relevant Legislation, Convention and Standards

International Finance Corporation Guidelines for Waste Facilities: The operation of the onsite incinerator will follow the IFC 2007 Environmental, Health and Safety guidelines for waste management facilities, with specific regard to the guidelines for hazardous waste incineration

Waste management facility guidelines include recommended measures to prevent, minimize and control air emissions, water effluents and solid waste. The EPC Contractor and Operator will implement these guidelines during the construction and management of the onsite incinerator.

Environmental, Health, and Safety (EHS) Guidelines: Environmental Waste Management: The proposed development will also follow the WBG EHS Guidelines for waste management, which apply to the management of non-hazardous and hazardous waste, The Guidelines outline recommendations on the development of a waste management system that addresses issues linked to waste minimisation, generation, transport, disposal and monitoring.

IFC Performance Standard 3, Resource Efficiency and Pollution Prevention: The proposed development will meet the relevant provisions of this standard with particular regard to paragraph 12, wastes.

13.2 Potential Impacts

It was identified during the inception mission that Sierra Leone does not have appropriate waste processing facilities to receive sludge waste from treatment of HFO prior to combustion. The design has since been altered to include an on-site incinerator facility to combust the residues, with ashes disposed of at Central Dump landfill. Chemical constituents of this ash waste will be confirmed, but will likely contain salts of Sodium, Vanadium, Magnesium, Silicon etc. Operations of the incinerator will be infrequent and intermittent, and are likely to occur once or twice a week. Emissions from the incinerator are considered in the air quality impact assessment.

Two distinct phases are envisaged for waste management, the first encompassing the initial construction activities, and secondly, the operational phase of proposed development.

13.2.1 Waste Streams – Construction

A major component of construction wastes will be the generation of soil arisings through excavation, other solid wastes generated in construction include:

- Building rubble;
- General construction waste, e.g. cement bags and waste concrete.
- Plastics.
- Electrical cabling.
- Scrap metals (mixed metals) including spent welding rods.
- Empty chemical containers.
- Packaging materials of cardboard and plastic.
- Fibreglass.
- Spilled oils and waste oils.
- Spilled oil clean-up materials.
- Paint.
- Waste wood.
- Paper.
- Domestic waste.
- Sewage effluent.
- Grass/ vegetation from stripping.

Due to the scale of the project it is likely that a significant amount of waste will be generated during the site preparation and construction phase, some of which is likely to be classified as hazardous. At this stage, it is not possible to provide accurate figures related to the quantities of waste generated as part of the construction phase although concrete wastage can amount to 5-10% of the total used.

13.2.2 Waste Streams – Operation

Once operational, there will be few significant sources of solid waste generated and the additional burden placed on the existing waste management infrastructure in the project area should be low.

- Domestic and commercial waste (cardboard, paper, pallets, packaging material from spares, waste printer cartridges, food wastes, dirty oil etc.);
- Wastes produced during maintenance, including:
    - Sludge removed from oil separators;
    - Scrap metals from maintenance; and,
    - Miscellaneous wastes (e.g. air filters).
- Paper and plastic packaging materials.

The principal solid wastes will be sludge from the treatment of HFO and the water/effluent treatment plant. HFO sludge waste will be burned in a small on-site incinerator, with the resulting ash disposed of in the central dump.

A very small volume of items which cannot be incinerated (e.g. batteries) will need to be stored and appropriate disposal determined as part of the Waste Management Plan.

Table 13.1 below provides a list of the expected hazardous waste.

Table 13.1: Hazardous Waste Streams

Project Phase	Hazardous Waste
Construction	Excavated materials which may contain heavy metals, hydrocarbons / other contaminants.
Construction and decommissioning	Scrap metals
Construction, operation and decommissioning	Empty chemical containers
Construction and operation	Paints and solvents associated with construction and maintenance activities.
Construction and decommissioning	Waste fibreglass
Operation	Spent water treatment filters/sludge and medical waste
Construction, operation and decommissioning	Land based spilled treated and untreated oil
Construction, operation and decommissioning	Waste oil clean up materials
Construction, operation and decommissioning	Chemicals and greases
Construction, operation and decommissioning	Batteries

13.2.3 Assessment of potential impacts

The generation of solid wastes and potentially improper and/or indiscriminate disposal of solid waste in and around the project facilities are potentially adverse effects associated with the development. Likely sensitive receptors are considered to be:

- Uncontaminated surface and near surface soils;
- Controlled waters – surface water and groundwater;
- Ecological receptors; and
- Human receptors – groundworkers, site workers and nearby communities.

The methodology adopted for assessing the significance of effects is presented in Section 6 of this ESHIA.

The impacts from the management of inert wastes, should they occur, would be at a local level i.e. within 1 km of the project site. However, wider district or regional impacts could occur if the waste removed from the site for disposal by third parties is not disposed of appropriately by the waste contractors. For hazardous wastes it is possible that arrangements will need to be made to transport wastes further afield, and even possibly overseas dependent on the availability of suitable disposal contractors. As such the sensitivity of the site and surrounding areas with respect to land and water quality is considered to be of "district" geographical context (see Section 6 for geographical context definitions).

The potential impacts to these receptors from wastes during the construction and operation phase and the management methods and mitigation measures in place to reduce the significance of potential impacts are outlined below.

13.3 Construction and Decommissioning Phase Impacts

The following impacts have been identified for onshore and offshore components:

- Contamination of soils by direct exposure to contaminated wastes and or migration of contaminants in surface runoff or migration of contaminants such as oils/ hydrocarbons;
- Contamination of groundwaters through leaching of contaminants from waste materials which are not properly contained or illegally dumped;
- Contamination of surface waters through improper storage and disposal of wastes, either directly or by migration of contaminants in groundwaters;
- Harm to ecological receptors through improper waste disposal / illegal dumping of wastes in ecologically sensitive areas;
- Harm to ecological receptors through migration of contaminants leached from poorly managed waste materials and pollution of waterbodies;
- Human health impacts from direct contact with contaminated waste materials generated during excavation;
- Human health impacts through contamination of surface waters and ground waters (drinking water) with implications for fisheries and human consumption;
- Human health impacts from fugitive dusts generated from stockpiled waste materials;
- Human health impacts from fugitive dusts caused by transportation of waste materials;
- Visual impact from improper waste disposal/ illegal dumping of wastes;
- Impacts to sensitive receptors following accidental release / spillages of materials used during the construction process;
- Human health impacts from odours generated by waste materials or from vermin infestation;
- Human health impacts through inappropriate re-use of waste materials; and
- Unnecessary disposal of materials and use of natural resources.

Without appropriate waste storage options there is a chance that environmental contamination could occur. Furthermore, given that the nature of some of the wastes that may could be potentially hazardous, then the receiving environment would likely suffer lasting effects should solid waste of a hazardous nature be discharged.

The magnitude of any effect that construction of the development may have on land or water quality or the effect that existing land or water quality may have on human health or the environment is assessed as medium. The significance of the effect from construction activities is therefore assessed as minor without mitigation.

13.4 Operational Phase Impacts

The following impacts previously identified for the construction phase apply to the operational phase of the project:

- Contamination of soils, groundwaters and surface waters following improper storage and disposal of wastes;
- Harm to ecological receptors through improper waste disposal / illegal dumping of wastes in ecologically sensitive areas or through migration of contaminants leached from poorly managed waste materials and pollution of waterbodies;
- Human health impacts following improper storage and disposal or re-use of wastes through contamination of surface waters and ground waters (drinking water) with implications for fisheries and human consumption;
- Impacts to sensitive receptors following accidental release / spillages of waste materials used during operation;
- Human health impacts from odours generated by waste materials or from vermin infestation; and
- Unnecessary disposal of materials and use of natural resources.

As discussed above in construction without appropriate waste storage options there is a chance that environmental contamination could occur. This would represent a breach of environmental legislation on the basis that inappropriate waste disposal was taking place. Furthermore, given that the nature of some of the wastes that may could be potentially hazardous, then the receiving environment would likely suffer lasting effects should solid waste of a hazardous nature be discharged.

The magnitude of any effect that construction of the project may have on land or water quality or the effect that existing land or water quality may have on human health or the environment is assessed as medium. The significance of effect of on and offshore from construction activities is therefore assessed as minor without mitigation.

13.4.1 Decommissioning

When the project is eventually decommissioned, there will be potential for generation of significant quantities of hazardous and non-hazardous materials.

Once the facilities are completely disconnected, and all hazardous materials removed, it will be handed over to a competent contractor (or contractors) to complete the dismantling and demolition work.

It is probable that most of the plant and equipment will be at the end of its useful operating life and will be obsolescent or obsolete and unsuitable for further use. It will therefore need to be dismantled for recycling, where it is economic to do so. Unsalvageable material will be disposed of at a licensed landfill. Any remaining aqueous effluents would be disposed of in accordance with the normal operating licence or as agreed with the regulatory authorities.

Site buildings and structures would be removed to permit the future use of the site. Soils would be remediated to the agreement of the EPA-SL.

Decommissioning will take account of the environmental legislation and waste disposal requirements. Materials will be re-used or recycled where practical. A Decommissioning Plan will be developed in advance of the commencement of the decommissioning work and contain measures for disposal and removal of materials from the facilities.

The operator would develop a decommissioning plan and the works would be undertaken in accordance with an ESMP, which would cover safety and environmental issues and would be agreed with the relevant authorities not less than 12 months prior to commencement of decommissioning.

The first step of decommissioning will be to make the plant safe for work in accordance with relevant safety procedures. Stored materials would be sold where possible or disposed of offsite by a licensed contractor. Storage tanks and pipes would be emptied and cleaned.

The magnitude of any effect that the decommissioning of the development may have is assessed as low. The significance of effect of the decommissioning of the plant is therefore assessed as negligible/minor without mitigation.

13.5 Cumulative Impacts Assessment

The operation of the HFO Power Plant will add to the loading on district waste disposal facilities which may already be unsuitable to accept certain types of waste. There is a risk that the existing facilities will not be able to cope with the quantities and types of wastes that are being produced. An audit of the waste disposal facilities is required to be undertaken by the EPC Contractor and project operator prior to use of the facilities to ensure they are appropriate for use.

Additional shipping will also increase the potential for waste generation and disposal facilities onshore.

The magnitude of any cumulative effects that the construction and operation of the development may have on land or water quality is assessed as high. This assessment is conservative and has been made considering the known lack of disposal facilities for wastes and the problems faced by developing countries in appropriate waste management. The cumulative significance of effect of the development is therefore assessed as medium without mitigation.

13.6 Waste Management and Mitigation

The potential impacts from as a result of the generation and disposal of waste at the site have been recognised as a potential impact if not adequately addressed from the outset. This section outlines the mitigation measures proposed to be employed at the site and represent best practice.

13.6.1 Waste disposal

Where disposal of wastes is required for construction, operation and decommissioning phases, this will be undertaken using a suitable waste contractor. All contractors and waste disposal facilities will be audited by the project prior to use.

According to the waste hierarchy principle, the primary objective for waste management should be the reduction of the amount of waste generated through the prudent and efficient use of raw materials. Where waste generation is unavoidable, there is a need to ensure that waste storage on site and final disposal is suitable for the types and quantities of wastes being generated.

The following principal options for the control of wastes generated from sites have been identified:

- Application of the waste hierarchy (reduce, reuse, recycle and dispose);

- Disposal of waste materials;
- Storage facilities for waste materials;
- Control of non-hazardous and hazardous wastes; and
- Reduce the risk of accidental spillage of waste materials.

The application of each of these for the project is discussed below.

Waste Hierarchy and disposal of wastes: Wastes will be suitably managed with the implementation of the Waste Management Plan (WMP) and standard mitigation options (such as hierarchy of reuse, recycling, and disposal).

Where possible, any waste soils at the site generated during the installation of the plant equipment (pile arisings and excavated materials) will be re-used on site. Where this is not possible (e.g. because of contamination or because they are geotechnically unsuitable) contamination will be neutralised utilising the services of suitable waste contractors and / or they will disposed to a suitable disposal site.

Waste disposal contractors and waste disposal sites are to be audited to ensure they meet the required national regulatory, EPA-SL and international IFC standards.

Storage: Prior to disposal the wastes generated may need to be stored on site. Provisions will be made to store wastes within designated areas located on hard surfaces to prevent infiltration to ground and covers will be provided where necessary. Suitable storage containers for wastes will be used where appropriate.

For arisings generated through excavation work, these will be placed on an impermeable membrane which also covers the spoil heap to prevent rain washing out contaminants. Rainwater collection bunds and trenches around the spoil heaps should be used as necessary.

Adequate containment for fuels and oils used in construction, including the use of secondary containment systems (for example bunds and drip trays) and provision of drainage trenches where necessary will be used to prevent pollution entering clean surface soil, water and groundwater.

All dry materials will be stored to minimise dust and wastage. Materials will be stored in containers where possible and all bagged materials will be stored on pallets and covered. Cements will be stored on original packaging pallets and within enclosed storage compounds where possible. If outside storage is required cement will be stored off the ground on pallets and covered with tarpaulin. No polluting materials will be stored on wetland areas or in the vicinity of any watercourses.

Control of hazardous and non-hazardous waste: Hazardous wastes may be generated through the disturbance and excavation of contaminated land and by use of hazardous materials in construction.

In order to identify potential hazardous waste and prevent pollution of clean soil, surface water and / or groundwater staff will be trained in identification of potential contamination (e.g. discoloured soils, odours etc.). If contamination is suspected the following measures will be implemented:

- Works will be stopped and the area covered as far as possible;
- Any contaminated spoil waste will be covered and stored in an impermeable, bunded area, away from drains and watercourses;
- Contaminated material will be segregated from inert material to avoid cross contamination; and

- Materials will be tested and disposed of as hazardous waste if appropriate via suitable waste disposal contractors. For hazardous wastes it is possible that arrangements will need to be made to transport wastes further afield, and even possibly overseas dependent on the availability of suitable disposal contractors.

Hazardous wastes generated from materials used in construction will be stored separately from inert wastes and sent for disposal using an appropriate disposal contractor. Workers will be trained in the handling of hazardous wastes and appropriate PPE (e.g. gloves, safety glasses etc.) will be provided where necessary.

Given the use of appropriate management and mitigation measures for construction wastes, there will be no significant impacts from wastes during the construction phase. There will be residual impact will be from use of landfill and natural resources but this will be minimised as far as possible by reduction of wastes and reuse of inert wastes where possible.

13.6.2 Solid Wastes Management in Operation

The management and mitigation measures stated for the construction phase also apply for wastes generated during operation. Less waste will be generated throughout the operation of the facility. Some of this waste will include hazardous waste sludge which cannot currently be processed / disposed of within Sierra Leone and therefore an incinerator will t form part of the design. Careful management of the incinerator operation will be required to ensure the correct burn temperatures are maintained to prevent production of harmful emissions.

Detailed waste management procedures will be developed for the operational phase in accordance with the requirements of the Waste and Environmental Management Plans and the ESMP. An Environmental Control Officer / Manager (title to be confirmed) will be appointed to ensure the management systems are implemented correctly.

As for the construction phase the waste hierarchy will be applied as far as practicable to reduce, reuse and recycle in preference to disposal. Following segregation, inert wastes reused as far as possible.

Provisions will be made for segregation of waste materials on site. For general wastes receptacles will be provided for different waste streams (e.g. for food wastes, plastics, metals etc.). The receptacles will be clearly marked and fit to hold the type of waste they will contain. There will be frequent emptying of waste receptacles and transfer to appropriate storage facilities on site and/ or transfer and disposal by suitable waste disposal contractors.

Waste storage areas will be suitably located on hard surfacing and covered where appropriate to ensure containment of wastes. Containers will be provided for storage of wastes where appropriate. There will be special provisions for the storage of any hazardous wastes and these will be segregated from inert wastes.

All storage areas will be regularly emptied and periodically cleaned and disinfected.

Staff will be fully trained in the handling and suitable disposal of waste streams and provided with PPE where appropriate.

The development of a detailed waste management plan for operations and implementation of the required mitigation measures will ensure that the impacts from waste are minimised. The main impact will be from use of landfill resources and this will be minimised as far as possible by reduction of wastes and reuse of inert wastes where possible. The WMP will include information requirements for the recording of waste and waste disposal activities.

13.6.3 Accidental releases

Accidental release / spillages may arise through activities during both the operational and construction phase. In the event of an accidental release, measures are in place to contain wastes to prevent direct discharge to sewer outfall. Measures will be in place to contain these wastes and ensure they are appropriately treated and disposed. Measures will ensure there are no inappropriate discharges of wastes to sea

13.7 Residual Impacts

Following implementation of the mitigation measures identified above, the magnitude of any effect that the construction and operation of the development may have on land or water quality is assessed as low. The significance of effect is therefore assessed as negligible with the implementation of appropriate mitigation measures.

13.8 Conclusions

Environmental effects are associated with the generation of solid waste and potentially improper and/or indiscriminate disposal of solid waste in and around the project site and the marine environment with implications for subsequent land contamination, visual impact and public health issues. Mitigation measures to reduce the occurrence of these effects included appropriate use of the waste hierarchy (reuse, recycling, and disposal), adequate provisions for storage and segregation of wastes and appointment of approved waste contractors for removal and disposal of wastes to an approved facility. More detailed waste management procedures will be developed prior to operation and the EPC construction contractor will implement a WMP for the construction phase.

A residual impact is inevitable given that waste will be generated throughout the lifespan of the project, however the implementation of recommended mitigation measures will ensure the significance of this effect is reduced.

13.9 References

- WBG (2007) Environmental, Health, and Safety Guidelines for Waste Management Facilities
- WBG (2007) Environmental, Health, and Safety (EHS) Guidelines GENERAL EHS GUIDELINES: ENVIRONMENTAL WASTE MANAGEMENT
- IFC (2012) Performance Standard 3 Resource Efficiency and Pollution Prevention

14. Traffic and Transport

This section of the report outlines the existing traffic and transport, and access-related conditions in the vicinity of the proposed development. The likely significant effects of the proposed development are also identified for the construction and operational phases, followed by any necessary mitigation measures required to prevent, reduce or offset potential effects. Finally, the significance of the likely residual effects of the proposed development are described taking into account the mitigation measures.

14.1 Relevant Legislation, Convention and Standards

The Ministry of Transport and Aviation has the mandate of ensuring safe and reliable transport systems in Sierra Leone. This mandate covers all the modes of transport including road, air, and sea. Their vision statement reads, "to have a modern and efficient transportation system that can support the development of Sierra Leone."

Over the years specific agencies have been set up to manage various modes of transport, including the Sierra Leone Airport Authority, Sierra Leone Maritime Administration, and the Sierra Leone Road Transport Corporation.

The Ministry maintains oversight over policy development and implementation, and is responsible for ensuring efficient, sustainable and affordable transportation networks to facilitate economic development.

The key policy directives for the key modes of transportation include:

- ensuring physical access to services and revenue-generating opportunities;
- lowering transport costs to ensure affordability of transport;
- increasing efficiency in the delivery of transport services;
- promote safety in the roads, air and marine sectors;

Liaison with these bodies will be undertaken by the contractor prior to construction.

In addition to the above local governance, the Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of good practice, published by the World Bank/IFC. They are designed to provide guidance to users on EHS issues in specific industry sectors.

Recommendations and best practice guidance provided in relation to traffic safety include:

- Emphasising safety aspects among drivers;
- Adopting limits for trip duration and arranging driver shifts to avoid fatigue;
- Avoiding dangerous routes and times of day to reduce the risk of accidents;
- Use of speed control devices on trucks;
- Employing safe traffic control measures, including road signs and flag persons / banksmen to warn of dangerous conditions; and
- Regular maintenance of vehicles and use of manufacturer approved parts to minimise potentially serious accidents caused by equipment malfunction / failure.

It also recommends the following guidelines where a proposed development may contribute to a significant increase in traffic along existing roads, or where road transport is a significant component of a scheme:

- Minimising pedestrian interaction with construction vehicles;
- Collaboration with local communities and responsible authorities to improve signage, visibility and overall safety of roads;
- Collaborating with local communities on education about traffic and pedestrian safety;
- Using locally sourced materials, whenever possible, to minimise transportation; and
- Locating associated facilities such as staff accommodation close to project sites and arranging worker bus transport to minimise staff motorised trips.

14.2 Potential Impacts

14.2.1 Vehicle Route

The majority of the raw / construction materials will be sourced locally wherever possible. However, these materials then need to be transported to site using vehicles which are appropriate for the type, class and quantity of goods being transported. The entrance to the proposed development is off Factory Road; this is accessed from Bai Bureh Road either through Africanus Road / Factory Road or through Parsonage Street. The access roads between the site entrance and Bai Bureh Road are tarmac routes, although some parts are in poor repair.

It is also understood that some construction materials / equipment will be transported to the Proposed Development via the Queen Elizabeth II Quay container terminal, located approximately 3 km north-west of the proposed site. Figure 14.1 shows the vehicle route between the container terminal and the proposed development and highlights the key junctions along this route, as well as the access points to the proposed development. The proposed route will see vehicles using the Bai Bureh Road, a dual carriageway route, for the majority of the journey (3.5 km) from the container terminal to the proposed development. To access the Bai Bureh Road, vehicles leave the container terminal and use Racecourse Road, and Cline Street.

Figure 14.1: Vehicle Route from Dock

The key junctions identified on Figure 14.1 above are:

- Bai Bureh Road / Racecoure Road / Cline Street (5 arm junction)
- Bai Bureh Road / Africanus Road
- Africanus Road / Factory Road (4 arm roundabout)
- Bai Bureh Road / Parsonage Road

The local access route for the project and surrounding residences are illustrated in Figure 14.2 below. This roadway is currently unpaved, but is regularly utilised by trucks at present. Approximately 55 HGVs per day are anticipated to visit the site during project construction and 20 total vehicles during operations. Whilst 55 HGVs per day is not considered a particularly high number of trips, the area is heavily used by school children due to the presence of two nearby schools and the adjacent Islamic compound (whose entrance is directly on the access road). There are also shanty houses located in close proximity to the road and site entrance. On the basis of this and the current condition of the road, the community safety risks associated with the project would be considered moderately significant..

Therefore, a Transportation Management Plan will be developed for the project that will include limited road grading and maintenance (of the construction route from the west during the construction period) and will carefully consider additional measures around community health and safety (particularly regarding risks to school children along the access road route and shanty houses adjacent to site entrance) to reduce these risks to as low as is reasonably practicable. These and other possible measures will be agreed in consultation with IFC and EPA-SL during development of the Traffic Management Plan.

Figure 14.2: Local Access Route

14.2.2 Assessment Methodology

The Institute of Environmental Assessment (IEA) document 'Guidelines for the Environmental Assessment of Road Traffic' sets out a recommended list of environmental impacts which could be considered as potentially significant whenever a new development is likely to give rise to changes in traffic flows. This section deals with the following subjects listed in these guidelines:

- Road user delay and congestion;
- Highway user safety;
- Pedestrian delay and amenity;
- Dust and Dirt; and,
- Hazardous Loads.

The Guidelines for the Environmental Assessment of Road Traffic suggest that highway links should be separately assessed when traffic flows have increased by more than 30%. Other sensitive areas could be affected by traffic increases of at least 10%, or where Heavy Goods Vehicles (HGV) flows have increased significantly (by more than 30%). Since no traffic data is currently available for the highway networks around the proposed site it is not possible to identify where increases of this magnitude may occur. It is our understanding from site visits that the existing volume of traffic on Bai Bureh Road is such that the Proposed Development will at no time generate additional traffic that would create a 30% increase in traffic volumes. Therefore any future analysis, to be undertaken by the contractor prior to construction, should focus on Racecourse Road / Cline Street near the container terminal and Africanus Road / Factory Road / Parsonage Street near the proposed development.

The impacts of the proposed development will be considered under two scenarios; construction and operation of the site. This analysis was based upon available traffic data and professional judgement to assess the findings in relation to each of the criteria listed to give an assessment of significance for each effect. Effects are considered to be major, minor or negligible and can be negative or positive. Where positive impacts are identified mitigation is not required.

14.3 Construction Phase Impacts

14.3.1 Impact description

Traffic generated during construction of the proposed development will arise from the following:

- delivery of construction materials and equipment to the Proposed Development;
- long distance delivery of large operational infrastructure, e.g. boilers, condensers, engines and storage tanks;
- spoil removal; and
- Construction staff access/egress.

Information provided by the client indicates that approximately 200 local people will be employed during the construction period. Whilst it is not yet know where construction workers will be accommodated, the contractor will provide buses to transport workers to and from the construction site. Based on a capacity of 10 people per bus, it is estimated that a maximum of 20 two-way vehicle movements will be generated during the morning and evening peaks.

In addition, HGV traffic associated with the construction phase will likely be in the order of 55 vehicles (i.e. 110 vehicle movements) per day at the peak of construction. It is estimated that Light Goods Vehicle (LGV) during the construction phase will be in the order of 29 vehicles per day (i.e 58 vehicle movements). These movements include both the delivery of construction materials and the removal of construction waste. This level of trip generation is not considered to be significant when considered against the road capacities provided in Table 5.5 (Section 5.7).

Vehicles delivering items to the proposed development will include the following:

- HGVs delivering items such as aggregate and steel work;
- Low Loaders delivering steel work, pre-cast pile foundations, boiler components and turbine components;
- Road Tankers delivering items such as fuel and chemicals;
- Ready mixed cement vehicles; and,
- LGVs.

14.3.2 Impact significance

Road User Delay and congestion: The level of traffic generated during the construction of the proposed development is relatively small when compared to the notional capacities of the local roads, which are identified in Section 5.7 of this report. This level of traffic would add very little to the volumes of traffic already in existence, and it is important to note that this is temporary traffic. It is considered that the increases are unlikely to result in an adverse impact. Notwithstanding this point, as outlined previously it is recognised from site visits that many of the roads surrounding the proposed development are already congested and therefore operating at or close to saturated traffic conditions.

It will be important to manage the flow of vehicles to and from the proposed development site as they will be adding vehicles to an already "congested" highway network. Without any mitigation there is the potential for minor negative impacts to occur.

Highway User Safety: Due to the increase in construction traffic there is a potential for increases in road accidents between vehicles and pedestrians. Without mitigation there is the potential for major negative impacts to occur.

Pedestrian delay and amenity: Pedestrian delay is closely related to traffic flow along a link and the increases in traffic flow during the construction phase are unlikely to lead to any significant change to pedestrian delay. However, pedestrian amenity can be broadly defined as the relative pleasantness of a journey and this could potentially be affected by traffic flow and traffic composition. The minor increase in traffic flow as a result of construction staff travelling to and from the site is unlikely to result in any notable change to pedestrian amenity. Furthermore, whilst it is acknowledged that there will be additional HGV trips associated with the construction phase, this is likely to be no more than seven vehicles per hour when spread across a 12 hour day and is therefore also not likely to have a significant impact on pedestrian amenity.

Overall the effect of the construction phase of the proposed development on pedestrian delay and amenity is likely to be negligible.

Dust and Dirt: The effect of dust and dirt impacting on the local area and highway network is likely to be mostly felt during the construction period. Without mitigation there is the potential for minor negative impacts to occur.

Hazardous Loads: It is acknowledged that there may be hazardous loads associated with the construction of the proposed power plant, increased accidents and incidents with hazardous materials during transportation have the potential to result in damage to property and the environment, injury, and death. Without mitigation there is the potential for major negative impacts to occur.

Measures to manage and mitigate all the above impacts are provided in Section 14.5 of this report.

14.4 Operational Phase Impacts

14.4.1 Impact description

During the operation the proposed development will be operational on a 24 hour basis. It is anticipated that the proposed development will employ a total of approximately 50 staff[15], and these staff will work in three shifts.

Using data from Transport Assessments for two comparable power stations (100mW), it is estimated that approximately 75% of staff (36) would be office based staff working standard daytime office hours whilst the other half would be split between two further shifts. The anticipated shift patterns and split of employees is as follows:

- Shift 1 – 36 employees – 0800-1700
- Shift 2 – 6 employees – 1700-0000
- Shift 3 – 6 employees – 0000-0800

Employees at the site are likely to be resident within the western urban area of Freetown.

In addition to staff travelling to the site, there will also be routine maintenance and delivery vehicles access the site, and this will only be undertaken during daytime hours. Furthermore, there may be an occasional delivery from the nearby container terminal. However, this is expected to constitute no more than 1 or 2 vehicles per day.

14.4.2 Impact significance

Road User Delay and congestion: The level of traffic generated during the operational phase of the proposed development is significantly less than the construction phase, and again is relatively small when compared to the notional capacities of the local roads, as outlined in Section 5.7 of this report. This level of traffic would add very little to the volumes of traffic already in existence. Notwithstanding this, even this low level of increase could have the potential to have a minor negative impact on community safety in the local area on routes which are already congested, without appropriate mitigation measures.

Highway User Safety: Due to the increases in traffic there is a potential for increases in road accidents between vehicles and pedestrians. Without mitigation major negative impacts could occur.

Pedestrian delay and amenity: The relatively small increases in traffic flow as a result of the development are unlikely to result in any significant change to pedestrian delay.

It is acknowledged than there will be additional HGV trips associated with deliveries to the site during the operational phase, however again these are unlikely to have a significant impact on pedestrian amenity.

Overall the effect of the operational phase of the proposed development on pedestrian delay and amenity is likely to be negligible.

Overall, it will be important to manage the flow of vehicles to and from the proposed development site, and therefore measures to manage operational traffic are presented in the Section 14.5 below.

[15] Section 6.5 of EHSIA Scoping Report

14.5 Mitigation Measures

14.5.1 Construction Phase Mitigation Measures

All of the traffic and transport related impacts described above can be mitigated and managed effectively during construction. A Construction Traffic Management Plan (CTMP) will be prepared by the Contactor, and updated regularly as construction plans / sequences change / develop. The Contractor shall consult with the relevant government and local agencies in order to identify vehicle routes, timing of construction related trips, and to discuss/ agree appropriate mitigation measures.

The key issues addressed by the CTMP in terms of mitigation measures will include:

- Access to construction areas;
- Construction vehicle routeing;
- Temporary traffic control and management;
- Road crossings;
- Construction staff transport facilities;
- Keeping highways clean of mud and dust;
- Speed controls in residential areas;
- Road safety and awareness training for locals;
- Mechanisms for dealing with complaints about road safety; and
- Reducing the probability of traffic related incidents.

Notwithstanding the estimates of construction vehicles which are outlined in Section 14.3, the CTMP will also outline the number of vehicle movements expected at the various stages of construction, as well as the vehicle types expected to deliver materials and equipment. Given the level of congestion on the highway network in the morning and evening peak periods it is likely that the majority of construction traffic movements will be outside of these periods and limited to daylight hours where possible.

The following mitigation measures will be adopted within the CTMP to reduce the impacts from the construction stage of the proposed development:

- Identify those responsible for carrying out and managing the procedures;
- Reference the procedures and activities that are required to be developed and implemented;
- Identify any enabling works to be undertaken on the roads prior to construction activities to upgrade or stabilise the roads/ structures should these be required;
- Identify any key sensitivities along proposed access routes;
- Measures to prohibit off-road driving;
- Outline speed limits and methods of enforcement;
- Means to inform and educate the community of traffic risks;
- Outline measures that will be used to ensure the safety of the community and minimise the nuisance impact of traffic movements;
- Develop strategy for moving materials and people to/ from and within the proposed development area, including abnormal loads, e.g. ensuring that delivery of materials does not coincide with the start/end of the highway network peak periods;

- Procedures for monitoring construction generated traffic movements and associated environmental problems;
- Measures to ensure that employees travelling to and from the site are able to do so in a safe manner, e.g. provision of mini buses;
- Measures to prevent the use of unsuitable roads;
- A notification process to be developed to give residents/affected people advance warning of abnormal deliveries; and
- Implement good management practices such as provision of wheel washing facilities for all departing vehicles and sheeting of HGVs carrying loads likely to shed debris.

14.5.2 Residual Impact

Following the development and implementation of a CTMP which includes the mitigation measures presented above, it is considered that there should be a minor negative residual impact on the transport network.

14.5.3 Operational Phase Mitigation Measures

It should be noted that the levels of traffic generated when the proposed development is fully operational are significantly lower than during the construction period. Notwithstanding this, mitigation measures are proposed and will be implemented as part of an operational management plan for the proposed development. The following mitigation measures will be adopted within the management plan to reduce the impacts from the operational phase of the proposed development:

- Outline appropriate strategies for moving materials and people to/ from and within the proposed development areas, including ad hoc deliveries vehicles, e.g. ensuring that deliveries do not coincide with the highway peak periods;
- Procedures for monitoring the generated traffic movements and associated environmental problems;
- Measures to ensure that employees travelling to and from the site are able to do so in a safe manner, e.g. provision of mini bus(es) if appropriate;
- Measures to prevent the use of unsuitable roads;
- A notification process to be developed to give residents/affected people advance warning of unusual deliveries/delivery times (e.g. during maintenance works required to replace a large item of plant or equipment); and
- Safety education for those located in close proximity to the site, that have the potential to be impacted by the operation of the proposed development.

14.5.4 Residual Impact

Following the application of an operational traffic management plan, it is considered that there will be minor negative residual impacts as a result of the operation of this proposed development.

14.6 Marine Components

14.6.1 Construction and Operation

There will be a negligible increase in marine vessel movements during the construction phase, with one shipment a month required during mobilization and civil works to transport materials and one shipment a month required during operation to transport HFO.

The current NP facility has the capacity for mooring and offloading vessels with a maximum dead weight of 15,000 tons berth at the jetty and the nearly complete Addax jetty will allow the berthing of tankers of up to 55,000 tons water displacement. The current jetty capacity is sufficient to meet this project's requirements.

14.6.2 Assessment, Management and Mitigation

Analysis of the impacts of new vessels on existing vessel movements and fishing fleets will be undertaken prior to construction. Communication with the fishing community throughout the stakeholder engagement process prior to construction will be completed to establish exclusion zone limits and to confirm there is no impact on fish reserves.

To ensure timely supply of materials at construction and adequate supply of HFO at operation, planning and scheduling of activities will take place in partnership with operators of the Jetty.

As vessel movements are minimal these will have no impact further to those addressed in the scope of the ESHIA for the Addax Jetty. Additionally ship to shore transfer of materials is also addressed as part of the Addax Jetty ESHIA.

14.7 Cumulative Impacts Assessment

14.7.1 Construction and Operation

Initial desktop analysis indicates that the issues arising from the project are manageable. However, there is potential for construction of other sites in the region to coincide with construction of the site considered in this report. Further analysis of cumulative impacts will be undertaken by the contractor, during the preparation of the CTMP, and the operational management plan, at which point further information on timescales and development phasing will be known.

14.8 Conclusions

Based on the desktop analysis undertaken, impacts of the proposed development during both the construction and fully operational stages can be mitigated through the implementation of traffic management plans. In addition to the above, the following actions are also identified and will be undertaken by the contractor prior to commencing on-site:

- Marine vessel movement assessment.
- Discussions with Ministry of Transport and Aviation, and other local groups including consultation with local communities and project affected parties.

14.9 References

- Institute of Environmental Assessment: Guidance Notes No.1 – Guidelines for the Environmental Assessment of Road Traffic (1993)
- UK Design Manual for Roads & Bridges (DMRB) Volume 5, Section 1, Part 3 TA 79/99 'Traffic Capacity of Urban Roads'.
- Environmental, Health, and Safety (EHS) Guidelines, General EHS Guidelines: Community Health and Safety World Bank Group, 2007.

15. Stakeholder Consultation

15.1 Introduction

The purpose of this section is to describe the consultation carried out in relation to the proposed project and to outline the key issues raised by stakeholders to date. This section also outlines the requirements and commitments in relation to further consultation for the project going forward.

Consultations play a major role in identifying the potential impacts of any proposed project and can assist in the identification of socio-economic, religious and cultural impacts. The main objectives of the consultation process undertaken to date are as follows:

- To provide information about the project and its potential impacts to those interested in or affected by the project, and solicit their opinion to that regard;
- To understand and address stakeholder concerns and expectations of the project;
- To manage any unrealistic expectations and address misconceptions regarding the project;
- To agree on livelihood restoration measures, if any, and discuss potential concerns; and
- To ensure participation and acceptance of the project throughout the lifetime of the project by the key stakeholders including the community.
- To provide a mechanism to address any stakeholder grievances regarding the project.

The project has been in development since early 2013. However, from June 2014 and throughout much of 2015, the Ebola crisis in West Africa has significantly impacted Sierra Leone, this has resulted in a limited programme of survey work which has in turn restricted the consultation process undertaken to date. On that basis the current approach under Ebola conditions is to produce an ESHIA which focuses on the key issues relevant to the project, in order to progress the design and to develop the ongoing consultation process.

As the project progresses and detailed design is concluded, a greater level of detail will be available regarding the project's impacts and the environmental and social aspects that will require management during construction, operation and decommissioning. Further consultation as outlined in Section 1.4 below will be undertaken prior to and during the construction phase.

To date there has been 2 stages in the Consultation process;

- Stage 1: was undertaken during the ESHIA Scoping Phase – January 2014 to May 2014; and
- Stage 2: was undertaken during the ESHIA Assessment Phase – February 2015 to March 2015.

15.2 Stakeholder Consultation Stage 1: Scoping Phase

During the period January 2014 to May 2014 a number of informal and formal meetings were held with a number of Stakeholders including the following:

- Government (National, Regional and Local) Ministries, Departments and Agencies;
- Community Leaders (e.g. Religious, Educational);
- Local and International NGOs;
- International Financial Institutions;
- Vulnerable Groups (e.g., women, youth and elderly);

- Business Organisations;
- Communities & Community-Based Organisations (CBO).

Appendix I, Table A1 of this ESHIA presents a summary of the key observations/outcomes from the consultation meetings held during Stage 1 the ESHIA scoping phase, with full details available in the ESHIA: Scoping Report (Appendix G).

In addition to the various stakeholder meetings a Public Community Consultation Workshop took place on the 15th May 2014. The community consultation found that there is clear support for the project, but also there exists expectations that the project will provide tangible benefits in the form of job provision, electricity supply and economic and community development. It is also expected that potential adverse impacts will be predicted and prevented or managed. Ongoing consultation with the farmers at the SLRA site was highlighted as being of particular importance.

The issues raised were unanimous across all the districts and communities and in general consisted of the following:

- Prompt, fair and adequate compensation payment for affected properties.
- Job creation for the youth - there was a cyclical request for employment particularly unskilled labour to be sourced from the various affected communities.
- Permissible activities within any transmission corridor - communities inquired whether backyard gardening is allowed in the [presumed] 40m right of way.
- Compensation for affected lands within the proposed corridor - an appeal was made across all the communities visited for the lands within the proposed corridor to be compensated instead of only the structural properties.
- Extension of electric power to the communities who are not yet connected to the national grid.
- Upholding and respect of community values - reverence towards the communities' cultural heritage-shrines, sacred groves, etc.
- The health implication of the proposed high voltage line to the close-by communities regarding emission of EMF.
- Request for the provision of basic social amenities, not necessarily in the context of the proposed project.

It should be noted that some of the issues raised are beyond the remit of the project, for example connection to the National Grid for unconnected communities and there may be limits on the provision of basic social amenities. However, where reasonable and possible the project will endeavour to respond to community requests.

Full details of the Community Consultation Workshop can be found in the ESHIA Scoping Report, see Appendix G. The Stage 1 consultation allowed the project Team to provide project information and obtain information, views and concerns from the wider community as well as key stakeholders. The majority of these concerns are addressed within this ESHIA and where further action is required this is detailed in Section 1.4 and/or within the specialist sections of the ESHIA.

15.3 Stakeholder Consultation Stage 2: Assessment

To further inform the ESHIA a second round of consultation was undertaken during February 2015 to March 2015, the ESHIA assessment phase.

The Freetown community including the Kissy Dockyard and its environs, were engaged in a series of media based activities to inform the community and the populace that the project work is ongoing and to provide them with an opportunity for exchange of views, for input to and review by the project team;

- Information was published via three local tabloid newspapers namely the Salone Times, Awoko and Standards Times.
- Information was broadcast across local radio stations (Radio Democracy, Radio Citizen and Tumac Radio). These broadcasts were in the local dialects (krio, mende and temne) and were aired in the morning, afternoon and evening.
- A follow on community specific broadcast was undertaken on the 9th-10th March 2015 using a public address system.
- Hand bills were handed out to interested individuals and posters put up at strategic points in the community.

In addition a number of face-to-face meeting were held with the following key stakeholders in the project area:

- The Deputy Director of the Environmental Protection Agency.
- A group of garden farmers cultivating at the site.
- The Energy Distribution and Supply Agency and the Energy Generation and Transmission Corporation were similarly engaged on 3rd March 2015.

Further consultation was undertaken which focused on gathering demographic information on households, business premises and schools within the Kissy Dockyard community, particularly those that are located within 500 m radius of the project site. A total 320 household, 18 businesses and 5 schools were distributed with questionnaires, see Appendix J.

Overall the project is highly welcomed and the concerns raised were reflective of those raised during the Stage 1 consultation process. A summary of the consultation held during Stage 2 is provided in Appendix I Table A2.

15.4 Actions Going Forward

15.4.1 Pre-Construction

Further consultation reports will be prepared as the project develops, pre-construction phase consultation requirements will include the following;

- Two public consultation workshops will be held prior to construction (one close to the project site and a second in central Freetown).
- The SEP will be developed and implemented by CECA SL so that all concerns identified to date are managed and factored into the design phase of the project. This will be undertaken prior to construction.
- The SEP will be developed as per the following key requirements;
    - Identify the key target stakeholders.
    - Determine the key principles for stakeholder engagements, i.e. building understanding of the project, provision for the participation of vulnerable groups, involvement of stakeholders etc.
    - Understand what previous stakeholder engagement has taken place

- Develop a programme of stakeholder engagement around key project milestones.

While stakeholder engagement is an iterative process, constantly adapted to changing stakeholder requirements, effective engagement is supported by three key phases;

Phase I - Data Gathering: Understanding the location, needs, agendas and motivations of the stakeholders. Ascertaining potential project impacts on them.
Phase II - Implementation: Designing, scheduling & conducting engagement activities in a systematic fashion. Different methods will be used at different stages of the project.
Phase III - Monitoring & Evaluation: Checking to ensure the engagement meets the desired objective and is meaningful and effective.

15.4.2 CECASL

To ensure the continued involvement of key stakeholders and the community, CECA will:

- Ensure any specific consultation requirements identified within the ESHIA specialist sections are undertaken;
- Implement (and further develop if required) the CECASL SEP so that all concerns identified to date are managed and factored into the design development for the project; and
- Establish a grievance mechanism will also be established that will allow stakeholders, and in particular the local community, to have the ability to lodge complaints or voice their concerns, and for any such complaints to be dealt with, recorded and monitored by CECASL.

Appendix B: List of Report Preparers – Individuals and Organizations

Organizations involved in the Preparation of ESHIA Report

Princeton Energy Resources International, LLC (PERI) – Prime Contractor

INTEGEMS

Power Engineers

Table 1 List of Preparers from PERI

Name	Organization	Title & Role	Email
David Phillippi	PERI	Engineer	dphillippi@perihq.com
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Atiyeh Thurston	PERI	Engineer	athurston@perihq.com

*Portions of the ESHIA were taken directly from the original ESIA done by Jacobs.

Appendix C: General Arrangement Drawing

MAP OF OFF SITE LINEARS

EQUIPMENT LIST:-

TAG No	DESCRIPTION (SIMPLE CYCLE)	TAG No	DESCRIPTION (COMBINED CYCLE)
101	LM2500 UNIVERSAL	201	HRSG
102	GCB	202	HRSG / STG PCM
103	FUEL GAS FILTER SKID	203	ST GENERATOR
104	WASTE DRAINS TANK	204	HP/LP STEAM TURBINE
105	WATER WASH CART	205	FEED WATER PUMPS
106	CO2 SKID	206	RECIRCULATION PUMP
107	GENERATOR LUBE OIL SKID	207	HRSG STACK
108	AUXILIARY SKID	208	BY PASS STACK
109	TLO/HYDRAULIC & GLO FIN FAN COOLR	209	ACC
110	AIR FILTER	210	CONDENSATE TANK
111	BOP PCM	211	CONDENSATE PUMPS
112	RAW AND FIRE WATER TANK	212	BDT WITH TRANSFER PUMP
113	LPG BUFFER TANKS	213	ADV
114	DRAIN PIT WITH TRANSFER PUMP	214	ADV PUMPS
115	DIESEL FORWARDING PUMPS	215	DRAIN POT PUMPS
116	PRETREATMENT TANK	216	CCW PUMP SKID
117	DIESEL FUEL OIL STORAGE TANK	217	CCW FIN FAN COOLERS
118	MOUNDED LPG STORAGE AREA	218	GSUT 33/11.5kV
119	UAT 11.5kV/400V	219	SAMPLING SKID
120	INCINERATOR / FLARE	220	DOSING SKID
121	GSUT 33/11.5kV	221	COMPRESSED AIR SKID
122	RISER TOWER	222	START-UP EJECTOR
123	COMBINED GT PCM	223	SERVICE EJECTOR
124	CONTROL MODULE (LPG VAPORIZER)	224	GSC
125	LPG HEAT EXCHANGER	225	CCW TANK
126	LOW PRESSURE LPG PUMPS	226	HP / LP BYPASS STATION
127	BLACK START DIESEL GEN	227	FLASH TANK
128	WATER INJECTION BOOST SKID	228	STG LAYDOWN AREA
129	HIGH PRESSURE LPG PUMPS	229	-
130	11-KV SWITCHGEAR BLDG	230	MAIN PIPE RACK
131	DEMINERALIZED WATER TANK	231	BDT FINFAN COOLER
132	FILTERED WATER TANK	232	WATER TREATMENT SYSTEM
133	SST 33kV/400V		
134	33-KV SWITCHGEAR BLDG (EDSA)		

LEGENDS:

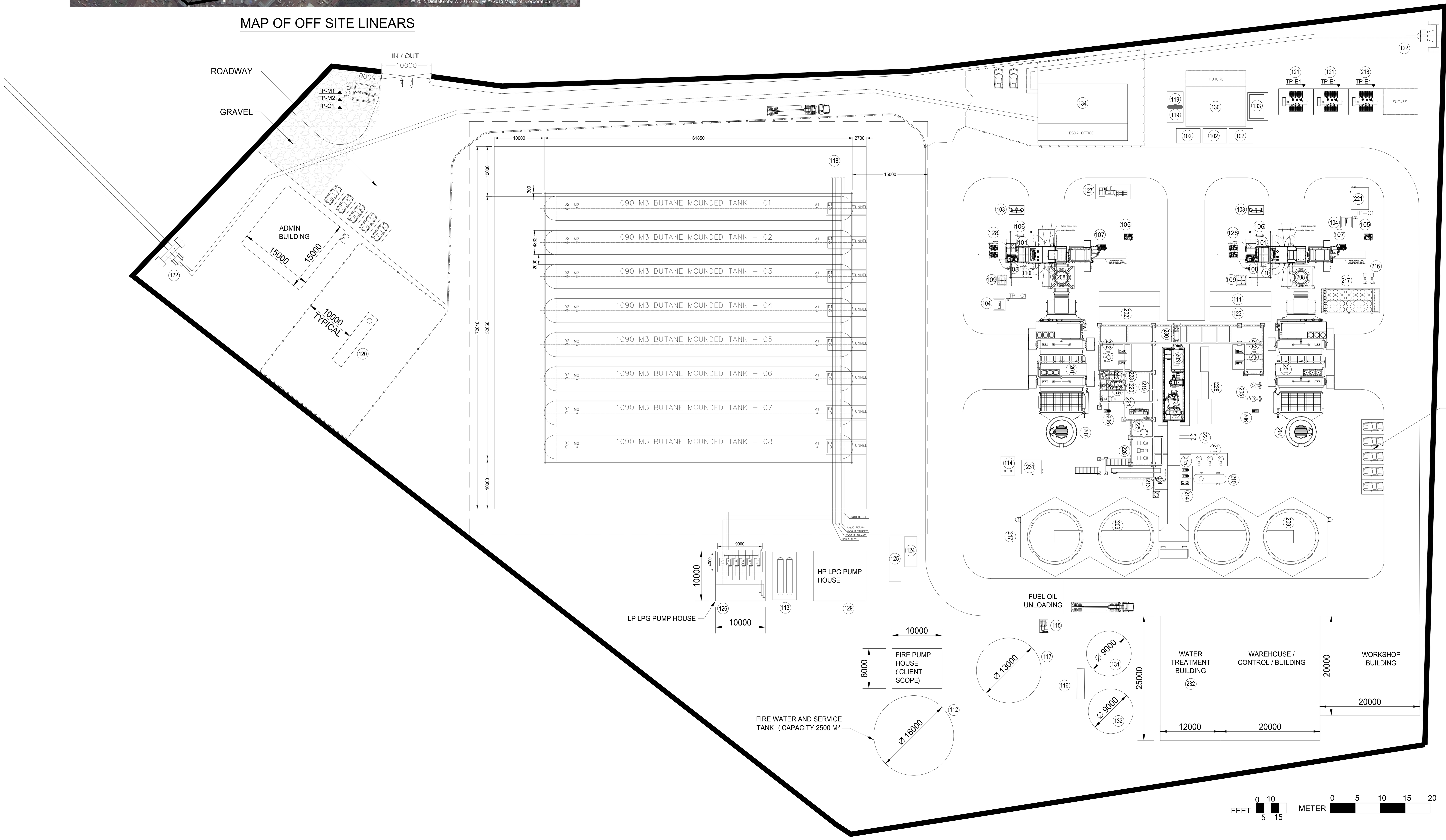
BSDG-BLACK START DIESEL GENERATOR
GSUT-GENERATOR STEP-UP TRANSFORMER

TERMINAL POINTS (TP):

TP-M1 LPG
TP-M2 WATER
TP-E1 OUTGOING POWER
TP-C1 WASTE DRAIN SYSTEM

OFF SITE LINEARS WILL BE BROUGHT TO THE PLANT SITE VIA UNDERGROUND PIPELINES.

DIESEL FUEL OIL STORAGE TANK WILL BE A DOUBLE-WALL DESIGN WITH FIRE RESISTANT INSULATION PER NFPA 30.



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REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD	REFERENCE DRAWINGS
0	ISSUED AS FINAL	07/10/2020	RAH	JT	JT	GG	

DSGN	JT	08/06/2020
DRN	RAH	08/06/2020
CKD	JT	08/06/2020
SCALE:	NTS	

FOR 297x420 DWG ONLY

POWER ENGINEERS

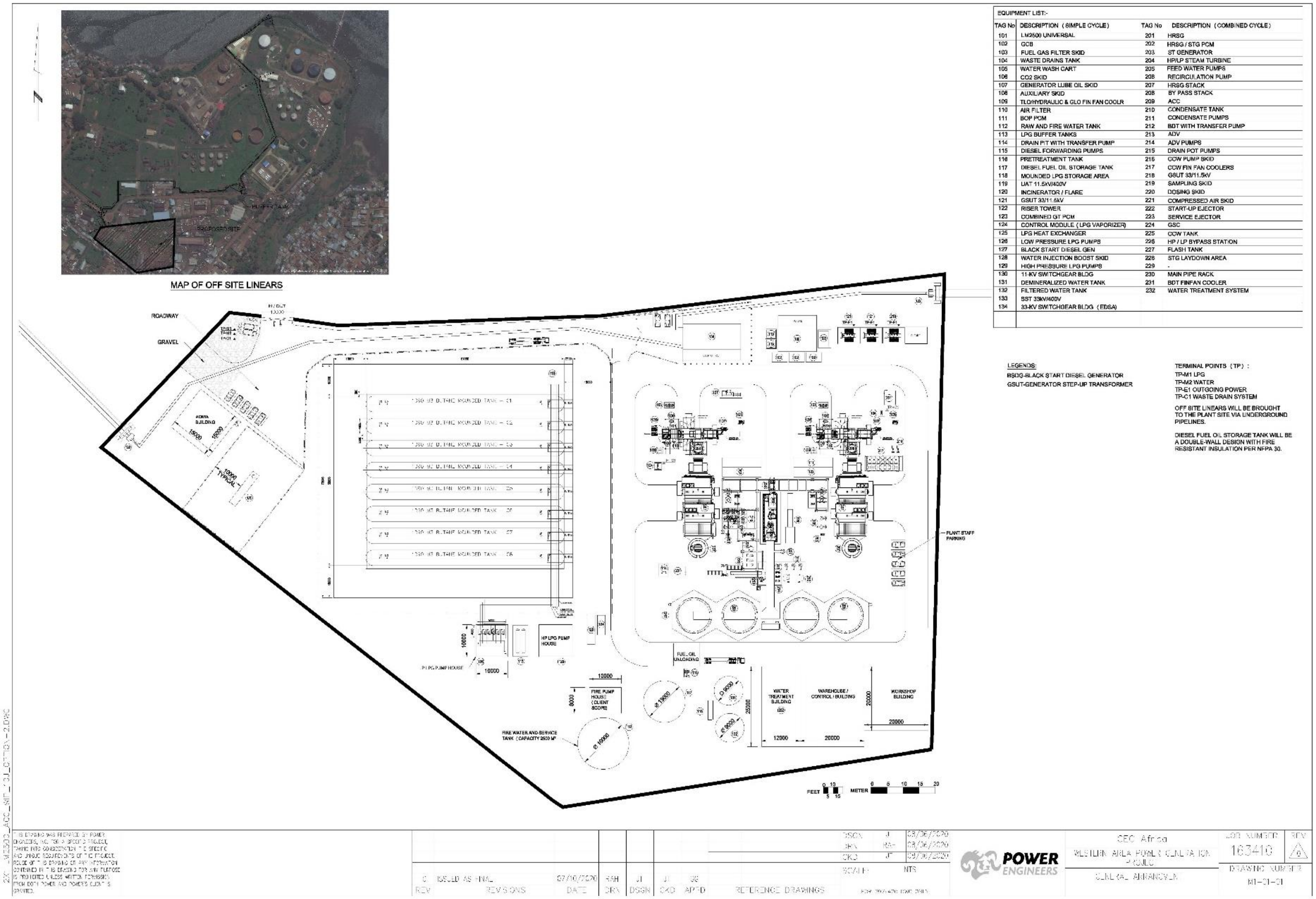
CEC Africa
WESTERN AREA POWER GENERATION PROJECT
GENERAL ARRANGMENT

JOB NUMBER 163410
REV 0
DRAWING NUMBER M1-01-01

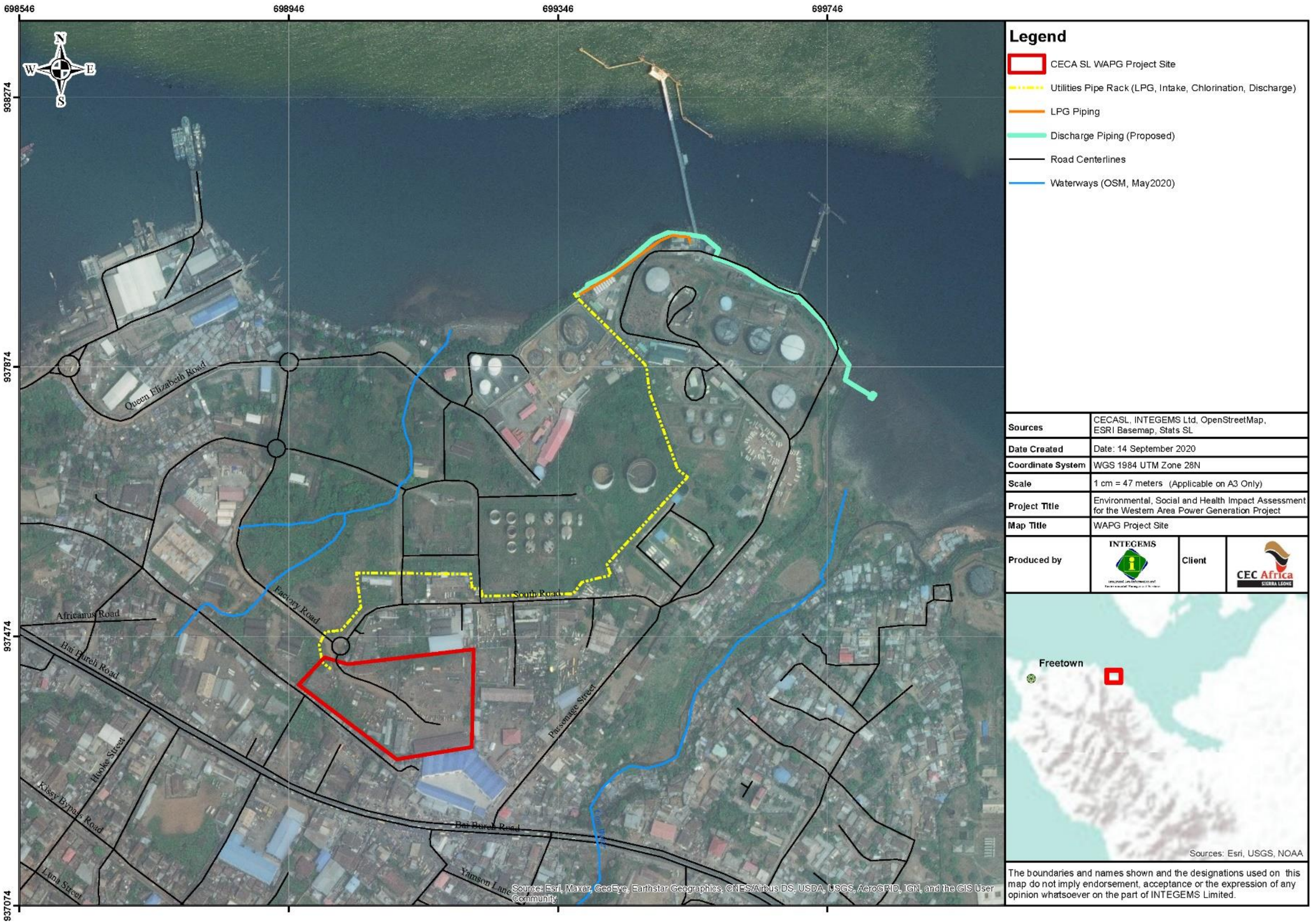
2X1_LM2500_ACC_WIP_10J_OPTION-2.DWG

Appendix D: Site Survey and Basemaps

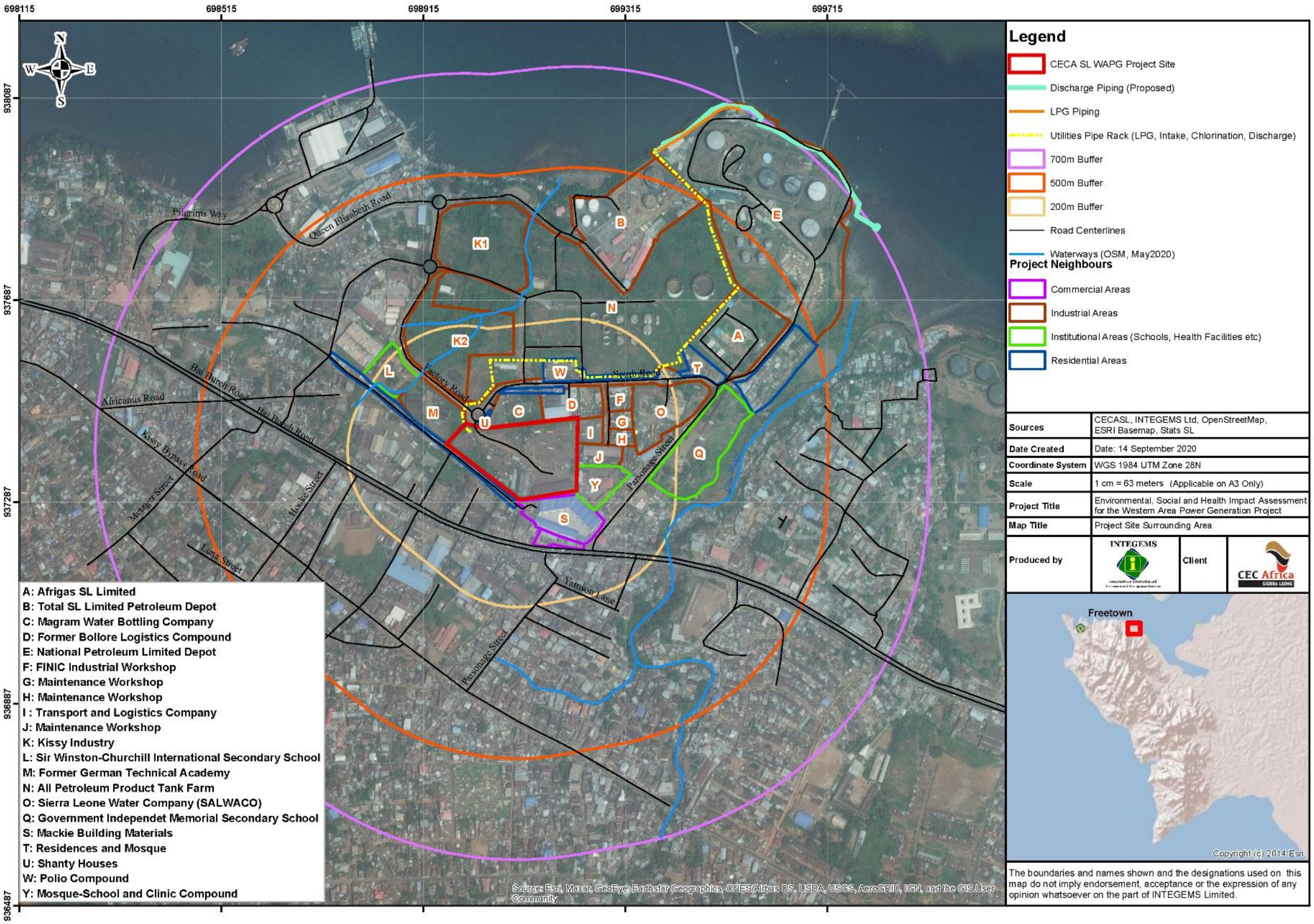
General Arrangement



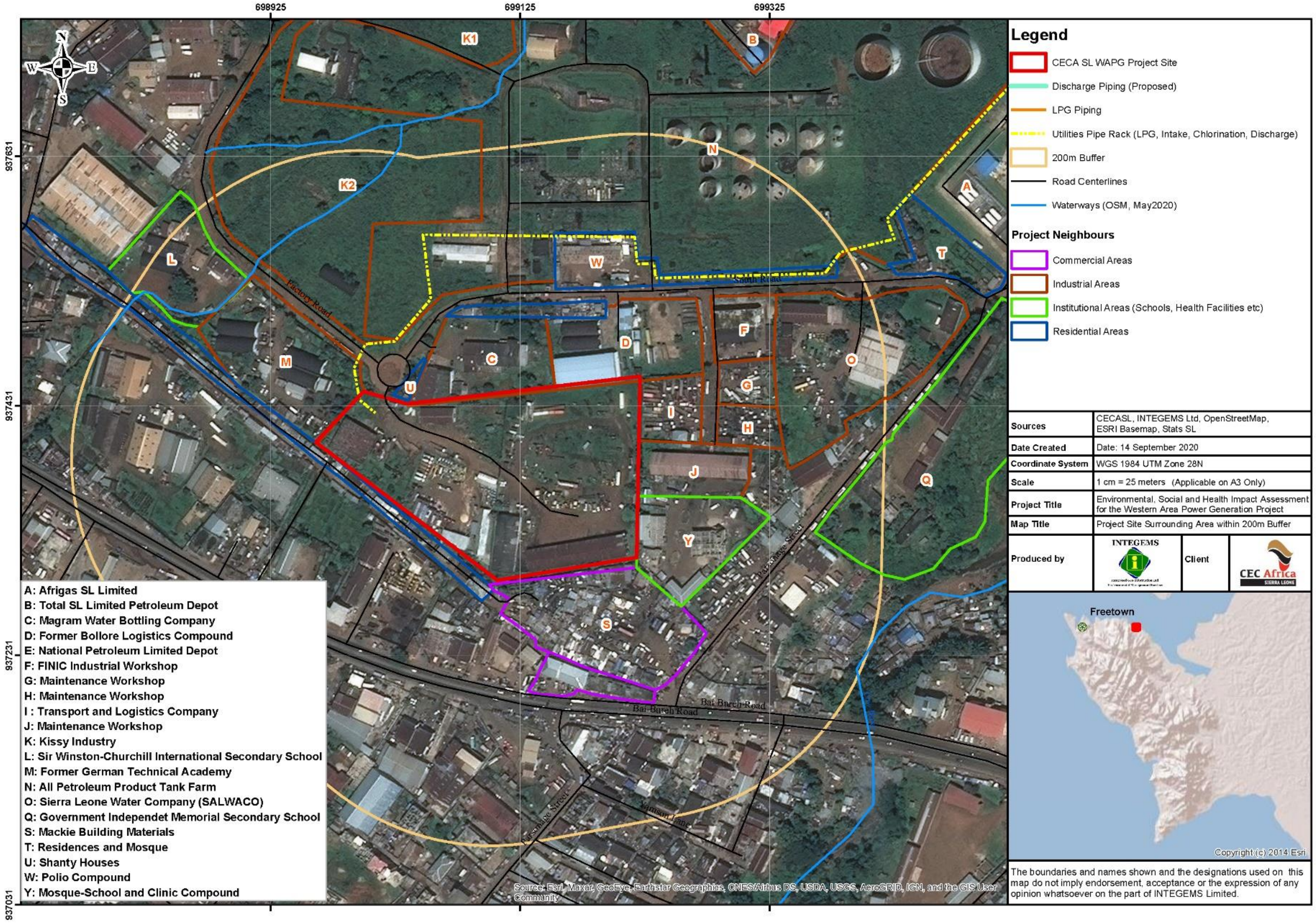
CECA-SL Project Site Area



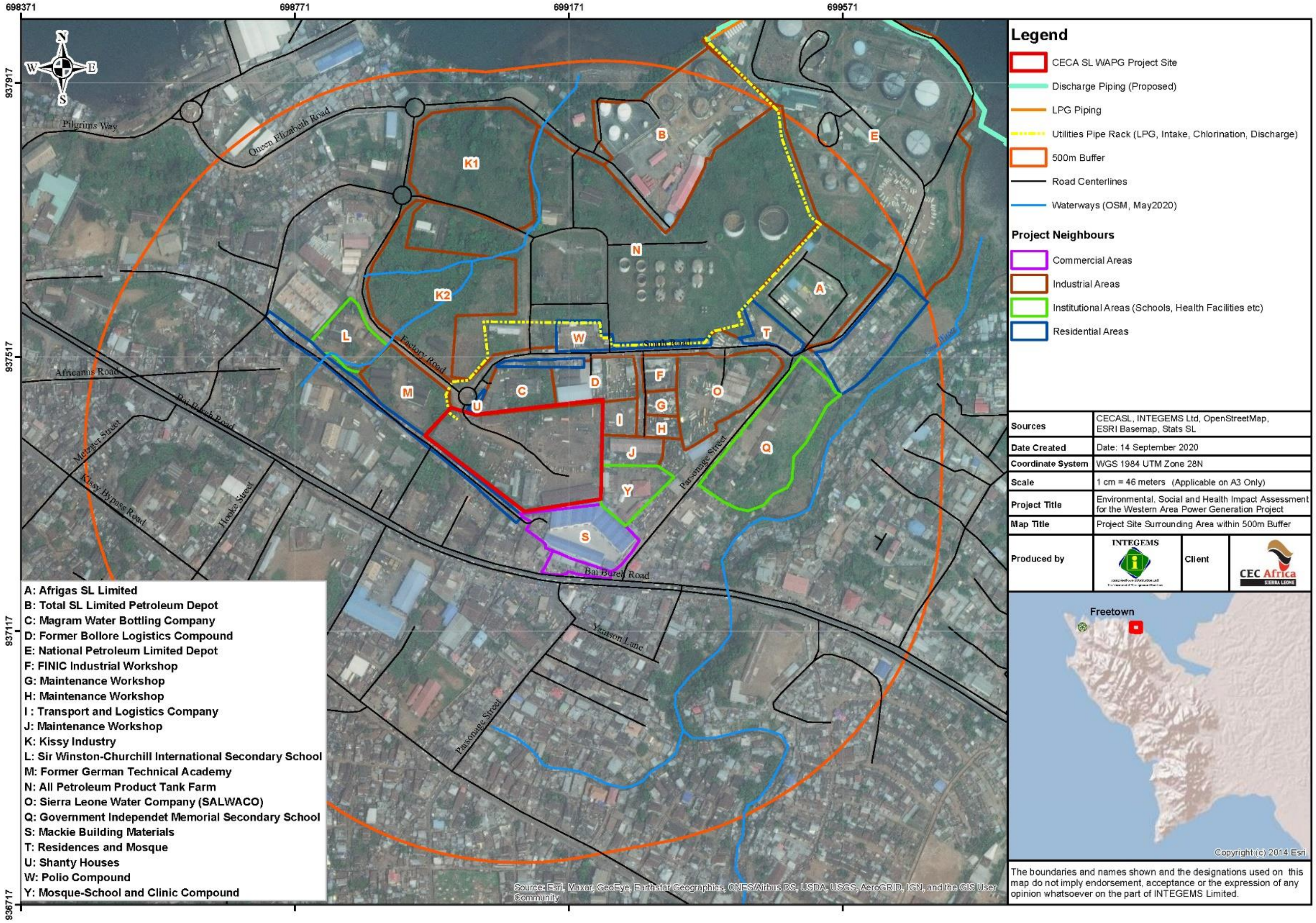
CECA-SL Project Site Area with Buffers



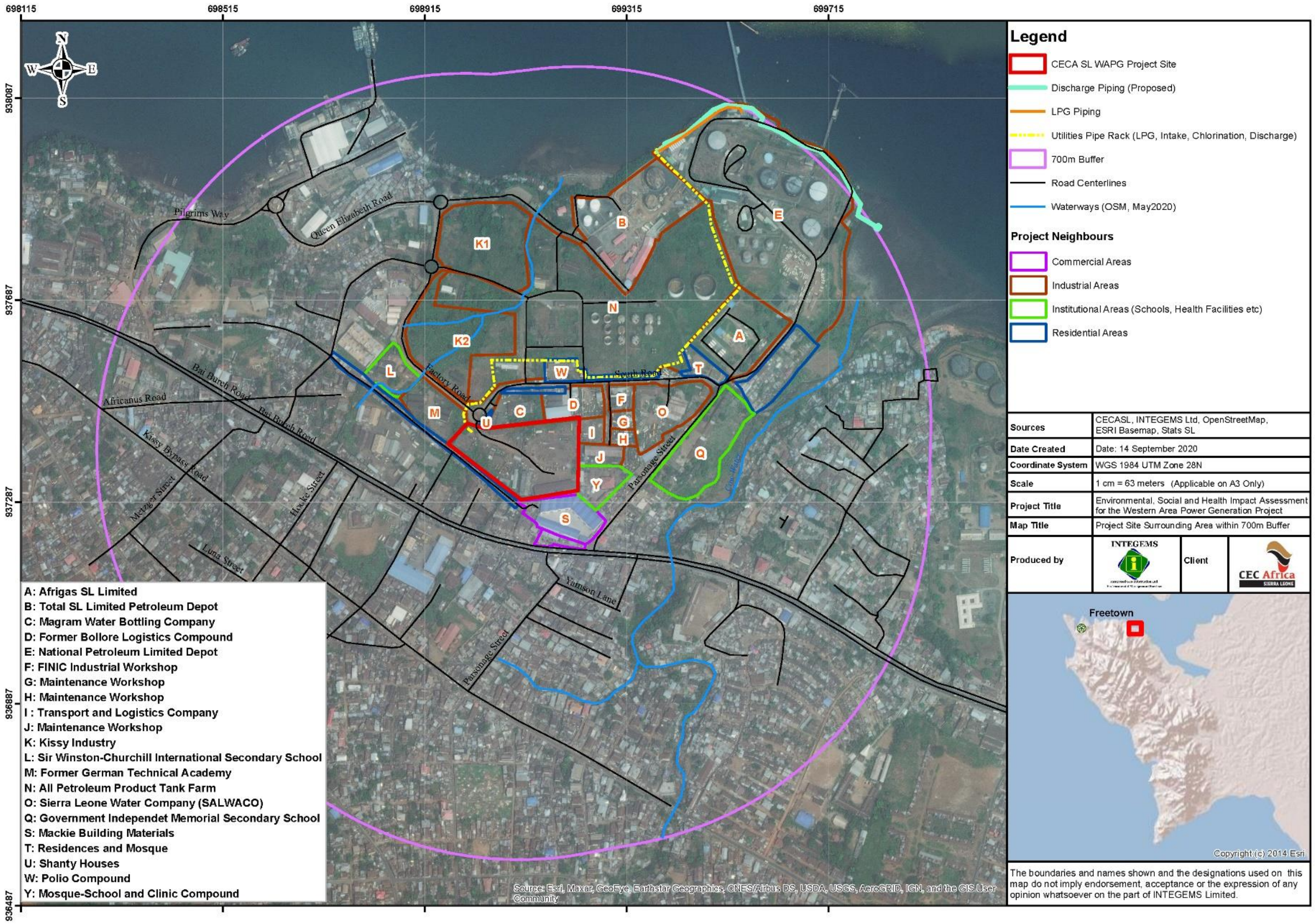
CECA-SL Project Site Area Within 200m Buffer



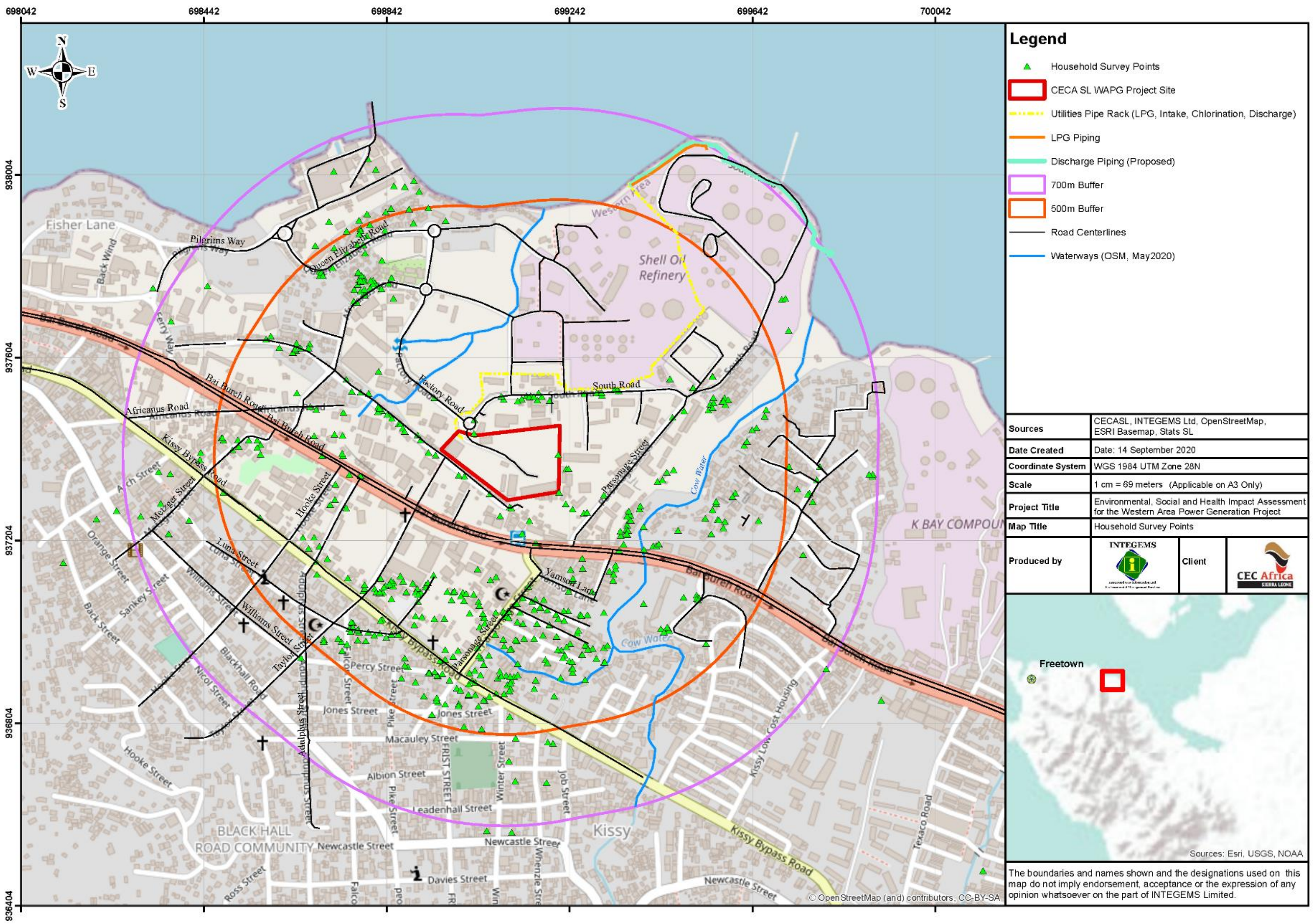
CECA-SL Project Site Area Within 500m Buffer



CECA-SL Project Site Area Within 700m Buffer



CECASL WAPGP Household Survey Points (September2020)



CECASL WAPGP Site Drone Photography (August 2020)


School
Kissy Industry
German Tech Academy
Site Entrance
Residences
Magram Water Company


Kissy Industry
APP's Petroleum Tank Farm
Old Refinery
Polio Compound
Magram
Project Site


Mosque, School
& Clinic
Garage
Garage
Wharehouse
Project Site


WAPG Project Site


Wharehouse
Project Site

Appendix E: Noise Levels and Figures

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT (ESHIA)

DRAFT AIR QUALITY AND NOISE BASELINE REPORT

May 2020

Western Area Power Generation Project
CEC Africa (Sierra Leone)

Prepared by

INTEGEMS

Integrated Geo-information and Environmental Management Services

Integrated Geo-information and Environmental Management Services Limited

DISCLAIMER

The findings, results, observations, conclusions and recommendations given in this report are based on the authors' scientific and professional knowledge as well as available information at the time of compiling this report. The contents of this report can be updated and/or modified if and when new information may become available.

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QUALITY ASSURANCE CHECK

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LIST OF ABBREVIATIONS

AQMP	Air Quality Monitoring Point
AWS	Automatic Weather Station
BATNEC	Best Available Technology Not Entailing Excessive Cost
BOOT	Build, Own, Operate and Transfer
CECASL	Copperbelt Energy Corporation Africa Sierra Leone
COVID	Coronavirus Disease
EDSA	Electricity Distribution and Supply Authority
EHS	Environmental, Health and Safety
EPA-SL	Environment Protection Agency-Sierra Leone
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Assessment
GCM	General Circulation Model
GIMSS	Government Independent Memorial Secondary School
GIS	Geographic Information System
GPS	Global Positioning System
HFO	Heavy Fuel Oil
IFC	International Finance Corporation
ITCZ	Inter-Tropical Convergence Zone
JAS	July, August and September
JFM	January, February and March
LPG	Liquified Petroleum Gas
NMP	Noise Monitoring Point
OND	October, November and December
PPA	Power Purchase Agreement
SALHOC	Sierra Leone Housing Corporation
SWISS	Sir Winston Churchill International Secondary School
UNDP	United Nations Development Programme
VOCs	Volatile Organic Compounds
WAPG	Western Area Power Generation
WBG	World Bank Group
WHO	World Health Organisation

1 INTRODUCTION

The Copperbelt Energy Corporation Africa Sierra Leone Limited (CECASL) is a joint venture established in 2014 to develop an electricity-generating, Heavy Fuel Oil (HFO) fired power generation plant on a Build Own Operate and Transfer (BOOT) basis on a parcel of land located 4 km east from the centre of Freetown. An Environmental, Social and Health Impact assessment (ESHIA) was undertaken for the project in 2015. However, the project has been restructured from an HFO-fired power generation plant to a Liquefied Petroleum Gas (LPG)/combined cycle plant and reconstituted as the Western Area Power Generation Project (hereinafter, the project).

CECASL has contracted Integrated Geo-information and Environmental Management Services (INTEGEMS) Limited to undertake a baseline update for the air quality and environmental noise for incorporation into the updated ESHIA of the project in order to comply with the environmental regulations of Sierra Leone as required by the Environment Protection Agency-Sierra Leone (EPA-SL).

The revised ESHIA is required to meet the requirements of International Financing Institutions (IFIs) as generally defined in the International Financing Corporation (IFC) Performance Standards for Environmental and Social Sustainability ('IFC Standards' or 'the Performance Standards') and the Environmental, Health and Safety (EHS) Guidelines of the World Bank Group (WBG).

This Air Quality and Environmental Noise Baseline Report (hereinafter, report) presents an updated baseline for air quality and noise within the project area and is compiled for incorporation into the ESHIA Report which is expected to present a statement of the likely social, environmental and health effects of the project including a description of the measures that are required to be implemented to avoid, reduce and where possible, remedy any identified significant adverse effects.

1.1 Project Overview

The project is located on a site in the Kissy Dock area, approximately 4 km east of the centre of Freetown, Sierra Leone on existing industrial land immediately south of the old refinery tank farm (currently under rehabilitation to be used as a petroleum storage depot by All Petroleum Products Limited) and is approximately 500 m from the sea (see Figure 1-1 and Figure 1-2). The power plant will be developed in two phases with Phase 1 constituting 83.5 MW output utilising 2 GE LME 2500 turbines in combined cycle with a steam turbine. CECASL Generation Limited will develop, finance, construct, own and operate the Power Plant and shall sell the entire output of the power plant to EDSA under a 20-year Power Purchase Agreement (PPA) with EDSA as the single off-taker.

Under the restructured project, the current scope includes two GE LME 2500 turbines in combined cycle with a steam turbine and associated balance of plant; a new substation at Kissy project site; substation upgrades at Blackhall Road, Ropoti and Wellington; new 33 kV line between Wellington and Blackhall Road; a 4,000 MT of on-site LPG storage; and an LPG pipeline from Kissy Jetty to the plant site.

1.2 Objective

The main objective of the study is to update the air quality and noise baseline data to be incorporated in the updated ESHIA Report that will provide an analysis of the project's potential environmental, social and health impacts.

1.3 Scope of Work

The scope of works includes the development of monitoring plans, acquisition of air quality and noise data and the preparation of air quality and noise baseline report for inclusion into the updated ESHIA Report. The geographic scope is limited to the project site and LPG pipeline at Kissy Dockyard and delineated area of influence of the environmental aspects under consideration.

1.4 The ESHIA Consultant – INTEGEMS Limited

INTEGEMS is a Sierra Leone-based multidisciplinary consultancy firm that integrates innovative GIS and remote sensing technologies with research and environmental management expertise to provide and enable public and private sector organisations effectively and efficiently respond to natural resources management challenges and opportunities.

INTEGEMS has been appointed by CECASL as the local ESIA Consultant for the project. INTEGEMS' ESIA Team has been involved in the project since 2014 and retains significant knowledge of the project environmental and social elements.

INTEGEMS has experience across Sierra Leone and has developed a thorough understanding of national, regional and local legislative requirements as well as the environmental and socio-economic challenges faced by various programmes, projects and organisations in Sierra Leone. In collaboration with strategic partners, INTEGEMS has successfully designed and carried out several environmental, socio-economic and health baseline surveys and impact assessments in diverse communities in Sierra Leone.

INTEGEMS is supported by extensive resources and expertise from a network of associates and partners and has drawn upon a wide range of technical specialists and strategic partners to contribute to and collaborate on the ESIA.

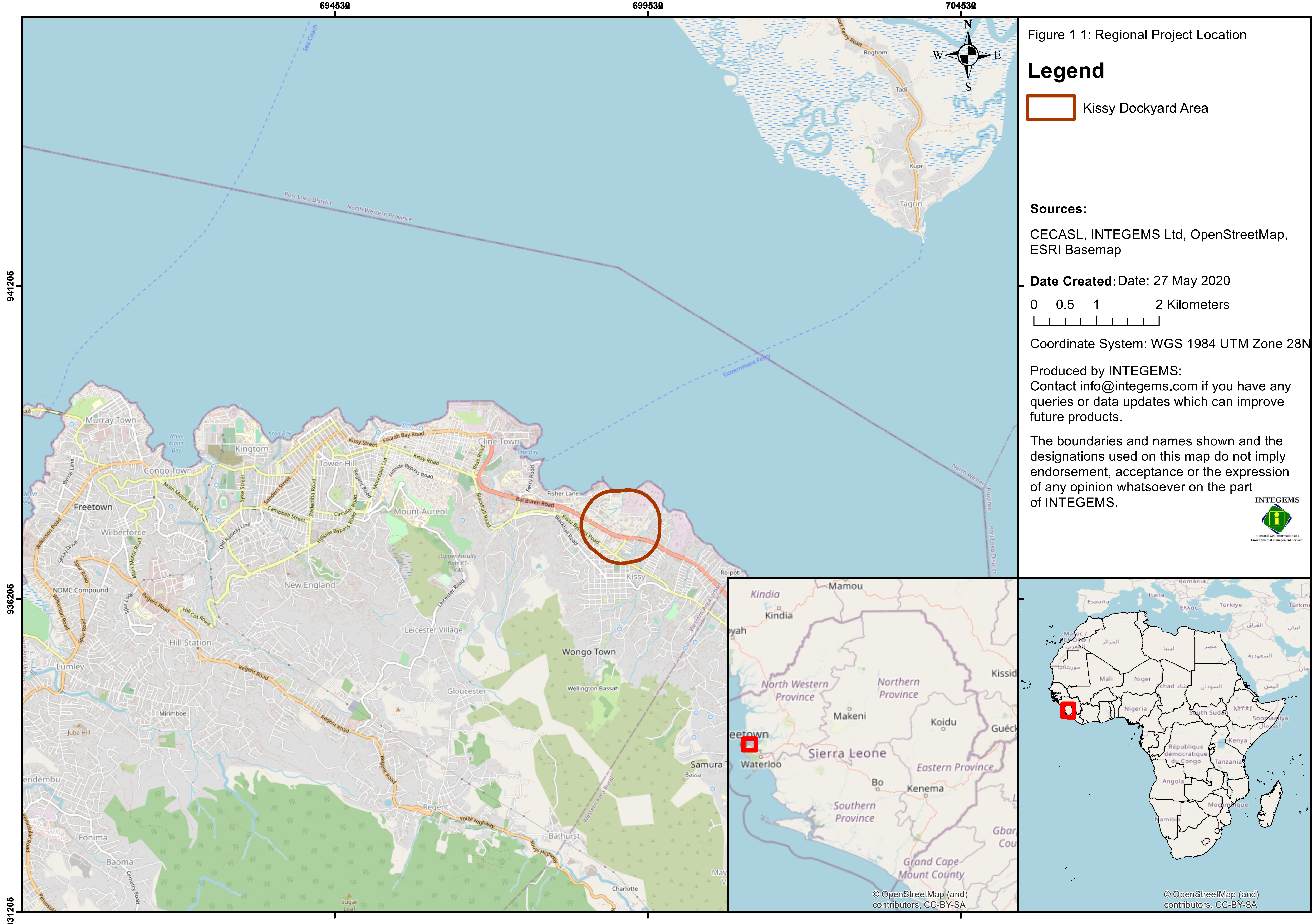
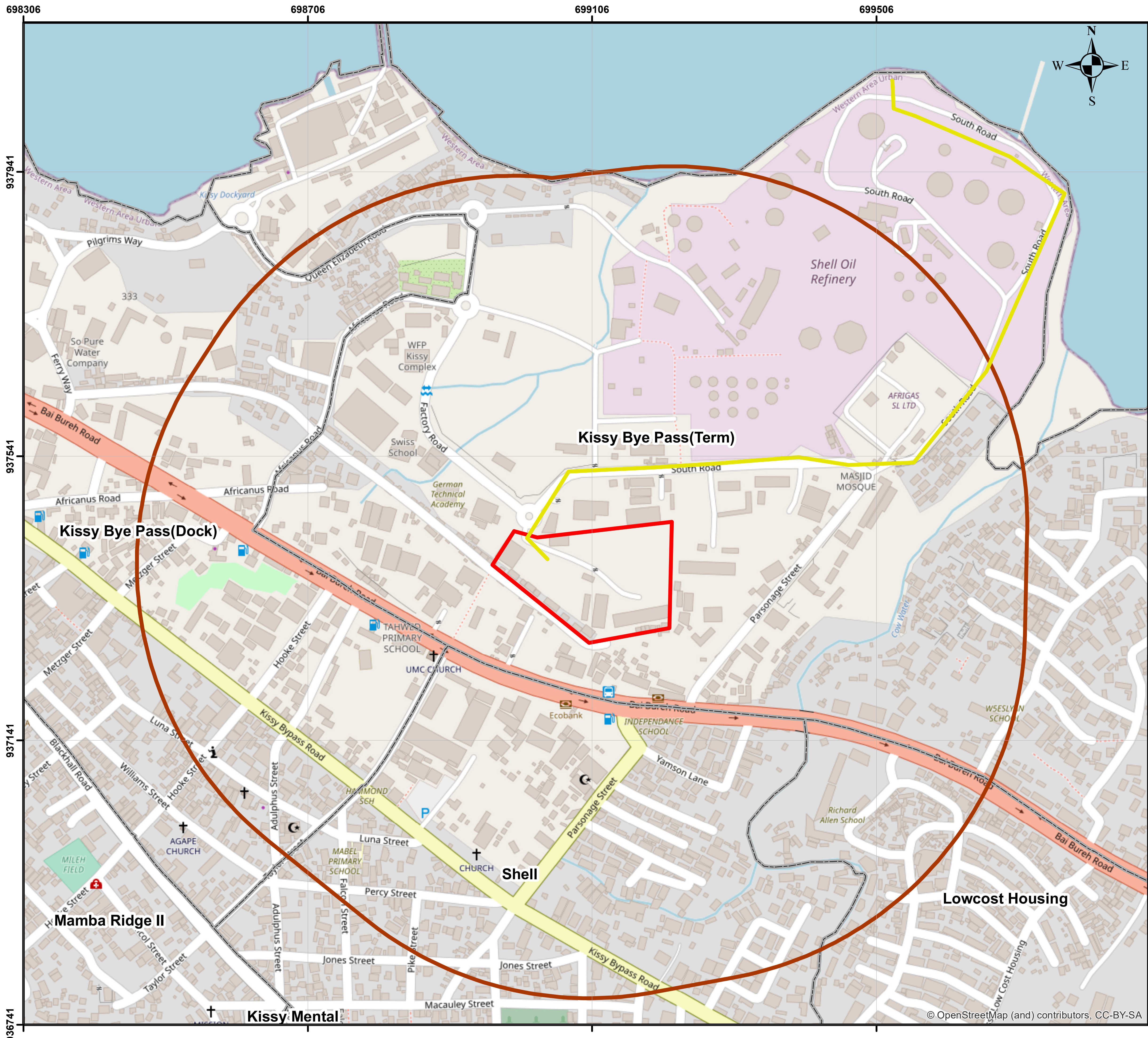


Figure 1 1: Regional Project Location

Figure 1-2: Project Location within Kissy Dockyard



Legend

- LPG Pipeline
- Project Site
- 500m Buffer
- Areas - Communities

Sources:

CECASL, INTEGEMS Ltd, OpenStreetMap, ESRI Basemap, Stats SL

Date Created: Date: 27 May 2020

0 0.05 0.1 0.2 Kilometers

Coordinate System: WGS 1984 UTM Zone 28N

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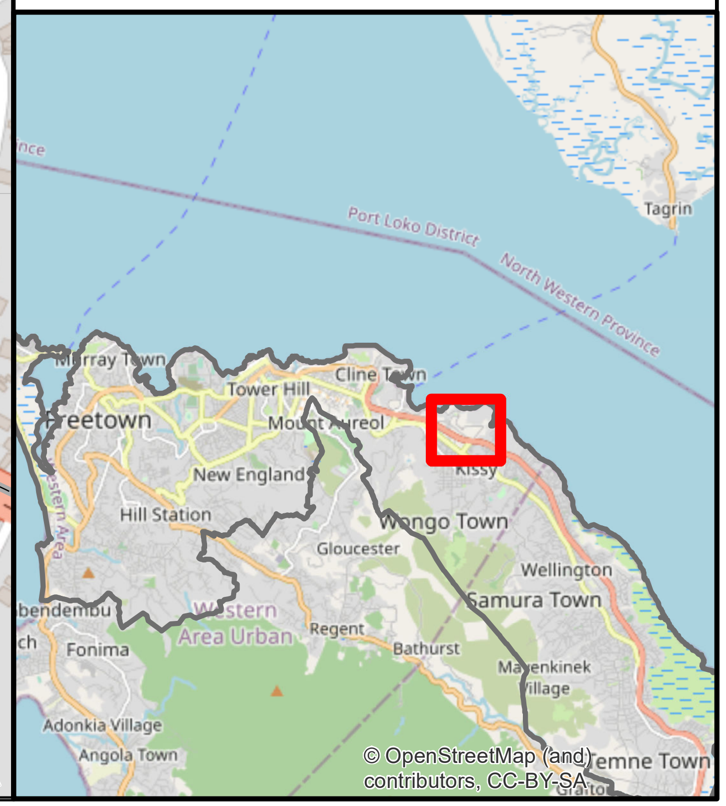


2 CLIMATE AND METEOROLOGY

2.1 General Description of Climate in Sierra Leone

Sierra Leone is located on the West coast of Africa, between latitude 7º and 10º north of the equator and longitude 10º and 13º west. The climate in Sierra Leone is tropical, with a wet season from May to October and a dry season from November to April.

The Inter-Tropical Convergence Zone (ITCZ) has a major influence on the climate of Sierra Leone. Throughout the year the ITCZ remains in the northern hemisphere in the eastern Pacific and Atlantic regions. Over Africa, the ITCZ migrates from the southern to the northern hemisphere between January and July (Tyson & Preston-Whyte, 2000). The hot weather during this period, heats the air in the ITCZ, increasing its humidity and making it buoyant. As the buoyant air rises as a result of the trade winds from the south-west, it expands and cools, producing rainfall over Sierra Leone and surrounding regions. As the ITCZ moves south during September, the wet season draws to a close.

The winds that originate during the dry season (winter), known as the Harmattan winds, consist of the northeast trade winds. These winds bring no precipitation apart from the occasional very light rain. The Harmattan winds transport dust from the Sahara Desert and usually blow from late November to mid-March. Average wind speeds in Sierra Leone are generally low.

The temperatures are consistently high throughout the country, roughly averaging from 25–27 °C, with slightly lower temperatures (22–25 °C) during the wet season. Diurnal temperatures vary from 25 °C to 34 °C although, they could be as low as 16 °C at night during the Harmattan (Figure 2-2). The average annual temperature has increased by 0.8 °C since 1960. Data is limited but, available data show significantly increasing trends in the frequency of 'hot' nights. The humidity, like the temperature, is usually high as a result of the heavy rains coupled with high temperature and maritime influences. Humidity rises to 93% in the wet season and decreases inland to about 47% as the rainfall declines. There is little seasonal variation in mean air temperatures, with slightly hotter conditions in April and May. Altitude influences temperature as well as other weather variables, with temperatures generally decreasing with altitude.

Due to heavy rainfall in the wet season, discharges and runoff are high and ranges from 20% to 40% of total annual rainfall. Rivers overflow their banks during this period. Average annual rainfall over Sierra Leone has decreased since 1960 but it is difficult to determine whether this is part of a long-term trend because of the variable nature of rainfall in this region. The dry season is prone to dusty and hot Harmattan winds and drought conditions. However, there is pronounced dry season from November to March when flows may be sufficiently reduced to be a constraint.

There is little variation in the day length due to the near-equatorial location, but sunshine hours are affected during the wet season. Sunshine is plentiful and varies substantially with the amount of cloudiness. During the dry season (November to March) mean monthly solar radiation is high, 380 cal/ cm^2/day (480 lux); mean hours of sunshine varies from 7-9, and pan evaporation is about 4.5 mm per day. The wet season is generally dull and cloudy with a mean monthly solar radiation of 280 cal/ cm^2/day, mean hours of sunshine is 3 hours/day in July and August, and pan evaporation generally less than 2.0 mm/day, due to high diurnal humidity.

Between the year 1991 and 2015, a mean annual rainfall of about 2,427 mm was recorded, with the highest annual rainfalls recorded in July, August and September (see Figure 2-1) (WBG, 2018).

Figure 2-1: Average Monthly Rainfall for Sierra Leone (1991 – 2015)

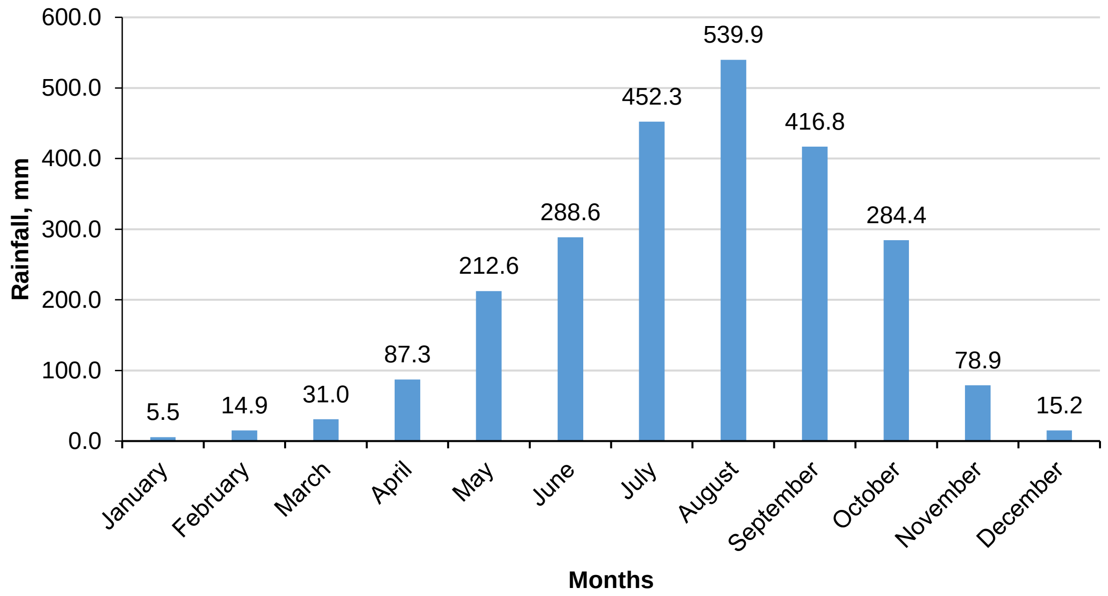
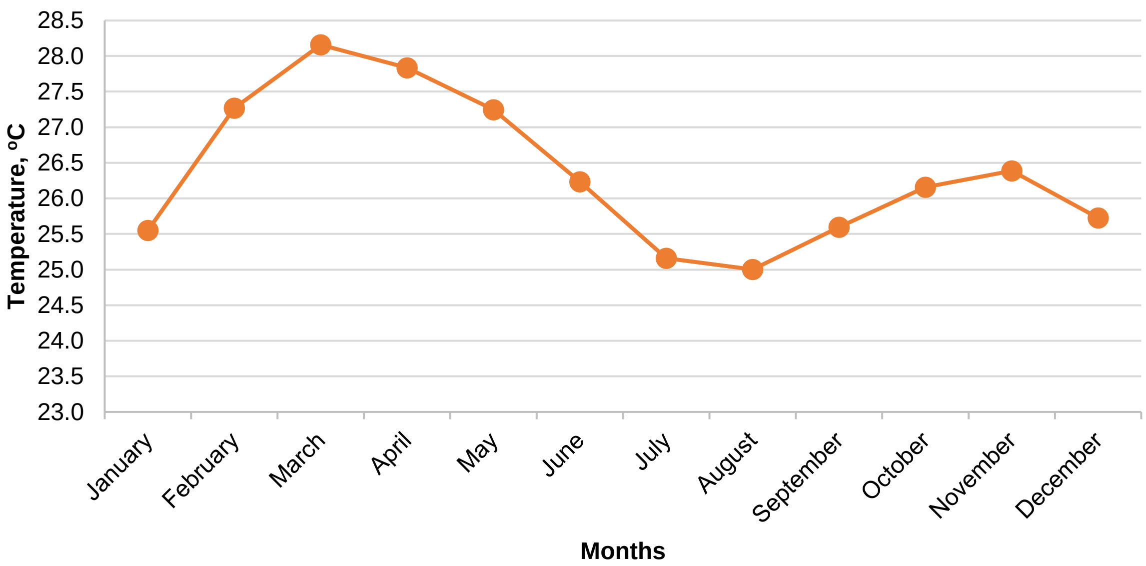


Figure 2-2: Mean Monthly Temperature for Sierra Leone (1991 – 2015)



2.2 Climate Conditions in the Project Area

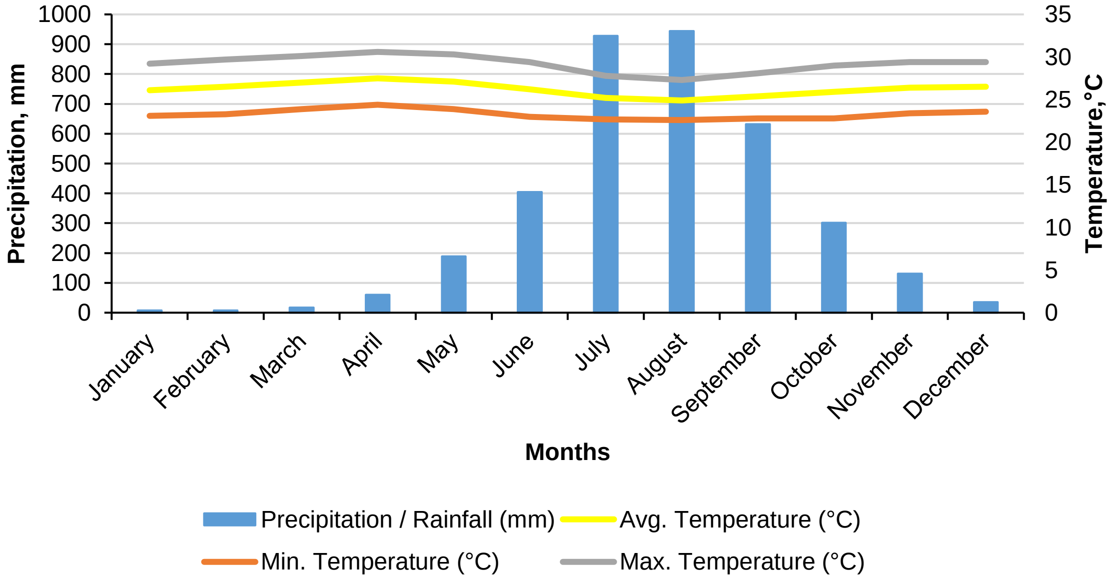
Generally, the climate of the project area (taken from the Climate of Freetown) is described as wet tropical monsoon with a single wet season each year. According to Köppen and Geiger, this climate is classified as Am. The average temperature in Freetown is 26.2 °C with rainfall around 3657 mm per year (see Table 2-1 and Figure 2-3)[1]. The precipitation varies 937 mm between the driest month and the wettest month. To acquire site-specific meteorological data for future analysis and modelling (including air emission dispersion or noise modelling), it is recommended that an automatic weather station is installed at the project site.

[1] CLIMATE DATA.ORG (accessed via: https://en.climate-data.org/africa/sierra-leone/western-area/freetown-526/, 25 May 2020)

Table 2-1: Temperature and Precipitation Records for Freetown (1982-2012)

Month	Temperature, °C			Precipitation / Rainfall (mm)
	Average	Minimum	Maximum	
January	26.1	23.1	29.2	8
February	26.5	23.3	29.7	7
March	27.0	23.9	30.1	17
April	27.5	24.4	30.6	60
May	27.1	23.9	30.3	189
June	26.2	23.0	29.4	404
July	25.2	22.7	27.8	928
August	24.9	22.6	27.3	944
September	25.4	22.8	28.1	632
October	25.9	22.8	29	302
November	26.4	23.4	29.4	131
December	26.5	23.6	29.4	35

Figure 2-3: Temperature and Precipitation Records for Freetown (1982-2012)



3 AIR QUALITY

Urban air pollution has the potential to cause significant environmental problems wherein pollution can build up in isolated pockets, and local sources for instance near industries or busy roads; thus, adding to the overall reduction of air quality of the area. The Kissy Dockyard area has both industrial/commercial and residential makeup.

There is no regulatory local monitoring undertaken within Sierra Leone, although some work carried out by the Njala University, Sierra Leone indicates that air quality at certain locations in Freetown is considered poor for some substances (Taylor & Nakai, 2012), and these locations could potentially be classified as degraded airsheds.

The key sources of air pollution which influence air quality in the vicinity of the project site are likely to be domestic or commercial-scale power generators, burning of household or commercial wastes, residential wood and charcoal ovens, road traffic emissions, industrial emissions and re-suspended dust/particulate matter from poorly surfaced or unsurfaced roads. Due to unreliable power sources, domestic and commercial power generators, commonly running on diesel are prevalent in most parts of Freetown, including around the site. This will lead to increased emissions of substances associated with combustion in addition to those emitted by road traffic, for example, nitrogen dioxide, sulphur dioxide, particulates and carbon monoxide. The amount of poorly surfaced roads is likely to lead to significant dust generation during the dry season. During the rainy season, the potential for significant dust generation is less likely.

3.1 Methodology

Air quality monitoring was undertaken to update the data acquired in 2015 for the previous ESHIA. The monitoring was undertaken at five locations between April and May 2020. As best as possible, these locations were the same locations as those in the 2015 baseline study. However, the sites were subjected to accessibility and security constraints. Therefore, only five sites were monitored, and with marginal deviations from the original positions. Generally, the selection of the locations is based on various factors such as site topography, prevailing wind direction, the layout of the proposed project components, the location of the nearest sensitive receptors and good international industry practise and guidelines. The list of locations is presented in Table 3-1 and illustrated in Figure 3-1.

The following are the air pollutants parameters measured during the monitoring: Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Ozone (O_3), Volatile Organic Compounds (VOCs), Particulate Matter aerodynamic diameter 10 µm (PM_{10}) and Particulate Matter of aerodynamic diameter 2.5 µm ($PM_{2.5}$). The monitoring was designed to record the average concentrations of each pollutant in the air at the specified locations over a three (3) days period.

Air pollutants are emitted into the atmosphere from a variety of sources and the concentration of these pollutants in the ambient air depends not only on the quantities that are emitted but also the conditions and ability of the atmosphere, to either absorb or disperse these pollutants. Understanding the behaviour of meteorological parameters is important because the atmosphere is the medium in which air pollutants are transported away from the source, which is determined by the meteorological parameters. Therefore, at each monitoring location data was additionally acquired for temperature and relative humidity.

The air quality monitoring was undertaken using a portable air quality monitor Aeroqual Series 500 sensor, which enables accurate short-term fixed real-time surveying of common outdoor air pollutants. The sensors are housed within an interchangeable cartridge ("head") that attaches to the monitor base which can be removed and replaced in seconds, allowing users to measure as many gases as desired.

The measurements were carried out by placing the equipment at a height of about 1.5 -1.7 metres from the ground level and sufficiently away from any disturbance or direct obstacle from the source(s) under consideration to ensure that the air that is monitored is representative of the air that most residents/visitors were breathing. During the monitoring, the field staff were stationed on the sites on a daily basis to perform routine data checks, performance audits, and scheduled maintenance. The field technicians carried out QA/QC duties, including change of filters (where necessary), and retrieval/download of raw data. Photographic reference for each measurement location was also recorded as shown in Figure 4-4 to Figure 4-5.

Table 3-1: Air Quality Monitoring Locations

Site ID	Site Name	Description	Latitude	Longitude
AQMP 01	Shell Police Station	Location AQMP 01 is approximately 74 m south of the project site along Bai Bureh Road, a highway with frequent vehicular movement, petty trading and numerous small and large-scale commercial activities. Within the vicinity of the point is a Bus Park for passengers travelling out of Freetown to the Province with a gas station located at a distance of 40 m south of the monitoring point.	8.474425	-13.191168
AQMP 02	Sierra Leone Housing Cooperation (SALHOC) Gate	Monitoring point AQMP 02 is located southwest of the project site at a distance of about 132 m. The point is similarly located along Bai Bureh Road. Within the immediate vicinity of AQMP 02 are SALHOC Compound, National Petroleum (NP) gas station, Commodity Trading Company (CTC), Tahweb Primary School and a tyre servicing centre about 10 meters away.	8.475105	-13.193238
AQMP 03	Sir Winston Churchill International Secondary School (SWISS)	AQMP 03 is located at the SWISS compound at approximately 137 m northwest of the project site. The monitoring point is about 30 m south of Factory Road, an unpaved road within the Kissy Dockyard industrial zone. A metal welding shop is located within the SWISS compound, although this facility was not operational during the monitoring period.	8.477215	-13.193336
AQMP 04	Masjid IHASAN Mosque	Location AQMP 04 is 266 m east of the project site at the Masjid (Mosque) IHASAN compound along South Road, which is frequently plied by fuel bowsers en route to NP's Fuel Depot, which is about 200 m northeast. The critical receptors within the vicinity of this point include squatters along South Road and the Government Independent Memorial Secondary School along Parsonage Street.	8.477328	-13.188037
AQMP 05	Fomel Industries and National Industrialisation Centre (FINIC) Fence	AQMP 05 is located adjacent FINIC at about 67 m east of the project site and about 30 m off South Road. Within the most immediate vicinity of AQMP 05 is Bollore Logistics Compound and with squatters along the fences of the industrial compounds.	8.476635	-13.189709

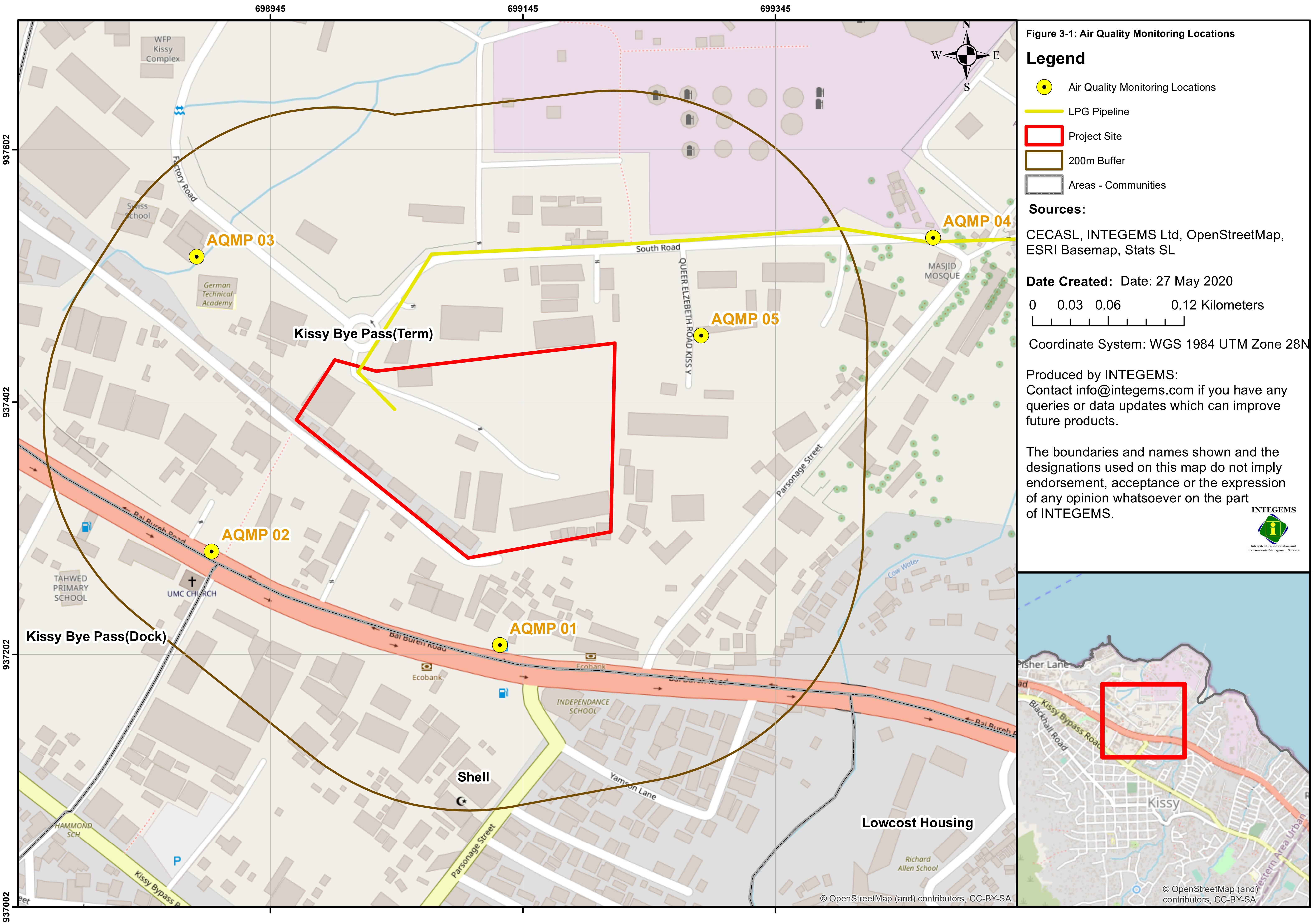


Figure 3-1: Air Quality Monitoring Locations

3.2 Results and Analysis

The air quality at the site is generally influenced by activities and sources such as the combustion of engines, open burning by residents and businesses, the concentration of dust particles from roads and emissions from equipment and machinery used in transportation and industrial operations. These impacts may affect the environment and human health. In studying the receiving environment, the following was observed:

- The area is characterised by industrial and commercial uses with some formal and informal shanty dwellings and school dispersed between.
- There are several sources of air pollutants in the area which includes domestic and commercial-scale power generators, burning of household or commercial wastes, road traffic emissions (i.e. exhaust and non-exhaust emissions), emissions from industrial operations and re-suspended particulate matter from paved and unpaved roads.
- The most sensitive receptors within the area residences, schools, places of worship and employees of various entities within the project area.
- The weather was warmer with temperatures ranging from 32.3 ^{o}C to 36.6 ^{o}C with an average of 34.7 ^{o}C over the two weeks of monitoring.

The results from the air quality monitoring are presented in Table 3-2 and Table 3-3, while the analysis is presented in Sections 3.2.1 to 3.2.6. Guidelines published by the WHO (WHO, 2005) are utilised in this report as there are no applicable ambient air quality guidelines in Sierra Leone.

Table 3-2: Mean Air Pollutant Concentrations

Parameter	Units	WHO Daily Standard Values	AQMP 01	AQMP 02	AQMP 03	AQMP 04	AQMP 05
$PM_{2.5}$	µg/m^3	25	24.11	38.05	34.77	16.23	68.32
PM_{10}	µg/m^3	50	63.53	82.99	93.49	48.81	71.48
NO_2	µg/m^3	200	18.48	9.73	14.06	23.7	15.27
CO	µg/m^3	3000	57.44	75.76	28.85	0	0
O_3	µg/m^3	100	21.88	24.12	23.28	26.17	27.95
SO_2	µg/m^3	20	0	0	0	0	0
VOCs	mg/m^3	NA	624	391	307	617	635
Temperature	^oC	NA	34.8	33.6	34	35.9	35
Relative Humidity	%	NA	56.3	59.6	60.9	50.9	55.8

Table 3-3: Daily Air Mean Pollutant Concentrations

Locations	Day	Date, dd/mm/yyyy	$PM_{2.5}$, µg/m^3	PM_{10}, µg/m^3	NO_2, µg/m^3	CO, µg/m^3	O_3, µg/m^3	SO_2, µg/m^3	VOC, mg/m^3	Temperature, ^oC	Relative Humidity, %
Standard Values			25	50	200	3,000	100	20	NA	NA	NA
AQMP 01	1	15/04/2020	21.29	63.15	9.177	0.00	10.62	0.00	977	34.1	57.5
	2	16/04/2020	33.56	68.72	34.810	172.31	34.67	0.00	478	35.1	55.1
	3	17/04/2020	17.47	58.72	11.460	0.00	20.35	0.00	417	35.2	56.4
AQMP 02	1	18/04/2020	19.77	63.12	6.308	0.00	26.42	0.00	385	32.3	61.5
	2	19/04/2020	59.23	108.31	13.538	0.00	24.64	0.00	411	35.6	53.9

Locations	Day	Date, dd/mm/yyyy	$PM_{2.5}$, µg/m^3	PM_{10}, µg/m^3	NO_2, µg/m^3	CO, µg/m^3	O_3, µg/m^3	SO_2, µg/m^3	VOC, mg/m^3	Temperature, ^oC	Relative Humidity, %
	3	20/04/2020	35.15	77.54	9.346	227.28	21.29	0.00	378	33.0	63.3
AQMP 03	1	21/04/2020	35.77	83.03	23.154	0.00	24.03	0.00	322	34.7	57.3
	2	22/04/2020	31.12	87.04	7.615	86.54	15.46	0.00	312	35.1	58.4
	3	23/04/2020	37.42	110.39	11.423	0.00	30.35	0.00	286	32.3	66.9
AQMP 04	1	24/04/2020	20.62	47.95	31.690	0.00	34.13	0.00	405	35.3	57.3
	2	25/04/2020	8.58	18.46	23.920	0.00	22.42	0.00	467	35.9	49.5
	3	28/04/2020	19.49	80.03	15.490	0.00	21.95	0.00	979	36.6	45.9
AQMP 05	1	29/04/2020	48.19	70.50	15.850	0.00	23.54	0.00	752	35.9	54.5
	2	30/04/2020	142.47	114.36	25.420	0.00	37.42	0.00	498	32.6	58.8
	3	01/05/2020	14.31	29.59	4.540	0.00	22.89	0.00	656	36.5	54.2

3.2.1 Particulate Matter

Particulate Matter is airborne particles that include dust, smoke, soot, dirt and liquid droplets and can either be emitted naturally (e.g. windblown dust of roads) or by human activity (e.g. stack emissions). PM is defined by size, with coarse particles being between 2.5-10 microns (µm), fine particles less than 2.5 µm, and ultrafine particles less than 0.1 µm. PM has adverse effects on humans, such as respiratory illnesses (asthma, bronchitis) or cardiovascular diseases and is also considered as being carcinogenic.

Except for location AQMP 04, the average PM concentrations for all other locations exceeded the WHO guideline values. The elevated particulate concentration in the study area is due to exhaust emissions (Fuel and oil combustion from automobiles), non-exhaust emissions (particles released into the air from brake wear, tyre wear, road surface wear and resuspension of road dust during on-road vehicle usage) and some fugitive emissions from other domestic and commercial activities such as biomass burning.

It must, however, be noted that monitoring was undertaken at the end of the dry season with sporadic rains, which would lead to lower ambient particulate as compared to the absolute dry season.

3.2.2 Sulphur Dioxide

Sulphur dioxide is a colourless gas and is characterised as having a sharp, irritant odour. It is a primary pollutant, which can react easily with other substances and form secondary pollutants such as sulphur trioxide and sulfuric acid, amongst others. SO_2 is formed by human activities through mainly industrial processes that contain sulphur, such as the combustion of coal, oil or gas. Sulphur dioxide is damaging to the human respiratory function when inhaled, causing coughing and shortness of breath. Either long term exposure or exposure to a large dose can result in chronic respiratory disease and the risk of acute respiratory illness. With respect to the impacts on vegetation, SO_2 can inhibit the photosynthetic properties of plants and in some cases, eliminate more sensitive species on the ecosystem level with continuous exposure.

The monitoring data indicated zero background SO_2 concentration across all the monitoring locations. This could be attributed to the absence of significant SO_2 sources within the monitoring locations. However, it must be noted that long-term atmospheric monitoring within the area could record SO_2 concentrations as was the case in the 2015 ESHIA study.

3.2.3 Nitrogen Dioxide

Nitrogen dioxide is a naturally forming gas, characterised as having an irritating odour. Small quantities can be produced by plants, soil and water, but anthropogenic activities, such as the combustion of fossil fuels and biomass, are the sources of most NO_2. Nitrogen dioxide is one of a group of gases called nitrogen oxides (NO_x). While all of these gases are harmful to human health and the environment, NO_2 is of greater concern. It primarily gets in the air from the burning of fuel in vehicles, power plants, and off-road equipment. Human respiratory tract irritation represents a direct effect of NO_2 exposures. Due to it being relatively insoluble (relative to SO_2), NO_2 can penetrate deep into the lungs, causing potential tissue damage. Effects of NO_2 exposure include alveolar tissue disruption and obstruction of the respiratory bronchioles. Long term effects of exposure include increased potential for lung infections.

The NO_2 concentrations recorded for all the locations are within the 24-hourly mean according to the WHO ambient air quality guideline of 200 µg/m^3. However, AQMP 01 and AQMP 02 positioned adjacent the busy Bai Bureh Road recorded roadside measurement which is not generally representative of ambient concentrations in the areas at proximity to the proposed project site.

3.2.4 Carbon Monoxide

Carbon monoxide is a colourless, odourless, highly toxic gas that deoxygenates human blood, causing oxygen deprivation. The most common source of carbon monoxide is motor vehicle emissions, where it results from the combustion of petrol in the presence of insufficient oxygen. It is also a result of hydrocarbon fuel-consuming industries and domestic fires.

Recorded data for CO in all monitoring points within the study area are lower than the WHO 24-hourly guideline value of 3000 µg/m^3. Locations AQMP 04 and 05 recorded zero CO background concentrations. This could be attributed to the absence of quantifiable CO emissions within the vicinities of the monitoring locations. Conversely, the CO concentrations recorded at the other locations could be attributed to exhaust emissions from frequent vehicular movement, emissions from generators and chimneys from nearby industrial activities.

3.2.5 Ozone

Ozone in the stratosphere absorbs most of the ultraviolet radiation from the Sun. Although ozone high up in the stratosphere provides a shield to protect life on Earth, direct contact with ozone is harmful to both plants and animals (including humans). Ground-level (or "bad") ozone is formed in the atmosphere by photochemical reactions in the presence of sunlight and precursor pollutants, such as NOx and VOCs[2]. Ozone is the major constituent of photochemical smog, which is a complex mixture and also containing oxidised organics. In the troposphere near the Earth's surface, the natural concentration of ozone is about 10 parts per billion. According to the US-EPA, exposure to ozone levels of greater than 70 parts per billion for 8 hours or longer is unhealthy. Such concentrations occur in or near cities during periods where the atmosphere is warm and stable. The harmful effects can include throat and lung irritation or aggravation of asthma or emphysema.

The monitoring results indicate that ozone concentration is relatively low compared to WHO guideline values. The concentration of natural tropospheric ozone is estimated at 10 ppb (about 21.1 $\mu g/m^3$)[3]. Therefore, it can be concluded that the recorded ozone levels are within the thresholds considered to be normal. Additionally, it is worthy to note that as a secondary pollutant, ozone's concentration in the troposphere is dependent on the interaction between NO_2 and VOCs and the relative abundance of sunlight.

3.2.6 Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are organic compounds that easily become vapours or gases. Along with carbon, they contain elements such as hydrogen, oxygen, fluorine, chlorine, bromine, Sulphur or nitrogen. Volatile organic compounds are released from burning fuel, such as gasoline, wood, coal, or natural gas. They are also emitted from diesel exhaust and released from solvents, paints, glues, etc. VOCs, when combined with nitrogen oxides, react to form ground-level ozone or photochemical smog.

VOCs concentration in all the monitoring sites ranges from 286 mg/m^3 to 979 mg/m^3. However, there is no known standard concentration value for the regulation of VOCs in the atmosphere. Potential sources of VOCs within the study area include vehicles (i.e. as evaporates and from exhaust emissions), manufacturing facilities, petroleum depots (i.e. storage tank farms), gas stations as well as from solvents, paints and glue within the surroundings.

3.3 Conclusion

The airshed refers to the local area around the power plant where ambient air quality is directly affected by emissions from the power plant. The size of the airshed depends on plant characteristics, such as stack height, topography and meteorological conditions. The monitoring results are all within the WHO guideline values except for particulates. This would indicate that there is a degraded airshed for PM_{10} and $PM_{2.5}$. The background measurements obtained in the vicinity of the site are likely to be elevated by traffic flows and emissions from nearby industries, petroleum depot, business units and residents.

[2] US EPA Ground-level Ozone Pollution (accessed via: https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics, 8 April 2020)

[3] Tropospheric Ozone (accessed via: https://www.ldeo.columbia.edu/~martins/eda/ozone_lec1.html, 27 May 2020)

4 ENVIRONMENTAL NOISE

According to the World Health Organisation (WHO), Noise is described as “unwanted sound”. Noise can have an effect on the environment and the quality of life enjoyed by individuals and communities. The effects of noise can, therefore, be an important consideration in the environmental management of power generation plants, and particularly during the operational phases of such projects where the plants have to be consistently powered on for effective power generation.

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, including road traffic, industries, wind, humans and, animals. Noise is considered ‘nuisance’ when it is excessive, disruptive and/or displeasing. Nuisance noise and/or high noise levels can affect both physiological and psychological human health, with long-term excessive noise levels being damaging to human hearing.

The human ear has a wide sound-sensitivity range, and thus the decibel (dB) is a logarithmic unit, that allows this range to be compressed into a comprehensible range. The human ear is less sensitive to low-frequency sound than high-frequency sound. Sound level meters for such studies are designed with an in-built weighing, termed the “A-weighted” dB(A) - decibels audible - a scale that approximates the human loudness response. The LA_{eq}, (logarithmic A-weighted equivalent) the most commonly used indicator for noise, is the equivalent continuous A-weighted sound pressure level, over a specified time interval, e.g. 15-minutes, 1-hour, 24-hours, etc. Decibel noise levels cannot be added or averaged arithmetically since they are logarithmic parameters. For example, if one source is generating a noise level of 50 dB(A), and another similar source is placed beside it, the noise level will increase to 53 dB(A), not 100 dB(A). Ten similar sources placed side by side increase the sound level by 10 dB(A), and one hundred sources increase the sound level by 20 dB(A). However, empirically, the human ear perceives the magnitude increase of 10 dB(A) as a doubling in noise.

4.1 Methodology

Ambient environmental noise monitoring was undertaken at Seven (7) locations within and around (i.e. 500 m buffer) the project site (see Figure 4-1) in April and May 2020. The monitoring locations were selected based on existing noise sources and potential receptors. At each of the locations, a Casella CEL 633A - a Class 1 noise meter was set to log 5-minute averages of the following A-weighted broadband statistical noise descriptors for a monitoring duration of 1 hour per log:

- **LA_{eq} (Equivalent Continuous Sound Pressure Level)** – the Equivalent Continuous Sound Pressure Level is the constant noise level that would result in the same total sound energy being produced over a given period. LAeq is a fundamental measurement parameter designed to represent a varying sound source over a given time as a single number. This number is a measure of the energy contained within the sound at the point of the receiver. This is useful in terms of the potential for sound to damage or disturb and is extensively used in environmental noise standards as well as many other regulations and documents.
- **LA_{90} (Background Noise Level)** - The Background Noise Level is the level of noise exceeded by 90% of the time of measurement. It’s measured to extensively rate traffic noise and background noise respectively.
- **LA_{10} (Commonly used to quantify road traffic noise)** - This is the level of noise exceeded during 10% of the time of measurement. It’s measured to extensively rate traffic noise and background noise respectively.
- **LAF_{max} (Maximum noise levels, fast time response)** - This shows the highest sound pressure level within the measurement period. It’s measured to ascertain the maximum sound level attained during any given measurement.
- **LAF_{min} (Minimum noise levels, fast time response)** - This shows the lowest sound pressure level within the measurement period. It’s measured to ascertain the minimum sound level attained during any given measurement.

It must be noted, however, that the assessment was done during the Novel Coronavirus Disease (COVID-19) pandemic with restrictive measures in place, including a nationwide curfew between 21:00-06:00 GMT, which prevented night-time monitoring. Therefore, the acoustic environment of the selected monitoring locations has been described for day-time noise over two days and compared with the WBG EHS guideline values for the day-time noise level in industrial and residential areas.

The coordinates of the all noise sampling locations were determined using GPS and site characteristics of the geo-referenced stations documented (Table 4-1). Photographic reference for each measurement location was also recorded (see Figure 4-6 - Figure 4-12). All measurement locations were subjected to site access and security constraints. In addition, the conditions captured during monitoring at certain locations/days may reflect potential reductions in ambient noise levels as a result of reduced working activities and travel within the local area under Covid-19 conditions. Because business has slowed down, curfews have been imposed, and activity is generally scarcer in the community than pre-COVID-19, noise conditions may presently be lower than under "business as usual" conditions.

As was recommended in the 2015 ESHIA Report, further measurements have been undertaken within 500 m of the project, where noise impacts are anticipated based upon preliminary modelling results, to get a better understanding of the existing background levels at receptor locations.

Table 4-1: Noise Monitoring Locations within and around the Project Area

ID	Name	Latitude	Longitude	Approx. Distance from Project Site (m)
NMP 01	Project Site	8.475598	-13.191870	0
NMP 02	Project Site	8.475754	-13.190315	0
NMP 03	Project Site	8.476494	-13.190938	0
NMP 04	Magram Water Bottling Company Compound	8.476960	-13.191005	40
NMP 05	Government Independent Memorial Secondary School	8.477320	-13.188037	278
NMP 06	Shell Lane	8.472696	-13.190654	295
NMP 07	Bai Bureh Road	8.470800	-13.190910	466

The Environmental Protection Agency Act (2008) currently has no specific provisions for protection against noise and does not set standards or guidance of specific relevance to the Project. In the absence of specific national or local guidance concerning noise issues, INTEGEMS has referred to guidance published by WBG/IFC. The IFC has published Environmental Health and Safety (EHS) Guidelines (April 2007) which are technical reference documents with general and industry-specific examples of international good practice. Reference to these guidelines forms part of the IFC's environmental and social review procedure and is compulsory for IFC clients.

The IFC 2012 Performance Standards, in conjunction with the WB/IFC EHS Guideline, advises that pollution, in general, be prevented by control at source. Whilst it is acknowledged that the Project is not an IFC project, the EHS Guidelines provide a useful resource in line to achieve IFC compliance. The Guidelines detail the performance levels and environmental management measures considered achievable using Best Available Technology Not Entailing Excessive Cost (BATNEC). The IFC PS specifies that noise abatement measures meet one of the following two conditions:

- Noise levels from the Project at the most sensitive point of reception should not exceed the limits specified in Table 4-2. This condition utilises the acceptable level criterion, which allows the use of a nominal table value, rather than the actual pre-development ambient level, as the baseline reference. Post-development noise is usually measured at noise receptors located outside the project boundary and compared with the applicable baseline level derived from the table.

- Noise levels from the Project at the most sensitive point of reception should not cause background levels to increase by more than 3 dB(A). This condition employs the noise emergence criterion, using as baseline the actual ambient level determined by measurement at receptor locations, i.e. both pre- and post-development levels are determined by measurement.

Table 4-2: WBG / IFC EHS Guideline - Noise Level Guidelines

Receptor		Noise Level - One Hour LA_{eq}, dB(A)	
		Daytime (07:00– 22:00)	Nigh-time (22:00-07:00)
(a)	Residential; institutional; educational	55	45
(b)	Industrial; commercial	70	70

4.2 Results and Analysis

The project site is located at Kissy Dockyard which is predominantly an industrial zone interspersed by small businesses and residential houses, with sources of major industrial-scale emissions that can cause a significant increase in noise levels. The project site is approximately 100 m north of Bai Bureh Road the major highway linking the provinces to Freetown and serving as a major source of noise from vehicular movement and roadside commercial activities around the Shell axis. Noise levels within the study buffer (i.e. 500 m buffer of the project site) are mainly characterised by continuous sound from vehicular movement, generators and power plants at business premises and industrial workshops/factories, intermittent noise from musical systems, impulsive noise from unidentified sources and low frequency sounds from human and animal communications.

A summary of noise data recorded at the monitoring locations is presented in Table 4-3 and Table 4-4 and graphically displayed in Figure 4-2, while detailed 1-hourly log data are presented in Appendix C. Analysis of the data captured is presented for each monitoring location in Sections 4.2.1 to 4.2.7 below. It is worthy to note that, all measured noise levels are sound pressure levels measured on the A scale. Therefore, except if explicitly stated, noise values presented in dB in this report are the same as dB(A).

Table 4-3: Average Noise Results for each location

Location ID	Location Description	LAeq, dB(A)
NMP 01	Project Site – Southern Boundary	59.8
NMP 02	Project Site – Eastern Boundary	48.2
NMP 03	Project Site - Northern Boundary	49.5
NMP 04	Magram Water Bottling Company	64.4
NMP 05	Government Independent Memorial Secondary School (GIMSS)	63.1
NMP 06	Shell Lane – Off Parsonage Street	69.0
NMP 07	Bai Bureh Road/ Africanus Road	75.1

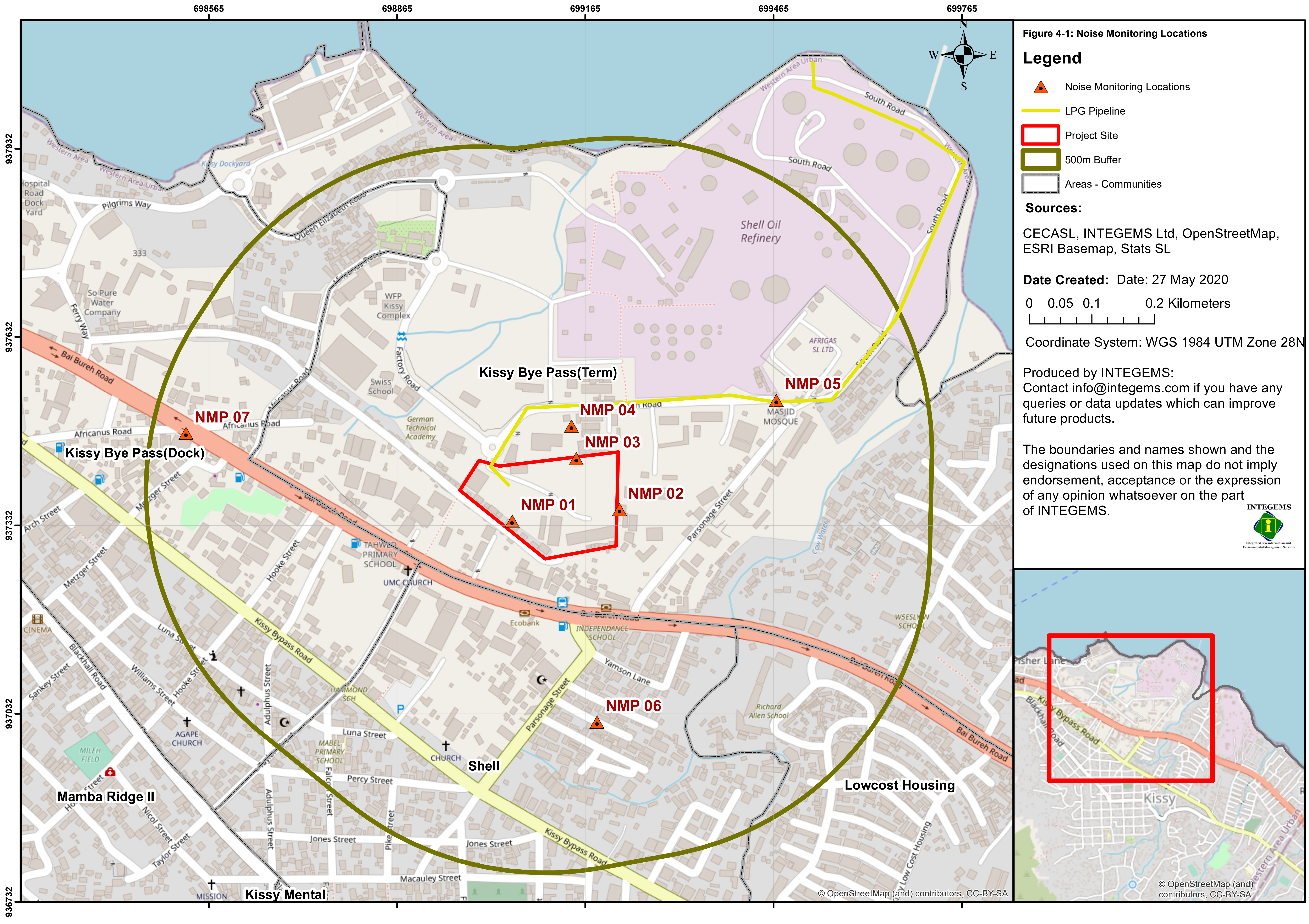
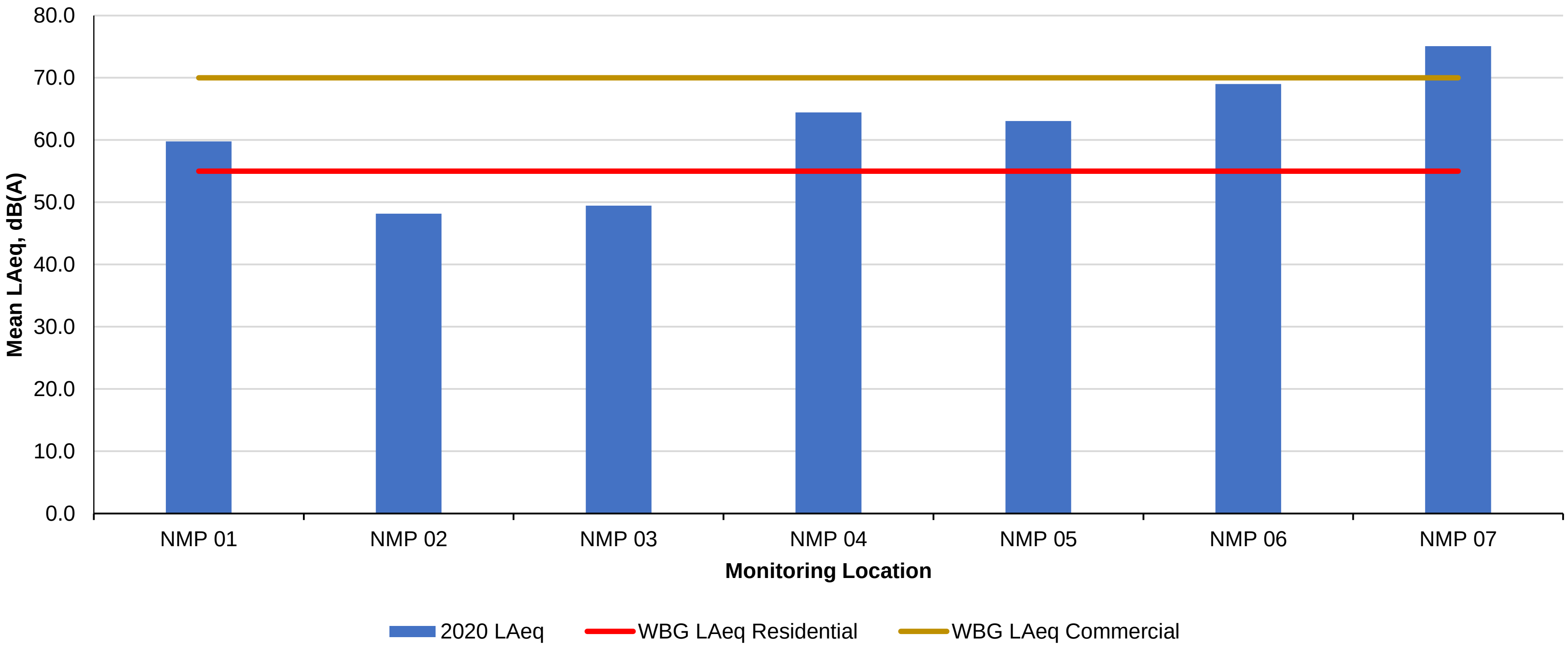


Figure 4-1: Noise Monitoring Locations

Table 4-4: Mean Daily Continuous Sound Pressure Level

Location ID	Location Name	Day	Date	Total Monitoring Duration, hrs	Average LAeq dB(A)
NMP 01	Project Site – Southern Boundary	Day 1	15 April 2020	7	62.9
		Day 2	18 April 2020	9	52.7
NMP 02	Project Site – Eastern Boundary	Day 1	16 April 2020	8	49.0
		Day 2	19 April 2020	8	47.2
NMP 03	Project Site - Northern Boundary	Day 1	17 April 2020	8	50.6
		Day 2	24 April 2020	8	47.9
NMP 04	Magram Water Bottling Company	Day 1	22 April 2020	7	51.2
		Day 2	23 April 2020	5	68.1
NMP 05	Government Independent Memorial Secondary School (GIMSS)	Day 1	20 April 2020	7	63.5
		Day 2	21 April 2020	8	62.6
NMP 06	Shell Lane – Off Parsonage Street	Day 1	25 April 2020	8	68.6
		Day 2	28 April 2020	7	68.9
NMP 07	Bai Bureh Road/ Africanus	Day 1	30 April 2020	8	75.2
		Day 2	01 May 2020	7	74.9

Figure 4-2: Mean Daily LAeq Recorded in April/May 2020



4.2.1 Location NMP 01 - Project Site (Southern Boundary)

This monitoring point is located within the project site along its southwestern boundary, which it shares with informal settlements. The point is about 100 m north of Bai Bureh Road. The major noise sources from this point are vehicular movement from Bai Bureh Road, power generators/plants from nearby industrial activities; commercial areas along Bai Bureh Road and from nearby residents.

From the data collected, NMP 01 recorded an average continuous sound pressure level (LAeq) of 62.9 dB(A) on the first day of monitoring. A significant decline was noted on the second day of monitoring with an LAeq of 52.7 dB(A). However, the second day of monitoring was undertaken on a weekend (Saturday) with less commercial and/or industrial activities as well as less road traffic. Nonetheless, these values are within WBG EHS guideline levels for day-time noise in industrial areas.

It must be noted that the highest LAeq value of 71 dB(A) was recorded between 16:55-17:55 GMT. This value is marginally above the WBG guideline noise level limit for an industrial/commercial area. Such noise levels could be of health concerns to the residents around this community as it exceeds the WBG/IFC EHS guideline of 55 dB(A) for day-time noise limit for residential areas on the first day of monitoring.

4.2.2 Location NMP 02- Project Site (Eastern Boundary)

Monitoring Location NMP 02 is situated within the project site, along its eastern boundary. The location is about 165 m north of Bai Bureh Road and 125 m southeast of lower Parsonage Street. The Major noise sources from this point include road traffic noise, noise from garage east of the project site, noise from commercial areas along Bai Bureh Road and Personage Street. The data collected shows an LAeq of 49 dB(A) on the first day and 47.2 dB(A) on the second day. Like NMP 01, the second day's monitoring for NMP 02 was undertaken on a weekend (Sunday) with less activities from all the major noise sources.

These LAeq values for both days of monitoring are below the WBG EHS guideline values for noise pollution in both commercial/industrial and residential/institutional. Therefore, it must be noted that the acoustic environment of the areas within the immediate vicinity of NMP 02 is very quiet with any increases in noise levels easily noticeable.

4.2.3 Location NMP 03- Project Site (Northern Boundary)

This location is also situated within the project site along its northern boundary, which is shared with Magram and Bollore Logistics. Monitoring Location NMP 03 is located about 75 m south of South Road. The major noise sources around the vicinity of this location include noise from Bollore Logistics' power generator other activities, traffic noise from South Road and noise from birds that nest on shrubs within the project site.

The recorded LAeq for this location was 50.6 dB(A) and 47.9 dB(A) on the first and second days, respectively. These values were much lower than the guideline level prescribed by WBG/IFC for both residential and commercial/industrial areas.

4.2.4 Location NMP 04 - Magram Water Bottling Company

Noise Monitoring Location 04 is situated in the Magram Water Bottling Company's Compound about 40 m north of the project site and 10 m west of Bollore Logistics Compound. The major noise sources from this location are the Magram generator and staff daily activities, sound of birds from trees around the monitoring point, and vehicular movement along South Road, which is about 36 m north of the location.

An average continuous sound pressure level of 51.2 dB(A) and 68.1 dB(A) on the first and second days, respectively at this monitoring location. The most significant contribution to the acoustic environment around NMP 04 is the Magram Generator/Plant, which was situated about 10 m from the point. On the first day of monitoring, it was observed that the Magram Generator/plant was intermittently turned on from 12:30-12:33 and 12:42-12:49. This contributed to that period (i.e. 12:30-13:30) recording the highest LAeq value of 56.2 dB(A) for that day. On the second day of monitoring, noise sources remained the same as the previous day. However, the contribution of the Magram generator to the acoustic environment was much more pronounced it was on for most of the monitoring period (10:10-13:33 and 15:26-16:34). However, the recorded LAeq values were lower than the WBG/IFC EHS guideline noise level for industrial/commercial settings.

4.2.5 Location NMP 05- Government Independent Memorial Secondary School

This monitoring location was situated at the Government Independent Memorial Secondary School, which is a critical receptor of day-time noise. The school is located at a distance of about 250 m east of the Project Site. The major noise sources for this location include traffic noise mainly from the movement of fuel bowsers and from the cranking of engines of bowsers parked along the Personage Street for repairs, noise from street hawkers and noise from singing birds on nearby trees. There was no school activity during the time of monitoring.

The average LAeq recorded at this monitoring location was 63.5 dB(A) and 62.6 dB(A) on days one and two, respectively. With similar weather conditions and consistent noise sources, the data shows an almost equal LAeq for the monitoring location across the two days of monitoring. The recorded LAeq values were found as prescribed by the WBG standard guideline value for residential/commercial areas.

4.2.6 Location NMP 06 - Shell Lane

This monitoring location could be described as a residential area with houses linearly placed along the Shell Lane, the monitoring location was situated at about 100 m away from Personage Street and is approximately 280 south of the project site. The major noise sources for this location are noise from domestic sources from residents (including community quarrels, low-frequency noise from daily communications, music from residents), noise from street hawkers (some use microphones) along the Shell Lane, road traffic noise from Personage Street and Shell Lane, noise commercial activities along Parsonage Street.

The data shows LAeq of 68.6 dB(A) and 69.4 dB(A) days one and two respectively. The Data shows an almost consistent LAeq for the monitoring location. However, these values were higher than the EHS guideline noise levels prescribed by WBG/IFC for residential areas but lower than the values set for industrial or commercial settings.

4.2.7 Location NMP 07 – Fisher Lane/Bai Bureh Road

This monitoring location was on Fisher Lane, along Bai Bureh Road. It could be described as a mixed commercial-residential area with residents along the fisher lane and on the adjacent side of Bai Bureh Road. Location NMP 01 is situated about 450 m west of the project site. The major noise sources within this monitoring point are the traffic noise from the Bai Bureh Road, noise from commercial activities, and noise from other small and medium scale industries around the area.

The average LAeq for this location were 75.2 dB(A) and 74.9 dB (A) for days one and two respectively. These values are above the recommended EHS guideline values for a day-time noise in both residential and commercial/industrial areas prescribed by the WBG/IFC.

4.3 Comparison with the 2015 Ambient Noise Levels

To establish the existing ambient noise environment, noise monitoring was conducted by INTEGEMS during February 2015 at the locations outlined in Table 4-5. The locations were selected with due consideration of risks around Ebola and were collected for a limited duration. While these locations were considered representative of conditions adjacent to the development site, they may not be representative of all the receptor locations in the project area.

As was the case for the April/May 2020 during COVID-19 outbreak, the conditions captured during monitoring at certain locations/days in 2015 may reflect potential reductions in ambient noise levels as a result of reduced working activities and travel within the local area under Ebola conditions. Therefore, a brief comparison of the result is presented here for measurement locations NMP 01 to NMP 04. A summary of noise data recorded at the four locations at which measurements were undertaken in 2015 is presented in Table 4-6 and graphically displayed in Figure 4-3.

Table 4-5: Noise Monitoring Locations in 2015

Measurement Location	Location Description
Point 1/ NMP 01	CRCC Compound
Point 2/ NMP 02	SLRA/MSU Compound
Point 3/ NMP 03	SLRA/MSU Compound
Point 4/ NMP 04	Magram Water Bottling Company Compound

Table 4-6: Day-time Ambient Noise Recorded in February 2015 and in April/May 2020

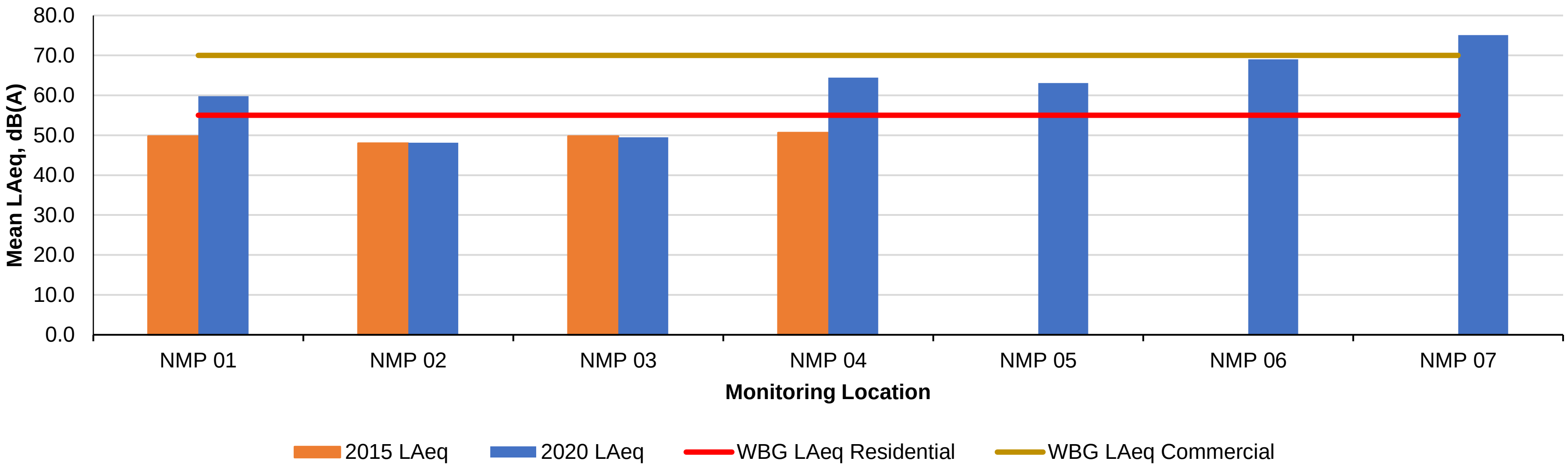
Location ID	Location Description	LAeq, dB(A)		WBG EHS Limit LAeq, dB(A)	
		2020	2015	Residential	Industrial
Point 1/ NMP 01	Project Site – Southern Boundary	59.8	49.8	55.0	70.0
Point 2/ NMP 02	Project Site – Eastern Boundary	48.2	48.0	55.0	70.0
Point 3/ NMP 03	Project Site - Northern Boundary	49.5	49.8	55.0	70.0
Point 4/ NMP 04	Magram Compound	64.4	50.6	55.0	70.0
NMP 05	GIMSS Compound	63.1	-	55.0	70.0
NMP 06	Shell Lane – Off Parsonage Street	69.0	-	55.0	70.0
NMP 07	Bai Bureh Road/ Africanus Road	75.1	-	55.0	70.0

Table 4-7: Average Night-time Noise Results for each Location

Location	2015 $LA_{eq,1h}$,dB(A)
Point 1/ NMP 01	48.6
Point 2/ NMP 02	43.8
Point 3/ NMP 03	45.3
Point 4/ NMP 04	38.9

The average noise levels measured in 2015 were below the WBG EHS Guideline limit during daytime for both industrial and residential settings. The average measured night-time noise levels around the site were well below the WBG EHS Guideline noise level for industrial areas (70 dB) but marginally exceeded the IFC night-time guideline level (45 dB) for residential areas at points 1 and 3. Comparable daytime noise levels were recorded at points 2 and 3 in April /May 2020, while the mean LAeq recorded at points 1 and 4 were significantly higher in 2020 than in 2015 (see Table 4-6). The deviations in the data from points 1 and 4 could be attributed to noise from an industrial power generator from a nearby metal works centre, which was in operation throughout the day 1 of monitoring at point 1 and from Magram's generator, which was in operation for a significant part of the day 2 of monitoring at point 4 (see Table 4-4).

Figure 4-3: Mean LAeq Recorded in February 2015 and in April/May 2020



These noise sources were not as apparent during the 2015 baseline survey as compared to the 2020 period. Therefore, it could be concluded that in the absence of the aforementioned sources, the levels recorded at points 1 and 4 could not have deviated by more than 3 dB as is seen from the data recorded on the day 2 of monitoring at point 1 (52.7 dB) and the day 1 of monitoring at point 4 (51.2 dB) in 2020.

Therefore, in the absence of night-time data due to the COVID-19 response curfews in the April/May 2020 monitoring period and with the level of similarities seen between the 2015 and 2020 day-time noise data, it is prudent to conservatively extrapolate that the night-time noise levels recorded at points 1 to 4 in February 2015 are representative of the current acoustic environment within these measurement areas. To account for the significant deviations, a penalty of 3 dB(A) has been added to the values recorded at point 1 and 4 (see Table 4-8).

However, the same cannot be inferred for NMP 05 – NMP 07 as measurements were not taken at these points in 2015. Additionally, from a qualitative point of view, the acoustic environment at these points are significantly different from that which was observed at points 1 to 4.

Thus, from the extrapolated data, the night-time noise levels ascribed to NMP 01 – NMP 04 are all below the WBG limit for industrial/commercial settings, while only levels at NMP 02 and NMP 04 were found to be lower than night-time guideline noise limits for residential/institutional settings.

Table 4-8: Average Night-time Noise Results for each Location

Location	2015 $LA_{eq,1h}$, dB(A)	Penalty, dB(A)	2020 with Penalty $LA_{eq,1h}$, dB(A)
Point 1/ NMP 01	48.6	+3	51.6
Point 2/ NMP 02	43.8	+0	43.8
Point 3/ NMP 03	45.3	+0	45.3
Point 4/ NMP 04	38.9	+3	41.9

4.4 Conclusion

The area surrounding and including the project boundary is zoned by Freetown City Council as commercial/industrial land use, according to the Director of Country Planning. It can be seen from the recorded noise monitoring results that the average measured night-time noise levels around the site are well below the WBG EHS Guideline noise level for industrial areas of 70 dB(A).

However, many of the buildings surrounding the project currently have residential, institutional or educational usage. According to the WBG EHS Guidelines, it is desirable that noise levels at these locations not exceed the lower values of 45 dB(A) during night-time and 55 dB(A) during the daytime, or result in a maximum increase in 'background' levels of 3 dB(A).

Additionally, given that night-time noise levels were derived from extrapolation of the 2015 noise data, it is recommended that night-time noise measurements are undertaken at a conducive time post-COVID-19 to describe the true acoustic environment of the project site and the area within a 500 m buffer around.

APPENDICES

Appendix A: Photographs of Air Quality and Noise Monitoring Locations

Figure 4-4: Air Quality Monitoring within and around the Project Area (1/2)

AQMP 01: Shell Police Station

AQMP 01: Shell Police Station

AQMP 02: SALHOC Gate

AQMP 02: SALHOC Gate

AQMP 03: SWISS Compound

ANMP 03: SWISS Compound

AQMP 04: Masjid IHASAN

AQMP 04: Masjid IHASAN

Figure 4-5: Air Quality Monitoring within and around the Project Area (2/2)

AQMP 05: FINIC Fence

AQMP 05: FINIC Fence

Figure 4-6: Ambient Noise Monitoring at NMP 01

Figure 4-7: Ambient Noise Monitoring at NMP 02

Figure 4-8: Ambient Noise Monitoring at NMP 03

Figure 4-9: Ambient Noise Monitoring at NMP 04

Figure 4-10: Ambient Noise Monitoring at NMP 05

Figure 4-11: Ambient Noise Monitoring at NMP 06

Figure 4-12: Ambient Noise Monitoring at NMP 07

Appendix B: Ambient Air Quality Monitoring Logs

Table 4-9: Air Quality Monitoring Logs for Shell Police Station (AQMP 01)

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
$PM_{2.5}$, µg/m^3								
Day 1	1	15/04/2020	10:50:00	11:45:00	00:55:00	12	18	27
	2	15/04/2020	15:10:00	16:05:00	00:55:00	18	25	60
Day 2	1	16/04/2020	12:41:00	13:46:00	01:05:00	15	25	49
	2	16/04/2020	17:02:00	18:02:00	01:00:00	30	42	61
Day 3	1	17/04/2020	10:10:00	10:55:00	00:45:00	11	17	32
	2	17/04/2020	13:28:00	14:28:00	01:00:00	10	18	31
PM_{10}, µg/m^3								
Day 1	1	15/04/2020	10:50:00	11:45:00	00:55:00	26	57	100
	2	15/04/2020	15:10:00	16:05:00	00:55:00	58	70	96
Day 2	1	16/04/2020	12:41:00	13:46:00	01:05:00	39	60	91
	2	16/04/2020	17:02:00	18:02:00	01:00:00	50	77	110
Day 3	1	17/04/2020	10:10:00	10:55:00	00:45:00	39	61	106
	2	17/04/2020	13:28:00	14:28:00	01:00:00	34	57	106
CO, µg/m^3								
Day 1	1	15/04/2020	11:56:00	12:51:00	00:55:00	0	0	0
	2	15/04/2020	16:16:00	17:11:00	00:55:00	0	0	0
Day 2	1	16/04/2020	10:23:00	11:23:00	01:00:00	0	345	2410
	2	16/04/2020	14:01:00	15:01:00	01:00:00	0	0	0
Day 3	1	17/04/2020	11:10:00	12:10:00	01:00:00	0	0	0
	2	17/04/2020	15:35:00	16:35:00	01:00:00	0	0	0
O_3, µg/m_3								
Day 1	1	15/04/2020	09:42:00	10:42:00	01:00:00	0	4	16
	2	15/04/2020	13:02:00	14:02:00	01:00:00	1	8	17
	3	15/04/2020	17:21:00	18:21:00	01:00:00	6	19	39
Day 2	1	16/04/2020	11:33:00	12:28:00	00:55:00	25	32	47
	2	16/04/2020	15:53:00	16:53:00	01:00:00	21	37	80
Day 3	1	17/04/2020	12:19:00	13:19:00	01:00:00	2	12	26
	2	17/04/2020	16:45:00	17:45:00	01:00:00	17	29	52
SO_2, µg/m^3								
Day 1	1	15/04/2020	11:56:00	12:51:00	00:55:00	0	0	0
	2	15/04/2020	16:15:00	17:10:00	00:55:00	0	0	0
Day 2	1	16/04/2020	10:24:00	11:24:00	01:00:00	0	0	0

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	2	16/04/2020	13:59:00	14:59:00	01:00:00	0	0	0
Day 3	1	17/04/2020	12:21:00	13:21:00	01:00:00	0	0	0
	2	17/04/2020	15:34:00	16:34:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	15/04/2020	09:42:00	10:37:00	00:55:00	0	6	32
	2	15/04/2020	13:02:00	14:02:00	01:00:00	0	4	21
	3	15/04/2020	17:21:00	18:21:00	01:00:00	0	18	91
Day 2	1	16/04/2020	11:34:00	12:34:00	01:00:00	0	30	86
	2	16/04/2020	15:53:00	16:53:00	01:00:00	0	40	111
Day 3	1	17/04/2020	11:10:00	12:10:00	01:00:00	0	0	1
	2	17/04/2020	16:45:00	17:45:00	01:00:00	3	23	59
VOCs, mg/m^3								
Day 1	1	15/04/2020	10:50:00	11:45:00	00:55:00	781	1314	2571
	2	15/04/2020	15:10:00	16:05:00	00:55:00	484	641	906
Day 2	1	16/04/2020	12:49:00	13:49:00	01:00:00	428	567	893
	2	16/04/2020	17:05:00	18:05:00	01:00:00	306	390	542
Day 3	1	17/04/2020	10:10:00	11:00:00	00:50:00	364	448	596
	2	17/04/2020	13:31:00	14:26:00	00:55:00	311	386	521
Temperature, C								
Day 1	1	15/04/2020	09:42:00	10:37:00	00:55:00	32.8	33.8	35.0
	2	15/04/2020	10:50:00	11:45:00	00:55:00	33.2	33.7	35.2
	3	15/04/2020	11:56:00	12:51:00	00:55:00	33.5	34.4	35.5
	4	15/04/2020	13:02:00	14:02:00	01:00:00	33.1	34.5	35.8
	5	15/04/2020	15:10:00	16:05:00	00:55:00	34.9	35.4	36.0
	6	15/04/2020	16:15:00	17:10:00	00:55:00	32.9	34.2	36.5
	7	15/04/2020	17:21:00	18:21:00	01:00:00	32.1	32.7	33.6
Day 2	1	16/04/2020	10:24:00	11:24:00	01:00:00	29.5	30.8	32.8
	2	16/04/2020	11:34:00	12:34:00	01:00:00	34.1	35.4	36.8
	3	16/04/2020	12:49:00	13:49:00	01:00:00	35.8	37.6	41.4
	4	16/04/2020	13:59:00	14:59:00	01:00:00	34.5	36.7	40.2
	5	16/04/2020	15:53:00	16:53:00	01:00:00	34.4	35.5	36.5
	6	16/04/2020	17:05:00	18:05:00	01:00:00	34.3	34.6	35.2
Day 3	1	17/04/2020	10:10:00	11:00:00	00:50:00	33.9	34.7	36.1
	2	17/04/2020	11:10:00	12:10:00	01:00:00	33.3	34.6	35.5
	3	17/04/2020	12:21:00	13:21:00	01:00:00	33.3	34.5	35.7
	4	17/04/2020	13:31:00	14:26:00	00:55:00	34.1	35.5	37.1

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	5	17/04/2020	16:45:00	17:45:00	01:00:00	35.1	36.6	38.4
Relative Humidity, %								
Day 1	1	15/04/2020	09:42:00	10:37:00	00:55:00	58.2	60.2	63.3
	2	15/04/2020	10:50:00	11:45:00	00:55:00	55.4	60.2	62.3
	3	15/04/2020	11:56:00	12:51:00	00:55:00	55.9	58.8	60.4
	4	15/04/2020	13:02:00	14:02:00	01:00:00	54.1	56.6	60.1
	5	15/04/2020	15:10:00	16:05:00	00:55:00	53.6	55.5	57.2
	6	15/04/2020	16:15:00	17:10:00	00:55:00	50.7	54.4	55.9
	7	15/04/2020	17:21:00	18:21:00	01:00:00	53.1	56.9	60.0
Day 2	1	16/04/2020	10:24:00	11:24:00	01:00:00	60.6	65.7	69.1
	2	16/04/2020	11:34:00	12:34:00	01:00:00	49.3	53.5	57.4
	3	16/04/2020	12:49:00	13:49:00	01:00:00	41.7	47.7	51.5
	4	16/04/2020	13:59:00	14:59:00	01:00:00	44.0	52.2	59.0
	5	16/04/2020	15:53:00	16:53:00	01:00:00	52.0	54.8	57.7
	6	16/04/2020	17:05:00	18:05:00	01:00:00	55.6	56.7	58.0
Day 3	1	17/04/2020	10:10:00	11:00:00	00:50:00	58.7	61.3	63.6
	2	17/04/2020	11:10:00	12:10:00	01:00:00	58.7	61.8	64.7
	3	17/04/2020	12:21:00	13:21:00	01:00:00	59.5	61.6	64.4
	4	17/04/2020	13:31:00	14:26:00	00:55:00	48.7	56.1	63.3
	5	17/04/2020	16:45:00	17:45:00	01:00:00	36.7	41.2	45.8

Table 4-10: Air Quality Monitoring Logs for SALHOC Gate (AQMP 02)

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
$PM_{2.5}$, µg/m^3								
Day 1	1	18/04/2020	10:22:00	11:22:00	01:00:00	8	13	22
	2	18/04/2020	16:59:00	17:59:00	01:00:00	19	26	38
Day 2	1	19/04/2020	12:39:00	13:39:00	01:00:00	18	79	471
	2	19/04/2020	16:58:00	17:58:00	01:00:00	31	39	57
Day 3	1	20/04/2020	10:51:00	11:51:00	01:00:00	19	39	216
	2	20/04/2020	15:05:00	16:05:00	01:00:00	20	32	51
PM_{10}, µg/m^3								
Day 1	1	18/04/2020	10:22:00	11:22:00	01:00:00	28	52	138
	2	18/04/2020	16:59:00	17:59:00	01:00:00	57	74	92
Day 2	1	19/04/2020	12:39:00	13:39:00	01:00:00	54	124	425

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	2	19/04/2020	16:58:00	17:58:00	01:00:00	72	93	129
Day 3	1	20/04/2020	10:51:00	11:51:00	01:00:00	46	73	258
	2	20/04/2020	15:05:00	16:05:00	01:00:00	61	82	120
CO, µg/m^3								
Day 1	1	18/04/2020	12:46:00	13:46:00	01:00:00	0	0	0
Day 2	1	19/04/2020	10:19:00	11:19:00	01:00:00	0	0	0
	2	19/04/2020	13:49:00	14:49:00	01:00:00	0	0	0
Day 3	1	20/04/2020	09:37:00	10:42:00	01:05:00	0	111	640
	2	20/04/2020	13:11:00	14:11:00	01:00:00	0	344	4470
O_3, µg/m^3								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	16	26	33
	2	18/04/2020	15:50:00	16:50:00	01:00:00	17	27	39
Day 2	1	19/04/2020	11:28:00	12:28:00	01:00:00	7	24	35
	2	19/04/2020	15:44:00	16:49:00	01:05:00	3	26	38
Day 3	1	20/04/2020	12:01:00	13:01:00	01:00:00	8	14	21
	2	20/04/2020	16:15:00	16:35:00	00:20:00	24	28	36
SO_2, µg/m^3								
Day 1	1	18/04/2020	13:55:00	14:55:00	01:00:00	0	0	0
Day 2	1	19/04/2020	09:10:00	10:10:00	01:00:00	0	0	0
	2	19/04/2020	13:49:00	14:49:00	01:00:00	0	0	0
Day 3	1	20/04/2020	09:37:00	10:37:00	01:00:00	0	0	0
	2	20/04/2020	13:11:00	14:11:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	0	6	34
Day 2	1	19/04/2020	12:39:00	13:39:00	01:00:00	0	5	29
	2	19/04/2020	16:58:00	17:58:00	01:00:00	0	22	44
Day 3	1	20/04/2020	10:51:00	11:51:00	01:00:00	0	4	29
	2	20/04/2020	15:05:00	16:05:00	01:00:00	0	15	56
VOCs, mg/m^3								
Day 1	1	18/04/2020	11:32:00	12:37:00	01:05:00	274	385	640
Day 2	1	19/04/2020	11:28:00	12:28:00	01:00:00	352	478	670
	2	19/04/2020	15:44:00	16:49:00	01:05:00	264	345	508
Day 3	1	20/04/2020	12:01:00	13:01:00	01:00:00	306	425	681
	2	20/04/2020	16:15:00	16:35:00	00:20:00	279	331	396
Temperature, C								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	31.1	31.9	33.2
	2	18/04/2020	11:32:00	12:37:00	01:05:00	31.6	32.7	33.6

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	3	18/04/2020	12:46:00	13:46:00	01:00:00	31.7	32.3	33.0
	4	18/04/2020	13:55:00	14:55:00	01:00:00	31.7	32.5	33.2
Day 2	1	19/04/2020	09:10:00	10:10:00	01:00:00	31.1	31.9	32.7
	2	19/04/2020	10:19:00	11:19:00	01:00:00	32.8	33.7	34.7
	3	19/04/2020	11:28:00	12:28:00	01:00:00	33.9	35.1	36.7
	4	19/04/2020	12:39:00	13:39:00	01:00:00	35.2	36.0	37.6
	5	19/04/2020	13:49:00	14:49:00	01:00:00	36.1	37.9	39.1
	6	19/04/2020	15:44:00	16:49:00	01:05:00	36.1	38.1	39.2
	7	19/04/2020	16:58:00	17:58:00	01:00:00	35.3	36.9	38.2
Day 3	1	20/04/2020	09:37:00	10:37:00	01:00:00	29.8	30.7	32.4
	2	20/04/2020	10:51:00	11:51:00	01:00:00	32.3	33.6	35.2
	3	20/04/2020	12:01:00	13:01:00	01:00:00	33.3	33.8	35.2
	4	20/04/2020	13:11:00	14:11:00	01:00:00	33.4	34.4	35.6
	5	20/04/2020	15:05:00	16:05:00	01:00:00	31.7	33.8	35.4
	6	20/04/2020	16:15:00	16:35:00	00:20:00	30.9	31.4	32.0
Relative Humidity, %								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	59.3	62.3	64.2
	2	18/04/2020	11:32:00	12:37:00	01:05:00	59.0	61.2	64.2
	3	18/04/2020	12:46:00	13:46:00	01:00:00	59.6	62.6	64.3
	4	18/04/2020	13:55:00	14:55:00	01:00:00	57.8	59.7	61.0
Day 2	1	19/04/2020	09:10:00	10:10:00	01:00:00	62.7	64.4	66.2
	2	19/04/2020	10:19:00	11:19:00	01:00:00	55.5	59.0	61.6
	3	19/04/2020	11:28:00	12:28:00	01:00:00	52.6	55.8	58.1
	4	19/04/2020	12:39:00	13:39:00	01:00:00	51.4	54.5	57.0
	5	19/04/2020	13:49:00	14:49:00	01:00:00	45.4	49.0	52.7
	6	19/04/2020	15:44:00	16:49:00	01:05:00	44.2	46.5	51.3
	7	19/04/2020	16:58:00	17:58:00	01:00:00	46.1	47.9	50.5
Day 3	1	20/04/2020	09:37:00	10:37:00	01:00:00	67.3	71.5	74.6
	2	20/04/2020	10:51:00	11:51:00	01:00:00	60.2	63.8	66.7
	3	20/04/2020	12:01:00	13:01:00	01:00:00	59.8	63.5	65.0
	4	20/04/2020	13:11:00	14:11:00	01:00:00	56.5	60.1	64.7
	5	20/04/2020	15:05:00	16:05:00	01:00:00	51.8	55.7	59.8
	6	20/04/2020	16:15:00	16:35:00	00:20:00	63.1	64.9	67.4

Table 4-11: Air Quality Monitoring Logs for SWISS Compound (AQMP 03)

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
$PM_{2.5}$, µg/m³								
Day 1	1	21/04/2020	09:38:00	10:38:00	01:00:00	39	48	75
	2	21/04/2020	13:30:00	14:30:00	01:00:00	22	23	27
	3	21/04/2020	17:36:00	18:36:00	01:00:00	22	36	47
Day 2	1	22/04/2020	11:53:00	12:53:00	01:00:00	27	35	54
	2	22/04/2020	16:17:00	17:17:00	01:00:00	22	28	36
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	28	35	47
	2	23/03/2020	13:25:00	14:25:00	01:00:00	25	40	71
PM_{10}, µg/m³								
Day 1	1	21/04/2020	09:38:00	10:38:00	01:00:00	68	91	119
	2	21/04/2020	13:30:00	14:30:00	01:00:00	61	69	93
	3	21/04/2020	17:36:00	18:36:00	01:00:00	69	89	126
Day 2	1	22/04/2020	11:53:00	12:53:00	01:00:00	72	95	135
	2	22/04/2020	16:17:00	17:17:00	01:00:00	66	79	90
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	90	115	145
	2	23/03/2020	13:25:00	14:25:00	01:00:00	75	106	149
CO, µg/m³								
Day 1	1	21/04/2020	12:12:00	13:12:00	01:00:00	0	0	0
	2	21/04/2020	16:23:00	17:23:00	01:00:00	0	0	0
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	0	0	0
	2	22/04/2020	13:05:00	14:05:00	01:00:00	0	173	1380
Day 3	1	23/03/2020	12:14:00	13:14:00	01:00:00	0	0	0
O_3, µg/m³								
Day 1	1	21/04/2020	09:45:00	10:45:00	01:00:00	3	8	14
	2	21/04/2020	13:31:00	14:26:00	00:55:00	20	27	36
	3	21/04/2020	17:36:00	18:36:00	01:00:00	22	37	48
Day 2	1	22/04/2020	11:53:00	12:53:00	01:00:00	13	19	23
	2	22/04/2020	16:17:00	17:17:00	01:00:00	4	12	17
Day 3	1	23/03/2020	11:03:00	12:03:00	01:00:00	19	28	35
	2	23/03/2020	16:17:00	17:17:00	00:20:00	24	33	42

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
SO_2, µg/m^3								
Day 1	1	21/04/2020	12:12:00	13:12:00	01:00:00	0	0	0
	2	21/04/2020	16:23:00	17:23:00	01:00:00	0	0	0
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	0	0	0
	2	22/04/2020	13:05:00	14:05:00	01:00:00	0	0	0
Day 3	1	23/03/2020	12:14:00	13:14:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	21/04/2020	10:59:00	11:59:00	01:00:00	0	11	31
	2	21/04/2020	15:14:00	16:14:00	01:00:00	17	35	60
Day 2	1	22/04/2020	10:40:00	11:40:00	01:00:00	0	15	49
	2	22/04/2020	14:17:00	15:17:00	01:00:00	0	1	8
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	0	13	60
	2	23/03/2020	13:25:00	14:25:00	01:00:00	0	10	46
VOCs, mg/m^3								
Day 1	1	21/04/2020	10:59:00	11:59:00	01:00:00	282	394	625
	2	21/04/2020	15:14:00	16:14:00	01:00:00	201	249	322
Day 2	1	22/04/2020	10:40:00	11:40:00	01:00:00	277	366	542
	2	22/04/2020	14:17:00	15:17:00	01:00:00	213	259	346
Day 3	1	23/03/2020	11:03:00	12:03:00	01:00:00	239	348	573
	2	23/03/2020	16:17:00	17:17:00	01:00:00	175	223	314
Temperature, C								
Day 1	1	21/04/2020	09:45:00	10:45:00	01:00:00	31.5	32.7	34.2
	2	21/04/2020	10:59:00	11:59:00	01:00:00	33.3	34.8	36.0
	3	21/04/2020	12:12:00	13:12:00	01:00:00	35.1	36.8	38.8
	4	21/04/2020	13:31:00	14:26:00	00:55:00	35.5	37.0	39.8
	5	21/04/2020	15:14:00	16:14:00	01:00:00	34.5	36.1	37.0
	6	21/04/2020	16:23:00	17:23:00	01:00:00	33.0	33.7	35.0
	7	21/04/2020	17:36:00	18:36:00	01:00:00	30.8	31.9	32.7
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	33.6	34.7	35.2
	2	22/04/2020	10:40:00	11:40:00	01:00:00	34.3	35.5	37.7

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
	3	22/04/2020	11:53:00	12:53:00	01:00:00	34.5	35.7	37.0
	4	22/04/2020	13:05:00	14:05:00	01:00:00	33.6	35.3	36.8
	5	22/04/2020	14:17:00	15:17:00	01:00:00	34.7	36.0	37.4
	6	22/04/2020	16:17:00	17:17:00	01:00:00	32.6	33.6	34.5
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	31.8	32.9	34.4
	2	23/03/2020	11:03:00	12:03:00	01:00:00	32.0	33.1	34.0
	3	23/03/2020	12:14:00	13:14:00	01:00:00	32.2	33.2	34.9
	4	23/03/2020	13:25:00	14:25:00	01:00:00	32.2	33.2	34.8
	5	23/03/2020	16:17:00	17:17:00	01:00:00	28.6	29.3	29.9
Relative Humidity, %								
Day 1	1	21/04/2020	09:45:00	10:45:00	01:00:00	59.3	62.8	65.3
	2	21/04/2020	10:59:00	11:59:00	01:00:00	51.6	55.0	58.5
	3	21/04/2020	12:12:00	13:12:00	01:00:00	48.3	51.4	53.9
	4	21/04/2020	13:31:00	14:26:00	00:55:00	46.2	51.9	55.2
	5	21/04/2020	15:14:00	16:14:00	01:00:00	52.9	54.8	58.2
	6	21/04/2020	16:23:00	17:23:00	01:00:00	57.2	60.4	62.5
	7	21/04/2020	17:36:00	18:36:00	01:00:00	63.2	64.9	67.5
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	59.6	61.0	63.2
	2	22/04/2020	10:40:00	11:40:00	01:00:00	54.1	58.6	62.8
	3	22/04/2020	11:53:00	12:53:00	01:00:00	52.9	56.5	59.5
	4	22/04/2020	13:05:00	14:05:00	01:00:00	54.3	57.3	61.2
	5	22/04/2020	14:17:00	15:17:00	01:00:00	52.9	55.6	58.9
	6	22/04/2020	16:17:00	17:17:00	01:00:00	59.1	61.5	64.1
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	62.1	66.2	69.4
	2	23/03/2020	11:03:00	12:03:00	01:00:00	63.0	65.4	68.6
	3	23/03/2020	12:14:00	13:14:00	01:00:00	60.2	64.1	66.8
	4	23/03/2020	13:25:00	14:25:00	01:00:00	59.6	62.9	65.8
	5	23/03/2020	16:17:00	17:17:00	01:00:00	73.7	75.8	77.7

Table 4-12: Air Quality Monitoring Logs for the Masjid IHASAN Mosque (AQMP 04)

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
$PM_{2.5}$, µg/m^3								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	11	19	38
	2	24/04/2020	13:03:00	14:03:00	01:00:00	13	18	26
	3	24/04/2020	16:53:00	17:53:00	01:00:00	19	25	37
Day 2	1	25/04/2020	12:21:00	13:21:00	01:00:00	6	8	10
	2	25/04/2020	15:50:00	16:50:00	01:00:00	6	10	22
Day 1	1	28/04/2020	09:41:00	10:41:00	01:00:00	9	13	27
	2	28/04/2020	13:17:00	14:17:00	01:00:00	9	10	12
	3	28/04/2020	17:27:00	18:27:00	01:00:00	24	36	65
PM_{10}, µg/m^3								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	20	36	63
	2	24/04/2020	13:03:00	14:03:00	01:00:00	33	45	77
	3	24/04/2020	16:53:00	17:53:00	01:00:00	42	63	137
Day 2	1	25/04/2020	12:21:00	13:21:00	01:00:00	9	18	32
	2	25/04/2020	15:50:00	16:50:00	01:00:00	9	19	55
Day 3	1	28/04/2020	09:41:00	10:41:00	01:00:00	30	40	64
	2	28/04/2020	13:17:00	14:17:00	01:00:00	29	36	48
	3	28/04/2020	17:27:00	18:27:00	01:00:00	59	164	486
CO, µg/m^3								
Day 1	1	24/04/2020	11:54:00	12:54:00	01:00:00	0	0	0
	2	24/04/2020	15:45:00	16:45:00	01:00:00	0	0	0
Day 2	1	25/04/2020	10:03:00	10:58:00	00:55:00	0	0	0
	2	25/04/2020	13:30:00	14:30:00	01:00:00	0	0	0
	3	25/04/2020	16:59:00	17:29:00	00:30:00	0	0	0
Day 3	1	28/04/2020	12:10:00	13:05:00	00:55:00	0	0	0
	2	28/04/2020	16:18:00	17:18:00	01:00:00	0	0	0
O_3, µg/m^3								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	14	24	41
	2	24/04/2020	13:03:00	14:03:00	01:00:00	11	38	63
	3	24/04/2020	16:53:00	17:53:00	01:00:00	33	40	51

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
Day 2	1	25/04/2020	15:51:00	16:46:00	00:55:00	18	22	29
	2	22/04/2020	16:17:00	17:17:00	01:00:00	4	12	17
Day 3	1	28/04/2020	10:56:00	11:56:00	01:00:00	7	15	26
	2	28/04/2020	15:10:00	16:05:00	00:55:00	21	29	43
SO_2, µg/m³								
Day 1	1	24/04/2020	11:54:00	12:54:00	01:00:00	0	0	0
	2	24/04/2020	15:45:00	16:45:00	01:00:00	0	0	0
Day 2	1	25/04/2020	16:59:00	17:59:00	01:00:00	0	0	0
Day 3	1	28/04/2020	12:10:00	13:05:00	00:55:00	0	0	0
	2	28/04/2020	16:18:00	17:18:00	01:00:00	0	0	0
NO_2, µg/m³								
Day 1	1	24/04/2020	10:46:00	11:46:00	01:00:00	0	25	103
	2	24/04/2020	14:12:00	15:12:00	01:00:00	0	38	61
Day 2	1	25/04/2020	14:39:00	15:39:00	01:00:00	0	24	60
Day 3	1	28/04/2020	09:42:00	10:42:00	01:00:00	0	2	9
	2	28/04/2020	13:17:00	14:17:00	01:00:00	0	11	42
	3	28/04/2020	17:27:00	18:27:00	01:00:00	2	33	52
VOCs mg/m³								
Day 1	1	24/04/2020	10:45:00	11:45:00	01:00:00	355	506	867
	2	24/04/2020	14:12:00	15:07:00	00:55:00	190	305	534
Day 2	1	25/04/2020	11:12:00	12:12:00	01:00:00	374	608	1241
	2	25/04/2020	14:39:00	15:39:00	01:00:00	243	325	551
Day 3	1	28/04/2020	10:56:00	11:56:00	01:00:00	804	1401	2772
	2	28/04/2020	15:10:00	16:05:00	00:55:00	390	556	886
Temperature, C								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	34.1	35.3	36.3
	2	24/04/2020	10:46:00	11:46:00	01:00:00	34.2	35.8	37.1
	3	24/04/2020	11:54:00	12:54:00	01:00:00	35.3	36.4	37.1
	4	24/04/2020	13:03:00	14:03:00	01:00:00	35.1	36.0	37.3
	5	24/04/2020	14:12:00	15:12:00	01:00:00	32.9	34.4	36.4
	6	24/04/2020	15:45:00	16:45:00	01:00:00	33.3	34.2	36.2

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
	7	24/04/2020	16:53:00	17:53:00	01:00:00	33.4	35.3	37.0
Day 2	1	25/04/2020	14:39:00	15:39:00	01:00:00	33.6	34.6	36.7
	2	25/04/2020	15:51:00	16:46:00	00:55:00	36.2	36.8	37.5
	3	25/04/2020	16:59:00	17:59:00	01:00:00	33.6	36.3	39.1
Day 3	1	28/04/2020	09:42:00	10:42:00	01:00:00	31.4	32.5	33.8
	2	28/04/2020	10:56:00	11:56:00	01:00:00	35.0	36.9	38.3
	3	28/04/2020	12:10:00	13:05:00	00:55:00	36.2	37.3	38.2
	4	28/04/2020	13:17:00	14:17:00	01:00:00	35.8	36.9	38.1
	5	28/04/2020	15:10:00	16:05:00	00:55:00	36.3	37.2	38.9
	6	28/04/2020	16:18:00	17:18:00	01:00:00	38.0	39.1	40.1
	7	28/04/2020	17:27:00	18:27:00	01:00:00	34.0	36.6	38.9
Relative Humidity, %								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	52.9	55.3	57.7
	2	24/04/2020	10:46:00	11:46:00	01:00:00	52.7	55.3	59.0
	3	24/04/2020	11:54:00	12:54:00	01:00:00	54.2	55.6	59.2
	4	24/04/2020	13:03:00	14:03:00	01:00:00	51.1	55.4	58.0
	5	24/04/2020	14:12:00	15:12:00	01:00:00	54.1	61.5	66.5
	6	24/04/2020	15:45:00	16:45:00	01:00:00	56.1	60.8	62.8
	7	24/04/2020	16:53:00	17:53:00	01:00:00	52.7	57.2	60.4
Day 2	1	25/04/2020	14:39:00	15:39:00	01:00:00	47.0	50.8	53.5
	2	25/04/2020	15:51:00	16:46:00	00:55:00	46.0	48.8	51.8
	3	25/04/2020	16:59:00	17:59:00	01:00:00	43.6	48.8	53.9
Day 3	1	28/04/2020	09:42:00	10:42:00	01:00:00	57.2	60.1	62.6
	2	28/04/2020	10:56:00	11:56:00	01:00:00	46.4	49.7	54.3
	3	28/04/2020	12:10:00	13:05:00	00:55:00	39.3	45.6	48.9
	4	28/04/2020	13:17:00	14:17:00	01:00:00	33.6	42.8	46.7
	5	28/04/2020	15:10:00	16:05:00	00:55:00	37.3	42.6	46.2
	6	28/04/2020	16:18:00	17:18:00	01:00:00	36.6	38.0	40.1
	7	28/04/2020	17:27:00	18:27:00	01:00:00	39.1	42.7	47.0

Table 4-13: Air Quality Monitoring Logs for FINIC Fence (AQMP 05)

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
$PM_{2.5}$, μg/m³								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	16	72	611
	2	29/04/2020	14:00:00	15:00:00	01:00:00	15	25	69
Day 2	1	30/04/2020	12:21:00	13:16:00	00:55:00	23	272	943
	2	30/04/2020	16:15:00	17:15:00	01:00:00	10	13	16
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	11	20	37
	2	01/05/2020	12:54:00	13:54:00	01:00:00	5	7	11
	3	01/05/2020	17:10:00	18:05:00	00:55:00	13	16	25
PM_{10}, μg/m³								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	36	81	469
	2	29/04/2020	14:00:00	15:00:00	01:00:00	39	60	106
Day 2	1	30/04/2020	12:21:00	13:16:00	00:55:00	28	203	592
	2	30/04/2020	16:15:00	17:15:00	01:00:00	19	25	35
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	17	35	59
	2	01/05/2020	12:54:00	13:54:00	01:00:00	10	21	41
	3	01/05/2020	17:10:00	18:05:00	00:55:00	23	33	53
CO, μg/m³								
Day 1	1	29/04/2020	12:51:00	13:51:00	01:00:00	0	0	0
	2	29/04/2020	17:05:00	18:05:00	01:00:00	0	0	0
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	0	0	0
	2	30/04/2020	13:55:00	14:55:00	01:00:00	0	0	0
	3	30/04/2020	17:24:00	18:24:00	01:00:00	0	0	0
Day 3	1	01/05/2020	11:44:00	12:44:00	01:00:00	0	0	0
	2	01/05/2020	15:54:00	16:54:00	01:00:00	0	0	0
O_3, μg/m³								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	16	27	37
	2	29/04/2020	14:00:00	15:00:00	01:00:00	3	20	43
Day 2	1	30/04/2020	12:21:00	13:21:00	01:00:00	23	39	105
	2	30/04/2020	16:15:00	17:15:00	01:00:00	31	36	41
Day 3	1	01/05/2020	10:35:00	11:35:00	01:00:00	4	17	25
	2	01/05/2020	14:44:00	15:44:00	01:00:00	23	29	45
SO_2, μg/m³								
Day 1	1	29/04/2020	12:52:00	13:47:00	00:55:00	0	0	0
	2	29/04/2020	17:05:00	18:05:00	01:00:00	0	0	0
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	0	0	0

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	2	30/04/2020	13:55:00	14:55:00	01:00:00	0	0	0
	3	30/04/2020	17:24:00	18:24:00	01:00:00	0	0	0
Day 3	1	01/05/2020	11:45:00	12:45:00	01:00:00	0	0	0
	2	01/05/2020	15:54:00	16:54:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	29/04/2020	11:42:00	12:42:00	01:00:00	0	20	126
	2	29/04/2020	15:56:00	16:56:00	01:00:00	0	11	41
Day 2	1	30/04/2020	11:12:00	12:12:00	01:00:00	0	38	112
	2	30/04/2020	15:05:00	16:05:00	01:00:00	0	13	43
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	0	1	6
	2	01/05/2020	12:54:00	13:54:00	01:00:00	0	2	13
	3	01/05/2020	17:10:00	18:05:00	00:55:00	0	10	24
VOCs mg/m^3								
Day 1	1	29/04/2020	11:42:00	12:42:00	01:00:00	596	998	1926
	2	29/04/2020	15:55:00	16:55:00	01:00:00	325	505	879
Day 2	1	30/04/2020	11:12:00	12:12:00	01:00:00	400	624	1182
	2	30/04/2020	15:05:00	16:05:00	01:00:00	277	372	555
Day 3	1	01/05/2020	10:35:00	11:35:00	01:00:00	492	742	1285
	2	01/05/2020	14:44:00	15:44:00	01:00:00	403	570	810
Temperature, C								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	33.5	35.4	37.7
	2	29/04/2020	11:42:00	12:42:00	01:00:00	35.5	37.0	37.8
	3	29/04/2020	12:52:00	13:47:00	00:55:00	36.7	37.4	37.9
	4	29/04/2020	14:00:00	15:00:00	01:00:00	36.7	37.6	39.0
	5	29/04/2020	15:56:00	16:56:00	01:00:00	34.3	35.0	35.7
	6	29/04/2020	17:05:00	18:05:00	01:00:00	32.0	33.1	34.4
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	30.5	32.7	34.5
	2	30/04/2020	11:12:00	12:12:00	01:00:00	31.6	33.1	36.0
	3	30/04/2020	12:21:00	13:21:00	01:00:00	31.3	32.1	33.2
	4	30/04/2020	13:55:00	14:55:00	01:00:00	31.5	31.8	32.2
	5	30/04/2020	15:05:00	16:05:00	01:00:00	32.6	33.4	34.4
	6	30/04/2020	16:15:00	17:15:00	01:00:00	32.2	33.1	34.1
	7	30/04/2020	17:24:00	18:24:00	01:00:00	31.2	31.6	32.3
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	31.9	35.6	37.7
	2	01/05/2020	10:35:00	11:35:00	01:00:00	35.5	36.7	37.8
	3	01/05/2020	11:45:00	12:45:00	01:00:00	36.2	37.2	39.1

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	4	01/05/2020	12:54:00	13:54:00	01:00:00	36.7	37.9	39.0
	5	01/05/2020	14:44:00	15:44:00	01:00:00	36.5	37.4	38.4
	6	01/05/2020	15:54:00	16:54:00	01:00:00	35.7	36.3	36.7
	7	01/05/2020	17:10:00	18:05:00	00:55:00	33.9	34.5	35.4
Relative Humidity, %								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	49.7	54.3	57.4
	2	29/04/2020	11:42:00	12:42:00	01:00:00	51.0	52.3	54.6
	3	29/04/2020	12:52:00	13:47:00	00:55:00	49.0	51.7	54.2
	4	29/04/2020	14:00:00	15:00:00	01:00:00	47.0	48.9	50.8
	5	29/04/2020	15:56:00	16:56:00	01:00:00	53.9	56.3	58.9
	6	29/04/2020	17:05:00	18:05:00	01:00:00	59.2	63.4	66.0
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	38.5	45.9	56.3
	2	30/04/2020	11:12:00	12:12:00	01:00:00	38.0	56.1	63.5
	3	30/04/2020	12:21:00	13:21:00	01:00:00	59.1	62.0	64.3
	4	30/04/2020	13:55:00	14:55:00	01:00:00	61.1	63.5	64.9
	5	30/04/2020	15:05:00	16:05:00	01:00:00	57.6	59.2	60.5
	6	30/04/2020	16:15:00	17:15:00	01:00:00	58.2	60.8	62.9
	7	30/04/2020	17:24:00	18:24:00	01:00:00	62.2	64.2	65.6
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	53.3	57.4	66.0
	2	01/05/2020	10:35:00	11:35:00	01:00:00	51.9	54.3	56.2
	3	01/05/2020	11:45:00	12:45:00	01:00:00	48.0	51.0	54.6
	4	01/05/2020	12:54:00	13:54:00	01:00:00	47.1	49.1	50.7
	5	01/05/2020	14:44:00	15:44:00	01:00:00	51.0	52.5	53.9
	6	01/05/2020	15:54:00	16:54:00	01:00:00	54.4	55.1	56.1
	7	01/05/2020	17:10:00	18:05:00	00:55:00	57.3	60.0	61.6

Appendix C: Ambient Noise Monitoring Logs

Table 4-14: Ambient Noise Monitoring Logs for NMP 01

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
15/04/2020 10:10	15/04/2020 11:10	01:00:00	51.5	77.0	46.2	53.0	49.0
15/04/2020 11:11	15/04/2020 12:11	01:00:00	50.4	67.3	45.7	51.5	48.5
15/04/2020 12:12	15/04/2020 13:12	01:00:00	51.4	73.7	45.8	53.0	48.5
15/04/2020 13:12	15/04/2020 14:12	01:00:00	51.2	72.7	45.9	52.0	49.0
15/04/2020 14:52	15/04/2020 15:52	01:00:00	53.3	84.0	47.4	53.5	50.0
15/04/2020 15:53	15/04/2020 16:53	01:00:00	52.6	76.5	47.3	53.0	49.5
15/04/2020 16:55	15/04/2020 17:55	01:00:00	71.0	110.8	46.4	52.0	48.5
18/04/2020 08:40	18/04/2020 09:40	01:00:00	51.4	74.2	45.3	51.0	48.0
18/04/2020 09:41	18/04/2020 10:41	01:00:00	53.7	84.7	45.8	52.0	48.0
18/04/2020 10:43	18/04/2020 11:43	01:00:00	56.1	75.5	47.0	59.0	51.0
18/04/2020 11:43	18/04/2020 12:43	01:00:00	53.3	70.9	47.0	56.5	49.5
18/04/2020 12:48	18/04/2020 13:48	01:00:00	53.1	78.6	47.4	55.0	49.5
18/04/2020 13:48	18/04/2020 14:48	01:00:00	52.7	78.5	46.0	52.0	49.0
18/04/2020 14:48	18/04/2020 15:48	01:00:00	50.6	71.7	44.8	52.0	47.5
18/04/2020 15:49	18/04/2020 16:49	01:00:00	50.1	67.4	44.4	52.0	48.0
18/04/2020 16:50	18/04/2020 17:50	01:00:00	48.0	64.6	42.7	50.0	45.5

Table 4-15: Ambient Noise Monitoring Logs for NMP 02

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
16/04/2020 09:54	16/04/2020 10:54	01:00:00	47.8	85.0	38.9	46.5	42.0
16/04/2020 10:56	16/04/2020 11:56	01:00:00	44.8	66.9	40.2	47.0	42.5
16/04/2020 11:56	16/04/2020 12:56	01:00:00	47.6	86.2	39.0	50.5	42.5
16/04/2020 12:56	16/04/2020 13:56	01:00:00	45.5	76.3	37.9	46.0	41.5
16/04/2020 13:56	16/04/2020 14:56	01:00:00	52.5	91.3	38.3	48.5	44.5
16/04/2020 14:56	16/04/2020 15:56	01:00:00	52.9	87.6	41.8	49.0	46.0
16/04/2020 15:56	16/04/2020 16:56	01:00:00	46.1	80.1	39.4	47.0	44.0
16/04/2020 16:56	16/04/2020 17:56	01:00:00	45.3	69.3	38.5	46.5	41.5
19/04/2020 08:33	19/04/2020 09:33	01:00:00	48.7	83.3	36.0	40.5	47.5
19/04/2020 09:34	19/04/2020 10:34	01:00:00	43.9	71.9	36.9	41.5	39.0
19/04/2020 10:46	19/04/2020 11:46	01:00:00	46.0	69.0	38.2	50.5	41.5
19/04/2020 11:46	19/04/2020 12:46	01:00:00	48.8	79.5	40.0	48.5	44.0
19/04/2020 12:49	19/04/2020 13:49	01:00:00	47.9	72.9	42.2	49.0	45.5
19/04/2020 13:52	19/04/2020 14:52	01:00:00	47.2	79.6	40.8	47.5	43.5

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
19/04/2020 15:30	19/04/2020 16:30	01:00:00	46.7	73.3	39.6	49.5	44.5
19/04/2020 16:33	19/04/2020 17:33	01:00:00	46.0	71.9	39.3	45.5	42.0

Table 4-16: Ambient Noise Monitoring Logs for NMP 03

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
17/04/2020 09:30	17/04/2020 10:30	01:00:00	50.5	68.6	44.9	54.0	47.5
17/04/2020 10:30	17/04/2020 11:30	01:00:00	50.0	79.8	44.0	50.0	47.0
17/04/2020 11:30	17/04/2020 12:30	01:00:00	49.4	72.2	43.9	50.5	46.0
17/04/2020 12:30	17/04/2020 13:30	01:00:00	51.1	80.0	44.9	56.0	48.5
17/04/2020 14:00	17/04/2020 15:00	01:00:00	51.3	86.2	44.2	51.5	47.5
17/04/2020 15:01	17/04/2020 16:01	01:00:00	49.3	77.0	43.9	49.5	46.5
17/04/2020 16:01	17/04/2020 17:01	01:00:00	51.1	85.5	44.7	52.5	47.0
17/04/2020 17:01	17/04/2020 18:01	01:00:00	51.8	81.9	45.5	51.5	47.5
24/04/2020 09:42	24/04/2020 10:42	01:00:00	46.6	73.9	38.5	45.0	40.5
24/04/2020 10:42	24/04/2020 11:42	01:00:00	47.6	74.8	39.0	54.0	41.5
24/04/2020 11:43	24/04/2020 12:43	01:00:00	45.2	66.4	37.6	44.5	41.5
24/04/2020 12:44	24/04/2020 13:44	01:00:00	43.3	63.8	35.9	46.5	37.5
24/04/2020 14:03	24/04/2020 15:03	01:00:00	44.3	63.5	38.0	47.5	41.0
24/04/2020 15:04	24/04/2020 16:04	01:00:00	51.0	70.4	39.5	55.0	47.5
24/04/2020 16:04	24/04/2020 17:04	01:00:00	50.5	68.9	44.9	53.5	47.5
24/04/2020 17:05	24/04/2020 18:05	01:00:00	48.2	66.5	42.6	49.5	44.0

Table 4-17: Ambient Noise Monitoring Logs for NMP 04

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
22/04/2020 09:29	22/04/2020 10:29	01:00:00	47.4	76.0	36.4	47.5	41.5
22/04/2020 10:29	22/04/2020 11:29	01:00:00	47.2	76.0	38.3	45.5	40.5
22/04/2020 11:30	22/04/2020 12:30	01:00:00	46.1	71.3	39.7	45.5	41.5
22/04/2020 12:30	22/04/2020 13:30	01:00:00	56.2	72.0	40.3	49.0	42.5
22/04/2020 14:00	22/04/2020 15:00	01:00:00	48.2	67.1	42.9	51.5	46.5
22/04/2020 15:00	22/04/2020 16:00	01:00:00	51.7	85.0	43.5	49.5	46.5
22/04/2020 16:01	22/04/2020 17:01	01:00:00	51.3	67.7	43.9	56.0	48.5
23/04/2020 10:00	23/04/2020 11:00	01:00:00	67.8	77.5	43.8	69.0	68.5
23/04/2020 11:00	23/04/2020 12:00	01:00:00	68.7	75.8	67.7	69.0	68.5
23/04/2020 12:00	23/04/2020 13:00	01:00:00	68.7	71.9	67.8	69.0	68.5

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
23/04/2020 13:00	23/04/2020 14:00	01:00:00	66.2	69.9	43.6	69.0	48.5
23/04/2020 15:55	23/04/2020 16:55	01:00:00	68.7	82.1	46.8	69.5	69.0

Table 4-18: Ambient Noise Monitoring Logs for NMP 05

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
20/04/2020 09:01	20/04/2020 10:01	01:00:00	58.7	82.1	41.9	62.5	47.0
20/04/2020 10:01	20/04/2020 11:01	01:00:00	61.3	93.1	42.6	62.0	52.5
20/04/2020 11:10	20/04/2020 12:10	01:00:00	63.6	97.3	45.7	57.5	50.5
20/04/2020 12:11	20/04/2020 13:11	01:00:00	60.3	83.3	46.7	64.5	53.0
20/04/2020 14:04	20/04/2020 15:04	01:00:00	60.7	91.0	47.0	63.5	51.0
20/04/2020 15:05	20/04/2020 16:05	01:00:00	64.2	89.4	46.5	68.0	58.5
20/04/2020 16:05	20/04/2020 16:34	01:00:00	68.1	91.4	45.4	67.5	52
21/04/2020 09:32	21/04/2020 10:32	01:00:00	60.2	83.6	43.1	64.5	51.5
21/04/2020 10:32	21/04/2020 11:32	01:00:00	61.3	84.6	45.3	60.5	51.5
21/04/2020 11:32	21/04/2020 12:32	01:00:00	64.6	89.2	44.6	62.4	50.5
21/04/2020 12:32	21/04/2020 13:32	01:00:00	63.7	81.6	43.2	57.5	49.0
21/04/2020 14:36	21/04/2020 15:36	01:00:00	62.8	92.7	47.2	66.5	55.0
21/04/2020 15:36	21/04/2020 16:36	01:00:00	65.5	94.9	45.4	66.5	53.0
21/04/2020 16:37	21/04/2020 17:37	01:00:00	59.2	88.3	44.5	58.0	49.0
21/04/2020 17:37	21/04/2020 18:37	01:00:00	59.0	84.2	45.7	58.5	52.0

Table 4-19: Ambient Noise Monitoring Logs for NMP 06

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Level Pressure dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
25/04/2020 09:52	25/04/2020 10:52	01:00:00	66.5	88.2	50.6	72.0	60.0
25/04/2020 11:08	25/04/2020 12:08	01:00:00	69.3	94.0	49.8	69.5	61.0
25/04/2020 12:09	25/04/2020 13:09	01:00:00	69.3	93.1	51.4	76.0	61.0
25/04/2020 13:09	25/04/2020 14:09	01:00:00	66.3	89.1	48.5	69.5	57.5
25/04/2020 14:09	25/04/2020 15:09	01:00:00	68.8	92.1	50.5	72.5	60.0
25/04/2020 15:09	25/04/2020 16:09	01:00:00	69.8	96.0	50.6	69.5	59.0
25/04/2020 16:10	25/04/2020 17:10	01:00:00	68.6	89.5	52.2	69.5	58.5
25/04/2020 17:10	25/04/2020 18:10	01:00:00	69.0	95.0	51.8	70.0	60.5
28/04/2020 09:47	28/04/2020 10:47	01:00:00	72.6	97.6	48.3	75.0	57.5
28/04/2020 10:47	28/04/2020 11:47	01:00:00	70.6	96.9	49.4	74.5	59.5
28/04/2020 11:47	28/04/2020 12:47	01:00:00	69.4	97.5	49.5	69.5	55.0

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Level Pressure dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
28/04/2020 12:47	28/04/2020 13:47	01:00:00	68.1	93.4	46.5	61.0	52.5
28/04/2020 13:47	28/04/2020 14:47	01:00:00	67.1	93.3	46.5	66.5	56.0
28/04/2020 16:00	28/04/2020 17:00	01:00:00	59.9	68.4	51.2	64.0	54.0
28/04/2020 17:00	28/04/2020 18:00	01:00:00	70.3	95.8	50.3	69.5	57.5

Table 4-20: Ambient Noise Monitoring Logs for NMP 07

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Level Pressure dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
30/04/2020 10:12	30/04/2020 11:12	01:00:00	75.8	102.1	62.0	77.0	68.0
30/04/2020 11:15	30/04/2020 12:15	01:00:00	74.7	95.8	59.2	76.0	66.5
30/04/2020 12:15	30/04/2020 13:15	01:00:00	75.5	102.2	59.2	77.5	67.0
30/04/2020 13:16	30/04/2020 14:16	01:00:00	75.4	104.5	59.5	77.0	67.0
30/04/2020 14:16	30/04/2020 15:16	01:00:00	74.2	98.5	60.5	76.0	66.5
30/04/2020 15:16	30/04/2020 16:16	01:00:00	74.3	96.8	58.5	76.0	67.5
30/04/2020 16:16	30/04/2020 17:16	01:00:00	75.0	97.2	59.3	77.0	67.5
30/04/2020 17:16	30/04/2020 18:16	01:00:00	76.1	99.8	60.3	77.5	68.5
01/05/2020 09:31	01/05/2020 10:31	01:00:00	74.9	102.6	59.4	75.0	68.0
01/05/2020 10:31	01/05/2020 11:31	01:00:00	75.3	100.7	59.7	77.5	67.0
01/05/2020 11:32	01/05/2020 12:32	01:00:00	73.9	94.7	59.1	75.5	68.5
01/05/2020 12:32	01/05/2020 13:32	01:00:00	73.8	93.7	56.4	76.5	68.5
01/05/2020 14:55	01/05/2020 15:55	01:00:00	75.2	101.9	56.7	76.0	66.5
01/05/2020 15:55	01/05/2020 16:55	01:00:00	75.8	101.4	57.7	76.0	67.5
01/05/2020 16:56	01/05/2020 17:56	01:00:00	75.3	106.0	59.4	76.5	66.0

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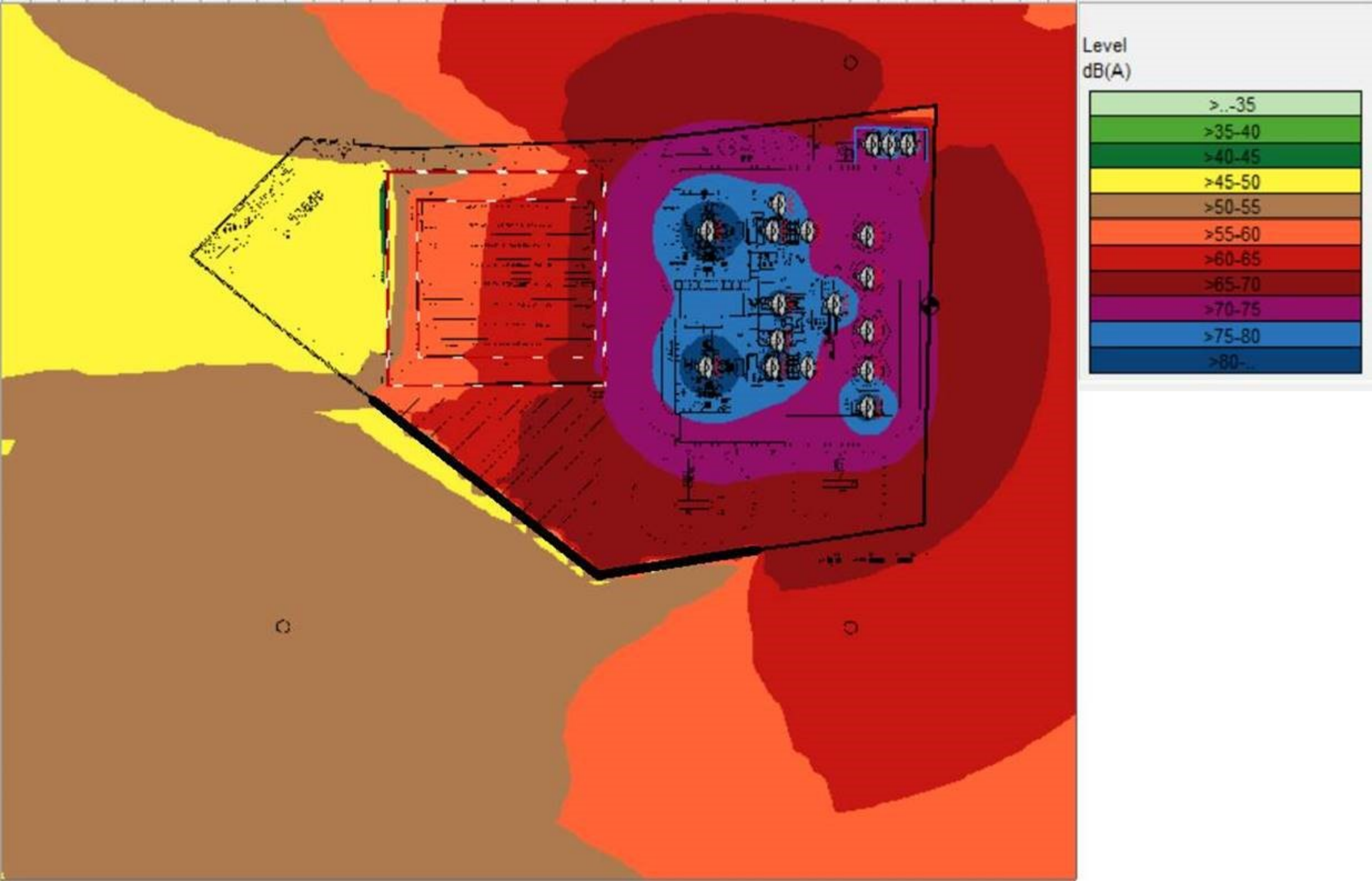
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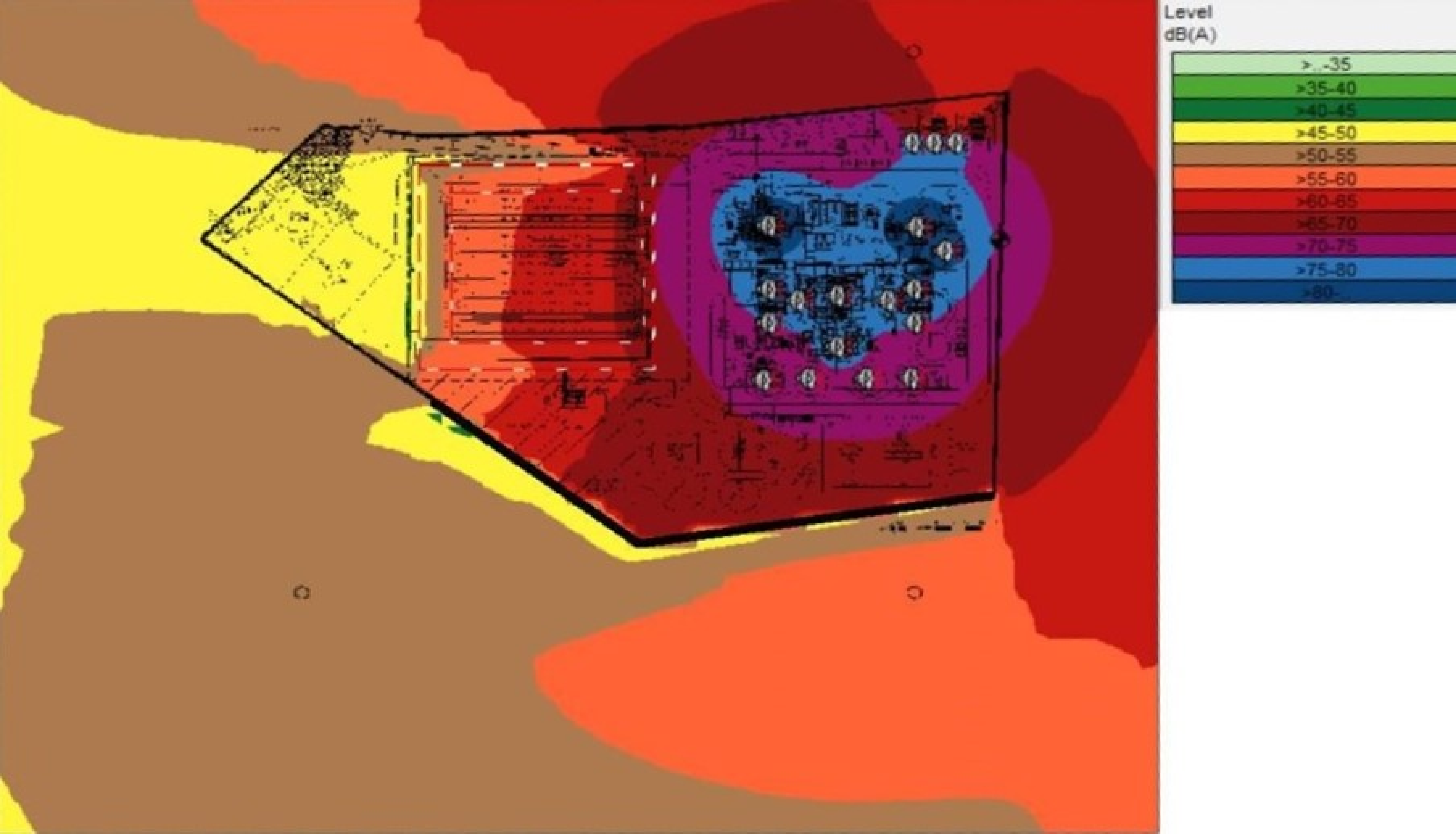
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Appendix F: Air Quality Report

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT (ESHIA)

DRAFT AIR QUALITY AND NOISE BASELINE REPORT

May 2020

Western Area Power Generation Project
CEC Africa (Sierra Leone)

Prepared by

INTEGEMS

Integrated Geo-information and Environmental Management Services

Integrated Geo-information and
Environmental Management Services Limited

DISCLAIMER

The findings, results, observations, conclusions and recommendations given in this report are based on the authors' scientific and professional knowledge as well as available information at the time of compiling this report. The contents of this report can be updated and/or modified if and when new information may become available.

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QUALITY ASSURANCE CHECK

Title	CECASL Western Area Power Generation (WAPG) Project – Air Quality & Noise Baseline Assessment Report			
Type	Draft Report			
Date	29 May 2020			
Subject	Environment, Social and Natural Resources Management			
Client	Copperbelt Energy Corporation Africa Sierra Leone Generation Limited			
Description	CECASL Western Area Power Generation (WAPG) Project – Air Quality & Noise Baseline Assessment Report			
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Rights	© INTEGEMS Limited and CECASL			
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Rev-1	Document 1	29.05.2020	INTEGEMS	Inclusion of 2015 noise data

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LIST OF ABBREVIATIONS

AQMP	Air Quality Monitoring Point
AWS	Automatic Weather Station
BATNEC	Best Available Technology Not Entailing Excessive Cost
BOOT	Build, Own, Operate and Transfer
CECASL	Copperbelt Energy Corporation Africa Sierra Leone
COVID	Coronavirus Disease
EDSA	Electricity Distribution and Supply Authority
EHS	Environmental, Health and Safety
EPA-SL	Environment Protection Agency-Sierra Leone
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Assessment
GCM	General Circulation Model
GIMSS	Government Independent Memorial Secondary School
GIS	Geographic Information System
GPS	Global Positioning System
HFO	Heavy Fuel Oil
IFC	International Finance Corporation
ITCZ	Inter-Tropical Convergence Zone
JAS	July, August and September
JFM	January, February and March
LPG	Liquified Petroleum Gas
NMP	Noise Monitoring Point
OND	October, November and December
PPA	Power Purchase Agreement
SALHOC	Sierra Leone Housing Corporation
SWISS	Sir Winston Churchill International Secondary School
UNDP	United Nations Development Programme
VOCs	Volatile Organic Compounds
WAPG	Western Area Power Generation
WBG	World Bank Group
WHO	World Health Organisation

1 INTRODUCTION

The Copperbelt Energy Corporation Africa Sierra Leone Limited (CECASL) is a joint venture established in 2014 to develop an electricity-generating, Heavy Fuel Oil (HFO) fired power generation plant on a Build Own Operate and Transfer (BOOT) basis on a parcel of land located 4 km east from the centre of Freetown. An Environmental, Social and Health Impact assessment (ESHIA) was undertaken for the project in 2015. However, the project has been restructured from an HFO-fired power generation plant to a Liquefied Petroleum Gas (LPG)/combined cycle plant and reconstituted as the Western Area Power Generation Project (hereinafter, the project).

CECASL has contracted Integrated Geo-information and Environmental Management Services (INTEGEMS) Limited to undertake a baseline update for the air quality and environmental noise for incorporation into the updated ESHIA of the project in order to comply with the environmental regulations of Sierra Leone as required by the Environment Protection Agency-Sierra Leone (EPA-SL).

The revised ESHIA is required to meet the requirements of International Financing Institutions (IFIs) as generally defined in the International Financing Corporation (IFC) Performance Standards for Environmental and Social Sustainability ('IFC Standards' or 'the Performance Standards') and the Environmental, Health and Safety (EHS) Guidelines of the World Bank Group (WBG).

This Air Quality and Environmental Noise Baseline Report (hereinafter, report) presents an updated baseline for air quality and noise within the project area and is compiled for incorporation into the ESHIA Report which is expected to present a statement of the likely social, environmental and health effects of the project including a description of the measures that are required to be implemented to avoid, reduce and where possible, remedy any identified significant adverse effects.

1.1 Project Overview

The project is located on a site in the Kissy Dock area, approximately 4 km east of the centre of Freetown, Sierra Leone on existing industrial land immediately south of the old refinery tank farm (currently under rehabilitation to be used as a petroleum storage depot by All Petroleum Products Limited) and is approximately 500 m from the sea (see Figure 1-1 and Figure 1-2). The power plant will be developed in two phases with Phase 1 constituting 83.5 MW output utilising 2 GE LME 2500 turbines in combined cycle with a steam turbine. CECASL Generation Limited will develop, finance, construct, own and operate the Power Plant and shall sell the entire output of the power plant to EDSA under a 20-year Power Purchase Agreement (PPA) with EDSA as the single off-taker.

Under the restructured project, the current scope includes two GE LME 2500 turbines in combined cycle with a steam turbine and associated balance of plant; a new substation at Kissy project site; substation upgrades at Blackhall Road, Ropoti and Wellington; new 33 kV line between Wellington and Blackhall Road; a 4,000 MT of on-site LPG storage; and an LPG pipeline from Kissy Jetty to the plant site.

1.2 Objective

The main objective of the study is to update the air quality and noise baseline data to be incorporated in the updated ESHIA Report that will provide an analysis of the project's potential environmental, social and health impacts.

1.3 Scope of Work

The scope of works includes the development of monitoring plans, acquisition of air quality and noise data and the preparation of air quality and noise baseline report for inclusion into the updated ESHIA Report. The geographic scope is limited to the project site and LPG pipeline at Kissy Dockyard and delineated area of influence of the environmental aspects under consideration.

1.4 The ESHIA Consultant – INTEGEMS Limited

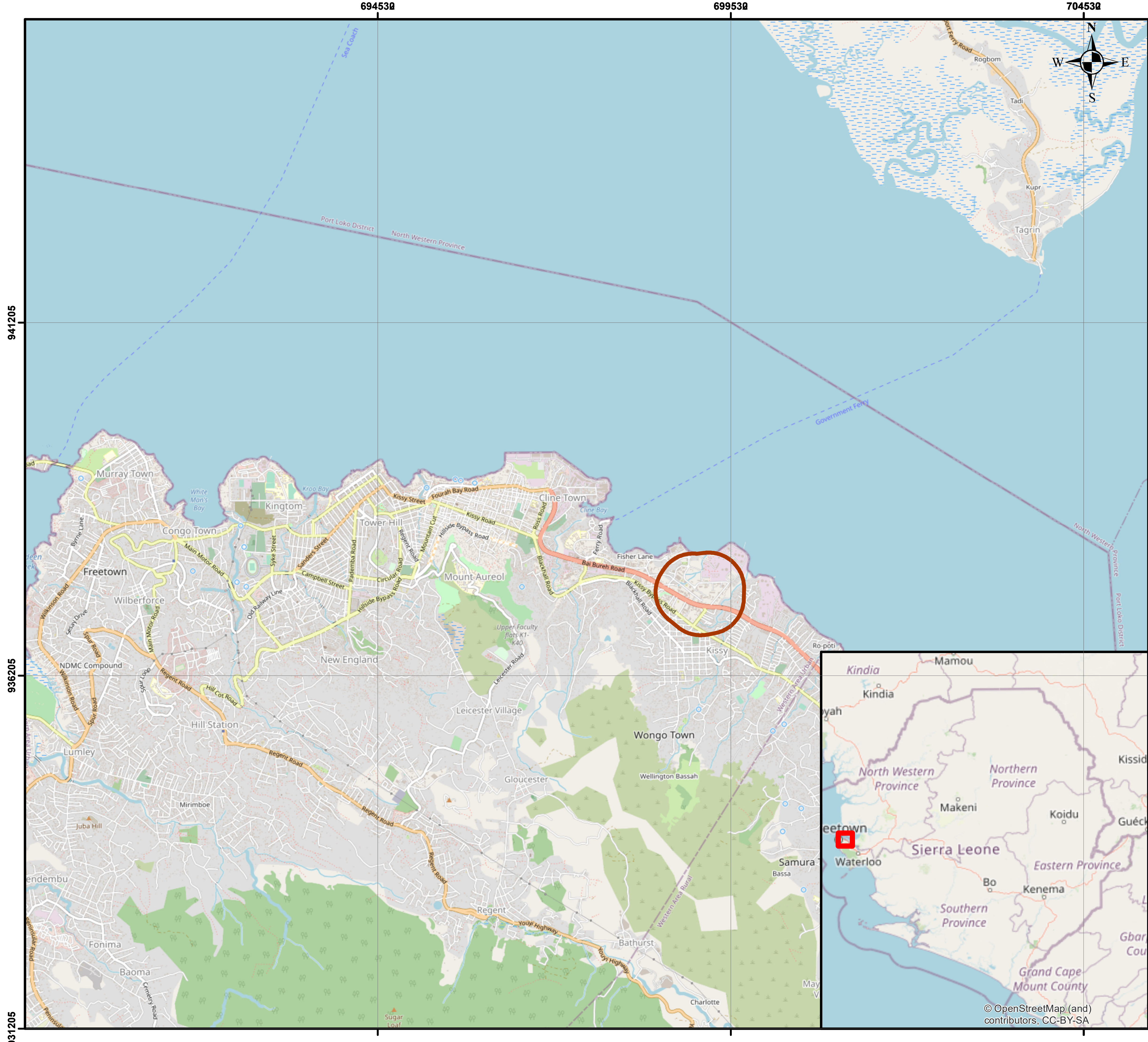
INTEGEMS is a Sierra Leone-based multidisciplinary consultancy firm that integrates innovative GIS and remote sensing technologies with research and environmental management expertise to provide and enable public and private sector organisations effectively and efficiently respond to natural resources management challenges and opportunities.

INTEGEMS has been appointed by CECASL as the local ESIA Consultant for the project. INTEGEMS' ESIA Team has been involved in the project since 2014 and retains significant knowledge of the project environmental and social elements.

INTEGEMS has experience across Sierra Leone and has developed a thorough understanding of national, regional and local legislative requirements as well as the environmental and socio-economic challenges faced by various programmes, projects and organisations in Sierra Leone. In collaboration with strategic partners, INTEGEMS has successfully designed and carried out several environmental, socio-economic and health baseline surveys and impact assessments in diverse communities in Sierra Leone.

INTEGEMS is supported by extensive resources and expertise from a network of associates and partners and has drawn upon a wide range of technical specialists and strategic partners to contribute to and collaborate on the ESIA.

Figure 1 1: Regional Project Location



Legend

Kissy Dockyard Area

Sources:

CECASL, INTEGEMS Ltd, OpenStreetMap, ESRI Basemap

Date Created: Date: 27 May 2020

0 0.5 1 2 Kilometers

Coordinate System: WGS 1984 UTM Zone 28N

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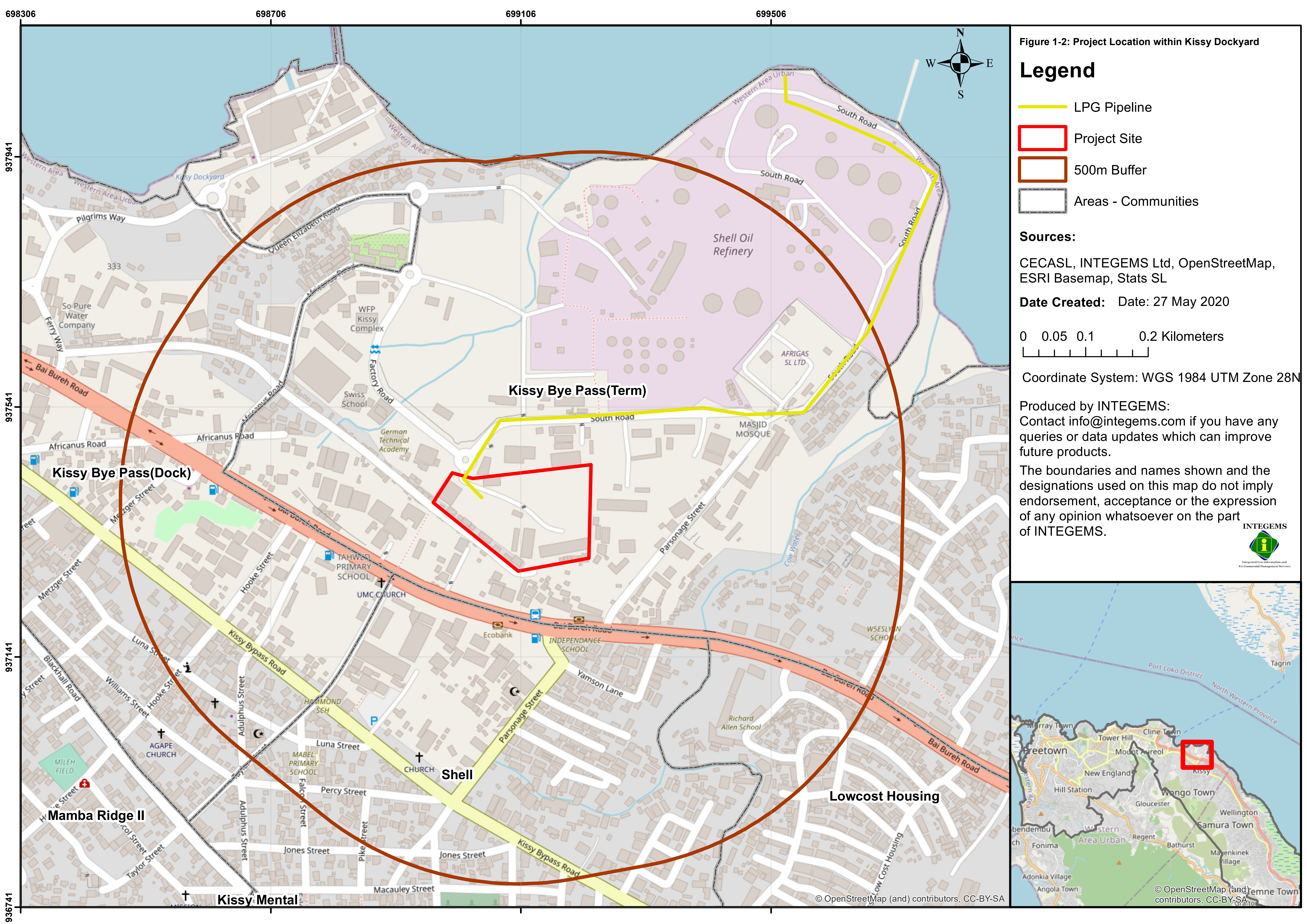


Figure 1-2: Project Location within Kissy Dockyard

2 CLIMATE AND METEOROLOGY

2.1 General Description of Climate in Sierra Leone

Sierra Leone is located on the West coast of Africa, between latitude 7º and 10º north of the equator and longitude 10º and 13º west. The climate in Sierra Leone is tropical, with a wet season from May to October and a dry season from November to April.

The Inter-Tropical Convergence Zone (ITCZ) has a major influence on the climate of Sierra Leone. Throughout the year the ITCZ remains in the northern hemisphere in the eastern Pacific and Atlantic regions. Over Africa, the ITCZ migrates from the southern to the northern hemisphere between January and July (Tyson & Preston-Whyte, 2000). The hot weather during this period, heats the air in the ITCZ, increasing its humidity and making it buoyant. As the buoyant air rises as a result of the trade winds from the south-west, it expands and cools, producing rainfall over Sierra Leone and surrounding regions. As the ITCZ moves south during September, the wet season draws to a close.

The winds that originate during the dry season (winter), known as the Harmattan winds, consist of the northeast trade winds. These winds bring no precipitation apart from the occasional very light rain. The Harmattan winds transport dust from the Sahara Desert and usually blow from late November to mid-March. Average wind speeds in Sierra Leone are generally low.

The temperatures are consistently high throughout the country, roughly averaging from 25–27 °C, with slightly lower temperatures (22–25 °C) during the wet season. Diurnal temperatures vary from 25 °C to 34 °C although, they could be as low as 16 °C at night during the Harmattan (Figure 2-2). The average annual temperature has increased by 0.8 °C since 1960. Data is limited but, available data show significantly increasing trends in the frequency of 'hot' nights. The humidity, like the temperature, is usually high as a result of the heavy rains coupled with high temperature and maritime influences. Humidity rises to 93% in the wet season and decreases inland to about 47% as the rainfall declines. There is little seasonal variation in mean air temperatures, with slightly hotter conditions in April and May. Altitude influences temperature as well as other weather variables, with temperatures generally decreasing with altitude.

Due to heavy rainfall in the wet season, discharges and runoff are high and ranges from 20% to 40% of total annual rainfall. Rivers overflow their banks during this period. Average annual rainfall over Sierra Leone has decreased since 1960 but it is difficult to determine whether this is part of a long-term trend because of the variable nature of rainfall in this region. The dry season is prone to dusty and hot Harmattan winds and drought conditions. However, there is pronounced dry season from November to March when flows may be sufficiently reduced to be a constraint.

There is little variation in the day length due to the near-equatorial location, but sunshine hours are affected during the wet season. Sunshine is plentiful and varies substantially with the amount of cloudiness. During the dry season (November to March) mean monthly solar radiation is high, 380 cal/ cm^2/day (480 lux); mean hours of sunshine varies from 7-9, and pan evaporation is about 4.5 mm per day. The wet season is generally dull and cloudy with a mean monthly solar radiation of 280 cal/ cm^2/day, mean hours of sunshine is 3 hours/day in July and August, and pan evaporation generally less than 2.0 mm/day, due to high diurnal humidity.

Between the year 1991 and 2015, a mean annual rainfall of about 2,427 mm was recorded, with the highest annual rainfalls recorded in July, August and September (see Figure 2-1) (WBG, 2018).

Figure 2-1: Average Monthly Rainfall for Sierra Leone (1991 – 2015)

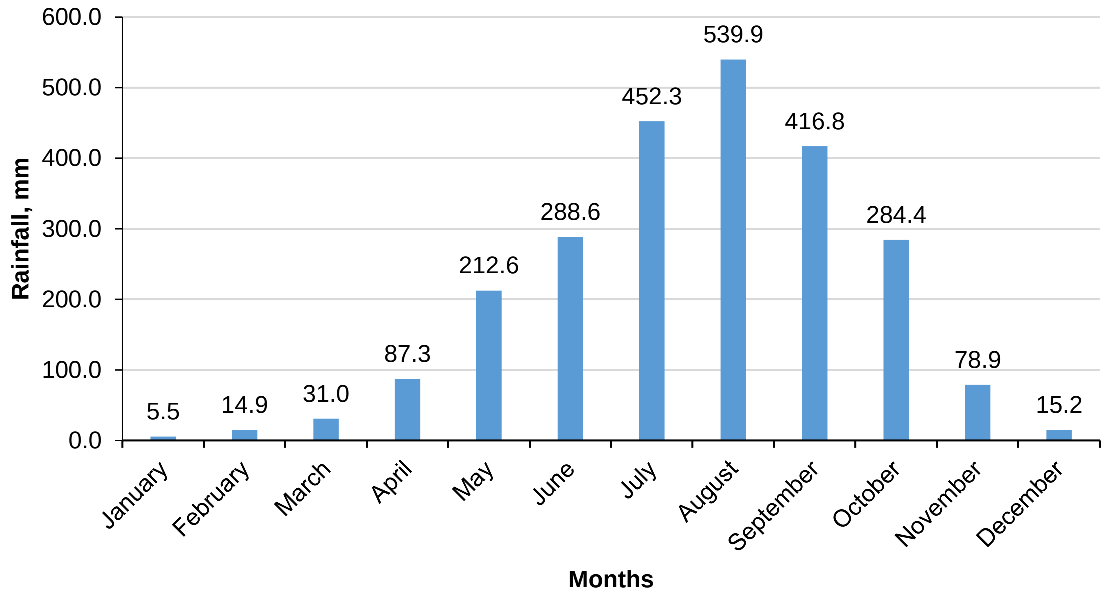
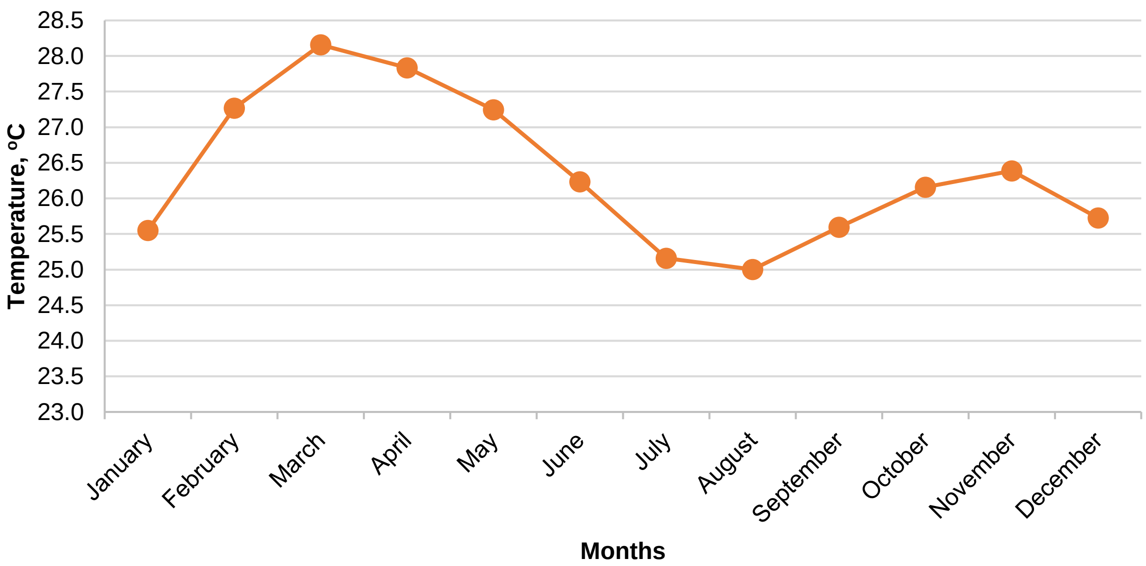


Figure 2-2: Mean Monthly Temperature for Sierra Leone (1991 – 2015)



2.2 Climate Conditions in the Project Area

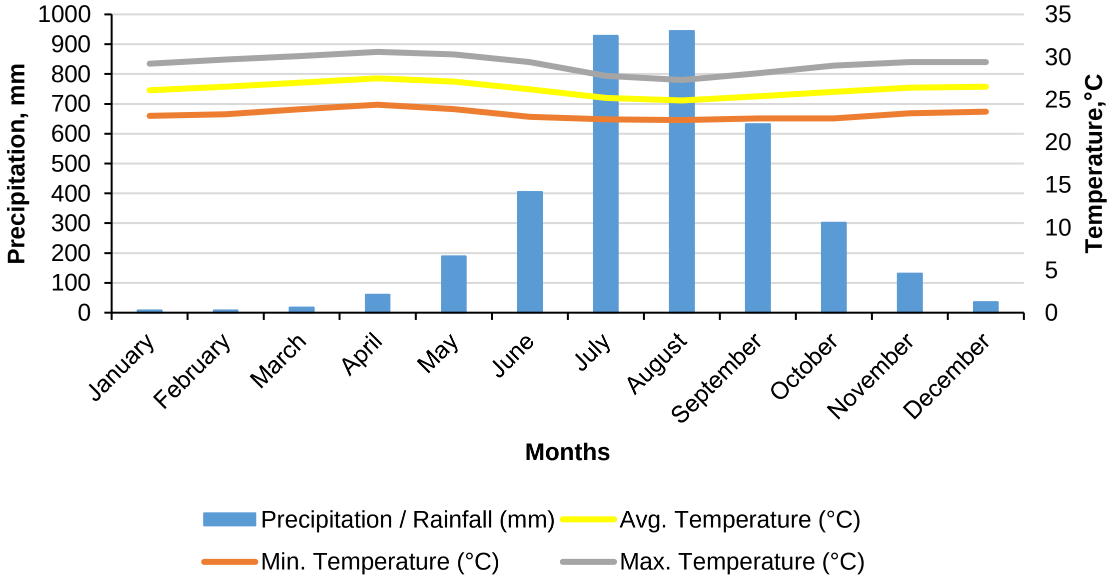
Generally, the climate of the project area (taken from the Climate of Freetown) is described as wet tropical monsoon with a single wet season each year. According to Köppen and Geiger, this climate is classified as Am. The average temperature in Freetown is 26.2 °C with rainfall around 3657 mm per year (see Table 2-1 and Figure 2-3)[1]. The precipitation varies 937 mm between the driest month and the wettest month. To acquire site-specific meteorological data for future analysis and modelling (including air emission dispersion or noise modelling), it is recommended that an automatic weather station is installed at the project site.

[1] CLIMATE DATA.ORG (accessed via: https://en.climate-data.org/africa/sierra-leone/western-area/freetown-526/, 25 May 2020)

Table 2-1: Temperature and Precipitation Records for Freetown (1982-2012)

Month	Temperature, °C			Precipitation / Rainfall (mm)
	Average	Minimum	Maximum	
January	26.1	23.1	29.2	8
February	26.5	23.3	29.7	7
March	27.0	23.9	30.1	17
April	27.5	24.4	30.6	60
May	27.1	23.9	30.3	189
June	26.2	23.0	29.4	404
July	25.2	22.7	27.8	928
August	24.9	22.6	27.3	944
September	25.4	22.8	28.1	632
October	25.9	22.8	29	302
November	26.4	23.4	29.4	131
December	26.5	23.6	29.4	35

Figure 2-3: Temperature and Precipitation Records for Freetown (1982-2012)



3 AIR QUALITY

Urban air pollution has the potential to cause significant environmental problems wherein pollution can build up in isolated pockets, and local sources for instance near industries or busy roads; thus, adding to the overall reduction of air quality of the area. The Kissy Dockyard area has both industrial/commercial and residential makeup.

There is no regulatory local monitoring undertaken within Sierra Leone, although some work carried out by the Njala University, Sierra Leone indicates that air quality at certain locations in Freetown is considered poor for some substances (Taylor & Nakai, 2012), and these locations could potentially be classified as degraded airsheds.

The key sources of air pollution which influence air quality in the vicinity of the project site are likely to be domestic or commercial-scale power generators, burning of household or commercial wastes, residential wood and charcoal ovens, road traffic emissions, industrial emissions and re-suspended dust/particulate matter from poorly surfaced or unsurfaced roads. Due to unreliable power sources, domestic and commercial power generators, commonly running on diesel are prevalent in most parts of Freetown, including around the site. This will lead to increased emissions of substances associated with combustion in addition to those emitted by road traffic, for example, nitrogen dioxide, sulphur dioxide, particulates and carbon monoxide. The amount of poorly surfaced roads is likely to lead to significant dust generation during the dry season. During the rainy season, the potential for significant dust generation is less likely.

3.1 Methodology

Air quality monitoring was undertaken to update the data acquired in 2015 for the previous ESHIA. The monitoring was undertaken at five locations between April and May 2020. As best as possible, these locations were the same locations as those in the 2015 baseline study. However, the sites were subjected to accessibility and security constraints. Therefore, only five sites were monitored, and with marginal deviations from the original positions. Generally, the selection of the locations is based on various factors such as site topography, prevailing wind direction, the layout of the proposed project components, the location of the nearest sensitive receptors and good international industry practise and guidelines. The list of locations is presented in Table 3-1 and illustrated in Figure 3-1.

The following are the air pollutants parameters measured during the monitoring: Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Ozone (O_3), Volatile Organic Compounds (VOCs), Particulate Matter aerodynamic diameter 10 µm (PM_{10}) and Particulate Matter of aerodynamic diameter 2.5 µm ($PM_{2.5}$). The monitoring was designed to record the average concentrations of each pollutant in the air at the specified locations over a three (3) days period.

Air pollutants are emitted into the atmosphere from a variety of sources and the concentration of these pollutants in the ambient air depends not only on the quantities that are emitted but also the conditions and ability of the atmosphere, to either absorb or disperse these pollutants. Understanding the behaviour of meteorological parameters is important because the atmosphere is the medium in which air pollutants are transported away from the source, which is determined by the meteorological parameters. Therefore, at each monitoring location data was additionally acquired for temperature and relative humidity.

The air quality monitoring was undertaken using a portable air quality monitor Aeroqual Series 500 sensor, which enables accurate short-term fixed real-time surveying of common outdoor air pollutants. The sensors are housed within an interchangeable cartridge (“head”) that attaches to the monitor base which can be removed and replaced in seconds, allowing users to measure as many gases as desired.

The measurements were carried out by placing the equipment at a height of about 1.5 -1.7 metres from the ground level and sufficiently away from any disturbance or direct obstacle from the source(s) under consideration to ensure that the air that is monitored is representative of the air that most residents/visitors were breathing. During the monitoring, the field staff were stationed on the sites on a daily basis to perform routine data checks, performance audits, and scheduled maintenance. The field technicians carried out QA/QC duties, including change of filters (where necessary), and retrieval/download of raw data. Photographic reference for each measurement location was also recorded as shown in Figure 4-4 to Figure 4-5.

Table 3-1: Air Quality Monitoring Locations

Site ID	Site Name	Description	Latitude	Longitude
AQMP 01	Shell Police Station	Location AQMP 01 is approximately 74 m south of the project site along Bai Bureh Road, a highway with frequent vehicular movement, petty trading and numerous small and large-scale commercial activities. Within the vicinity of the point is a Bus Park for passengers travelling out of Freetown to the Province with a gas station located at a distance of 40 m south of the monitoring point.	8.474425	-13.191168
AQMP 02	Sierra Leone Housing Cooperation (SALHOC) Gate	Monitoring point AQMP 02 is located southwest of the project site at a distance of about 132 m. The point is similarly located along Bai Bureh Road. Within the immediate vicinity of AQMP 02 are SALHOC Compound, National Petroleum (NP) gas station, Commodity Trading Company (CTC), Tahweb Primary School and a tyre servicing centre about 10 meters away.	8.475105	-13.193238
AQMP 03	Sir Winston Churchill International Secondary School (SWISS)	AQMP 03 is located at the SWISS compound at approximately 137 m northwest of the project site. The monitoring point is about 30 m south of Factory Road, an unpaved road within the Kissy Dockyard industrial zone. A metal welding shop is located within the SWISS compound, although this facility was not operational during the monitoring period.	8.477215	-13.193336
AQMP 04	Masjid IHASAN Mosque	Location AQMP 04 is 266 m east of the project site at the Masjid (Mosque) IHASAN compound along South Road, which is frequently plied by fuel bowsers en route to NP's Fuel Depot, which is about 200 m northeast. The critical receptors within the vicinity of this point include squatters along South Road and the Government Independent Memorial Secondary School along Parsonage Street.	8.477328	-13.188037
AQMP 05	Fomel Industries and National Industrialisation Centre (FINIC) Fence	AQMP 05 is located adjacent FINIC at about 67 m east of the project site and about 30 m off South Road. Within the most immediate vicinity of AQMP 05 is Bollore Logistics Compound and with squatters along the fences of the industrial compounds.	8.476635	-13.189709

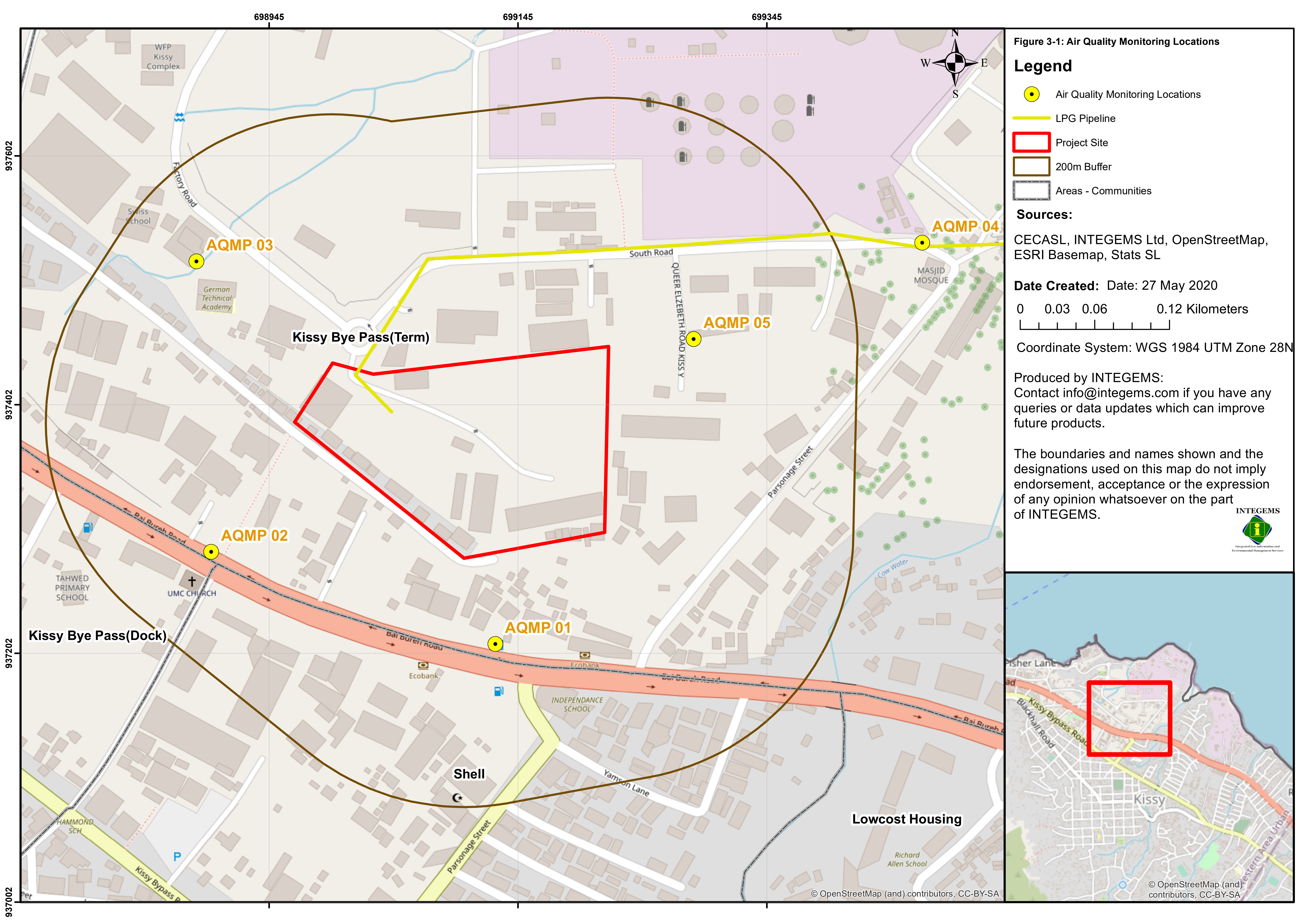


Figure 3-1: Air Quality Monitoring Locations

3.2 Results and Analysis

The air quality at the site is generally influenced by activities and sources such as the combustion of engines, open burning by residents and businesses, the concentration of dust particles from roads and emissions from equipment and machinery used in transportation and industrial operations. These impacts may affect the environment and human health. In studying the receiving environment, the following was observed:

- The area is characterised by industrial and commercial uses with some formal and informal shanty dwellings and school dispersed between.
- There are several sources of air pollutants in the area which includes domestic and commercial-scale power generators, burning of household or commercial wastes, road traffic emissions (i.e. exhaust and non-exhaust emissions), emissions from industrial operations and re-suspended particulate matter from paved and unpaved roads.
- The most sensitive receptors within the area residences, schools, places of worship and employees of various entities within the project area.
- The weather was warmer with temperatures ranging from 32.3 ^{o}C to 36.6 ^{o}C with an average of 34.7 ^{o}C over the two weeks of monitoring.

The results from the air quality monitoring are presented in Table 3-2 and Table 3-3, while the analysis is presented in Sections 3.2.1 to 3.2.6. Guidelines published by the WHO (WHO, 2005) are utilised in this report as there are no applicable ambient air quality guidelines in Sierra Leone.

Table 3-2: Mean Air Pollutant Concentrations

Parameter	Units	WHO Daily Standard Values	AQMP 01	AQMP 02	AQMP 03	AQMP 04	AQMP 05
$PM_{2.5}$	µg/m^3	25	24.11	38.05	34.77	16.23	68.32
PM_{10}	µg/m^3	50	63.53	82.99	93.49	48.81	71.48
NO_2	µg/m^3	200	18.48	9.73	14.06	23.7	15.27
CO	µg/m^3	3000	57.44	75.76	28.85	0	0
O_3	µg/m^3	100	21.88	24.12	23.28	26.17	27.95
SO_2	µg/m^3	20	0	0	0	0	0
VOCs	mg/m^3	NA	624	391	307	617	635
Temperature	^{o}C	NA	34.8	33.6	34	35.9	35
Relative Humidity	%	NA	56.3	59.6	60.9	50.9	55.8

Table 3-3: Daily Air Mean Pollutant Concentrations

Locations	Day	Date, dd/mm/yyyy	$PM_{2.5}$, µg/m^3	PM_{10}, µg/m^3	NO_2, µg/m^3	CO, µg/m^3	O_3, µg/m^3	SO_2, µg/m^3	VOC, mg/m^3	Temperature, ^{o}C	Relative Humidity, %
Standard Values			25	50	200	3,000	100	20	NA	NA	NA
AQMP 01	1	15/04/2020	21.29	63.15	9.177	0.00	10.62	0.00	977	34.1	57.5
	2	16/04/2020	33.56	68.72	34.810	172.31	34.67	0.00	478	35.1	55.1
	3	17/04/2020	17.47	58.72	11.460	0.00	20.35	0.00	417	35.2	56.4
AQMP 02	1	18/04/2020	19.77	63.12	6.308	0.00	26.42	0.00	385	32.3	61.5
	2	19/04/2020	59.23	108.31	13.538	0.00	24.64	0.00	411	35.6	53.9

Locations	Day	Date, dd/mm/yyyy	$PM_{2.5}$, µg/m³	PM_{10}, µg/m³	NO_2, µg/m³	CO, µg/m³	O_3, µg/m³	SO_2, µg/m³	VOC, mg/m³	Temperature, °C	Relative Humidity, %
	3	20/04/2020	35.15	77.54	9.346	227.28	21.29	0.00	378	33.0	63.3
AQMP 03	1	21/04/2020	35.77	83.03	23.154	0.00	24.03	0.00	322	34.7	57.3
	2	22/04/2020	31.12	87.04	7.615	86.54	15.46	0.00	312	35.1	58.4
	3	23/04/2020	37.42	110.39	11.423	0.00	30.35	0.00	286	32.3	66.9
AQMP 04	1	24/04/2020	20.62	47.95	31.690	0.00	34.13	0.00	405	35.3	57.3
	2	25/04/2020	8.58	18.46	23.920	0.00	22.42	0.00	467	35.9	49.5
	3	28/04/2020	19.49	80.03	15.490	0.00	21.95	0.00	979	36.6	45.9
AQMP 05	1	29/04/2020	48.19	70.50	15.850	0.00	23.54	0.00	752	35.9	54.5
	2	30/04/2020	142.47	114.36	25.420	0.00	37.42	0.00	498	32.6	58.8
	3	01/05/2020	14.31	29.59	4.540	0.00	22.89	0.00	656	36.5	54.2

3.2.1 Particulate Matter

Particulate Matter is airborne particles that include dust, smoke, soot, dirt and liquid droplets and can either be emitted naturally (e.g. windblown dust of roads) or by human activity (e.g. stack emissions). PM is defined by size, with coarse particles being between 2.5-10 microns (µm), fine particles less than 2.5 µm, and ultrafine particles less than 0.1 µm. PM has adverse effects on humans, such as respiratory illnesses (asthma, bronchitis) or cardiovascular diseases and is also considered as being carcinogenic.

Except for location AQMP 04, the average PM concentrations for all other locations exceeded the WHO guideline values. The elevated particulate concentration in the study area is due to exhaust emissions (Fuel and oil combustion from automobiles), non-exhaust emissions (particles released into the air from brake wear, tyre wear, road surface wear and resuspension of road dust during on-road vehicle usage) and some fugitive emissions from other domestic and commercial activities such as biomass burning.

It must, however, be noted that monitoring was undertaken at the end of the dry season with sporadic rains, which would lead to lower ambient particulate as compared to the absolute dry season.

3.2.2 Sulphur Dioxide

Sulphur dioxide is a colourless gas and is characterised as having a sharp, irritant odour. It is a primary pollutant, which can react easily with other substances and form secondary pollutants such as sulphur trioxide and sulfuric acid, amongst others. SO_2 is formed by human activities through mainly industrial processes that contain sulphur, such as the combustion of coal, oil or gas. Sulphur dioxide is damaging to the human respiratory function when inhaled, causing coughing and shortness of breath. Either long term exposure or exposure to a large dose can result in chronic respiratory disease and the risk of acute respiratory illness. With respect to the impacts on vegetation, SO_2 can inhibit the photosynthetic properties of plants and in some cases, eliminate more sensitive species on the ecosystem level with continuous exposure.

The monitoring data indicated zero background SO_2 concentration across all the monitoring locations. This could be attributed to the absence of significant SO_2 sources within the monitoring locations. However, it must be noted that long-term atmospheric monitoring within the area could record SO_2 concentrations as was the case in the 2015 ESHIA study.

3.2.3 Nitrogen Dioxide

Nitrogen dioxide is a naturally forming gas, characterised as having an irritating odour. Small quantities can be produced by plants, soil and water, but anthropogenic activities, such as the combustion of fossil fuels and biomass, are the sources of most NO_2. Nitrogen dioxide is one of a group of gases called nitrogen oxides (NO_x). While all of these gases are harmful to human health and the environment, NO_2 is of greater concern. It primarily gets in the air from the burning of fuel in vehicles, power plants, and off-road equipment. Human respiratory tract irritation represents a direct effect of NO_2 exposures. Due to it being relatively insoluble (relative to SO_2), NO_2 can penetrate deep into the lungs, causing potential tissue damage. Effects of NO_2 exposure include alveolar tissue disruption and obstruction of the respiratory bronchioles. Long term effects of exposure include increased potential for lung infections.

The NO_2 concentrations recorded for all the locations are within the 24-hourly mean according to the WHO ambient air quality guideline of 200 µg/m^3. However, AQMP 01 and AQMP 02 positioned adjacent the busy Bai Bureh Road recorded roadside measurement which is not generally representative of ambient concentrations in the areas at proximity to the proposed project site.

3.2.4 Carbon Monoxide

Carbon monoxide is a colourless, odourless, highly toxic gas that deoxygenates human blood, causing oxygen deprivation. The most common source of carbon monoxide is motor vehicle emissions, where it results from the combustion of petrol in the presence of insufficient oxygen. It is also a result of hydrocarbon fuel-consuming industries and domestic fires.

Recorded data for CO in all monitoring points within the study area are lower than the WHO 24-hourly guideline value of 3000 µg/m^3. Locations AQMP 04 and 05 recorded zero CO background concentrations. This could be attributed to the absence of quantifiable CO emissions within the vicinities of the monitoring locations. Conversely, the CO concentrations recorded at the other locations could be attributed to exhaust emissions from frequent vehicular movement, emissions from generators and chimneys from nearby industrial activities.

3.2.5 Ozone

Ozone in the stratosphere absorbs most of the ultraviolet radiation from the Sun. Although ozone high up in the stratosphere provides a shield to protect life on Earth, direct contact with ozone is harmful to both plants and animals (including humans). Ground-level (or "bad") ozone is formed in the atmosphere by photochemical reactions in the presence of sunlight and precursor pollutants, such as NOx and VOCs[2]. Ozone is the major constituent of photochemical smog, which is a complex mixture and also containing oxidised organics. In the troposphere near the Earth's surface, the natural concentration of ozone is about 10 parts per billion. According to the US-EPA, exposure to ozone levels of greater than 70 parts per billion for 8 hours or longer is unhealthy. Such concentrations occur in or near cities during periods where the atmosphere is warm and stable. The harmful effects can include throat and lung irritation or aggravation of asthma or emphysema.

The monitoring results indicate that ozone concentration is relatively low compared to WHO guideline values. The concentration of natural tropospheric ozone is estimated at 10 ppb (about 21.1 µg/m^3)[3]. Therefore, it can be concluded that the recorded ozone levels are within the thresholds considered to be normal. Additionally, it is worthy to note that as a secondary pollutant, ozone's concentration in the troposphere is dependent on the interaction between NO_2 and VOCs and the relative abundance of sunlight.

3.2.6 Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are organic compounds that easily become vapours or gases. Along with carbon, they contain elements such as hydrogen, oxygen, fluorine, chlorine, bromine, Sulphur or nitrogen. Volatile organic compounds are released from burning fuel, such as gasoline, wood, coal, or natural gas. They are also emitted from diesel exhaust and released from solvents, paints, glues, etc. VOCs, when combined with nitrogen oxides, react to form ground-level ozone or photochemical smog.

VOCs concentration in all the monitoring sites ranges from 286 mg/m^3 to 979 mg/m^3. However, there is no known standard concentration value for the regulation of VOCs in the atmosphere. Potential sources of VOCs within the study area include vehicles (i.e. as evaporates and from exhaust emissions), manufacturing facilities, petroleum depots (i.e. storage tank farms), gas stations as well as from solvents, paints and glue within the surroundings.

3.3 Conclusion

The airshed refers to the local area around the power plant where ambient air quality is directly affected by emissions from the power plant. The size of the airshed depends on plant characteristics, such as stack height, topography and meteorological conditions. The monitoring results are all within the WHO guideline values except for particulates. This would indicate that there is a degraded airshed for PM_{10} and $PM_{2.5}$. The background measurements obtained in the vicinity of the site are likely to be elevated by traffic flows and emissions from nearby industries, petroleum depot, business units and residents.

[2] US EPA Ground-level Ozone Pollution (accessed via: https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics, 8 April 2020)

[3] Tropospheric Ozone (accessed via: https://www.ldeo.columbia.edu/~martins/eda/ozone_lec1.html, 27 May 2020)

4 ENVIRONMENTAL NOISE

According to the World Health Organisation (WHO), Noise is described as "unwanted sound". Noise can have an effect on the environment and the quality of life enjoyed by individuals and communities. The effects of noise can, therefore, be an important consideration in the environmental management of power generation plants, and particularly during the operational phases of such projects where the plants have to be consistently powered on for effective power generation.

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, including road traffic, industries, wind, humans and, animals. Noise is considered 'nuisance' when it is excessive, disruptive and/or displeasing. Nuisance noise and/or high noise levels can affect both physiological and psychological human health, with long-term excessive noise levels being damaging to human hearing.

The human ear has a wide sound-sensitivity range, and thus the decibel (dB) is a logarithmic unit, that allows this range to be compressed into a comprehensible range. The human ear is less sensitive to low-frequency sound than high-frequency sound. Sound level meters for such studies are designed with an in-built weighing, termed the "A-weighted" dB(A) - decibels audible - a scale that approximates the human loudness response. The LA_{eq}, (logarithmic A-weighted equivalent) the most commonly used indicator for noise, is the equivalent continuous A-weighted sound pressure level, over a specified time interval, e.g. 15-minutes, 1-hour, 24-hours, etc. Decibel noise levels cannot be added or averaged arithmetically since they are logarithmic parameters. For example, if one source is generating a noise level of 50 dB(A), and another similar source is placed beside it, the noise level will increase to 53 dB(A), not 100 dB(A). Ten similar sources placed side by side increase the sound level by 10 dB(A), and one hundred sources increase the sound level by 20 dB(A). However, empirically, the human ear perceives the magnitude increase of 10 dB(A) as a doubling in noise.

4.1 Methodology

Ambient environmental noise monitoring was undertaken at Seven (7) locations within and around (i.e. 500 m buffer) the project site (see Figure 4-1) in April and May 2020. The monitoring locations were selected based on existing noise sources and potential receptors. At each of the locations, a Casella CEL 633A - a Class 1 noise meter was set to log 5-minute averages of the following A-weighted broadband statistical noise descriptors for a monitoring duration of 1 hour per log:

- **LA_{eq} (Equivalent Continuous Sound Pressure Level)** – the Equivalent Continuous Sound Pressure Level is the constant noise level that would result in the same total sound energy being produced over a given period. LAeq is a fundamental measurement parameter designed to represent a varying sound source over a given time as a single number. This number is a measure of the energy contained within the sound at the point of the receiver. This is useful in terms of the potential for sound to damage or disturb and is extensively used in environmental noise standards as well as many other regulations and documents.

- **LA_{90} (Background Noise Level)** - The Background Noise Level is the level of noise exceeded by 90% of the time of measurement. It's measured to extensively rate traffic noise and background noise respectively.

- **LA_{10} (Commonly used to quantify road traffic noise)** - This is the level of noise exceeded during 10% of the time of measurement. It's measured to extensively rate traffic noise and background noise respectively.

- **LAF_{max} (Maximum noise levels, fast time response)** - This shows the highest sound pressure level within the measurement period. It's measured to ascertain the maximum sound level attained during any given measurement.

- **LAF_{min} (Minimum noise levels, fast time response)** - This shows the lowest sound pressure level within the measurement period. It's measured to ascertain the minimum sound level attained during any given measurement.

It must be noted, however, that the assessment was done during the Novel Coronavirus Disease (COVID-19) pandemic with restrictive measures in place, including a nationwide curfew between 21:00-06:00 GMT, which prevented night-time monitoring. Therefore, the acoustic environment of the selected monitoring locations has been described for day-time noise over two days and compared with the WBG EHS guideline values for the day-time noise level in industrial and residential areas.

The coordinates of the all noise sampling locations were determined using GPS and site characteristics of the geo-referenced stations documented (Table 4-1). Photographic reference for each measurement location was also recorded (see Figure 4-6 - Figure 4-12). All measurement locations were subjected to site access and security constraints. In addition, the conditions captured during monitoring at certain locations/days may reflect potential reductions in ambient noise levels as a result of reduced working activities and travel within the local area under Covid-19 conditions. Because business has slowed down, curfews have been imposed, and activity is generally scarcer in the community than pre-COVID-19, noise conditions may presently be lower than under “business as usual” conditions.

As was recommended in the 2015 ESHIA Report, further measurements have been undertaken within 500 m of the project, where noise impacts are anticipated based upon preliminary modelling results, to get a better understanding of the existing background levels at receptor locations.

Table 4-1: Noise Monitoring Locations within and around the Project Area

ID	Name	Latitude	Longitude	Approx. Distance from Project Site (m)
NMP 01	Project Site	8.475598	-13.191870	0
NMP 02	Project Site	8.475754	-13.190315	0
NMP 03	Project Site	8.476494	-13.190938	0
NMP 04	Magram Water Bottling Company Compound	8.476960	-13.191005	40
NMP 05	Government Independent Memorial Secondary School	8.477320	-13.188037	278
NMP 06	Shell Lane	8.472696	-13.190654	295
NMP 07	Bai Bureh Road	8.470800	-13.190910	466

The Environmental Protection Agency Act (2008) currently has no specific provisions for protection against noise and does not set standards or guidance of specific relevance to the Project. In the absence of specific national or local guidance concerning noise issues, INTEGEMS has referred to guidance published by WBG/IFC. The IFC has published Environmental Health and Safety (EHS) Guidelines (April 2007) which are technical reference documents with general and industry-specific examples of international good practice. Reference to these guidelines forms part of the IFC’s environmental and social review procedure and is compulsory for IFC clients.

The IFC 2012 Performance Standards, in conjunction with the WB/IFC EHS Guideline, advises that pollution, in general, be prevented by control at source. Whilst it is acknowledged that the Project is not an IFC project, the EHS Guidelines provide a useful resource in line to achieve IFC compliance. The Guidelines detail the performance levels and environmental management measures considered achievable using Best Available Technology Not Entailing Excessive Cost (BATNEC). The IFC PS specifies that noise abatement measures meet one of the following two conditions:

- Noise levels from the Project at the most sensitive point of reception should not exceed the limits specified in Table 4-2. This condition utilises the acceptable level criterion, which allows the use of a nominal table value, rather than the actual pre-development ambient level, as the baseline reference. Post-development noise is usually measured at noise receptors located outside the project boundary and compared with the applicable baseline level derived from the table.

- Noise levels from the Project at the most sensitive point of reception should not cause background levels to increase by more than 3 dB(A). This condition employs the noise emergence criterion, using as baseline the actual ambient level determined by measurement at receptor locations, i.e. both pre- and post-development levels are determined by measurement.

Table 4-2: WBG / IFC EHS Guideline - Noise Level Guidelines

Receptor		Noise Level - One Hour LA_{eq}, dB(A)	
		Daytime (07:00– 22:00)	Nigh-time (22:00-07:00)
(a)	Residential; institutional; educational	55	45
(b)	Industrial; commercial	70	70

4.2 Results and Analysis

The project site is located at Kissy Dockyard which is predominantly an industrial zone interspersed by small businesses and residential houses, with sources of major industrial-scale emissions that can cause a significant increase in noise levels. The project site is approximately 100 m north of Bai Bureh Road the major highway linking the provinces to Freetown and serving as a major source of noise from vehicular movement and roadside commercial activities around the Shell axis. Noise levels within the study buffer (i.e. 500 m buffer of the project site) are mainly characterised by continuous sound from vehicular movement, generators and power plants at business premises and industrial workshops/factories, intermittent noise from musical systems, impulsive noise from unidentified sources and low frequency sounds from human and animal communications.

A summary of noise data recorded at the monitoring locations is presented in Table 4-3 and Table 4-4 and graphically displayed in Figure 4-2, while detailed 1-hourly log data are presented in Appendix C. Analysis of the data captured is presented for each monitoring location in Sections 4.2.1 to 4.2.7 below. It is worthy to note that, all measured noise levels are sound pressure levels measured on the A scale. Therefore, except if explicitly stated, noise values presented in dB in this report are the same as dB(A).

Table 4-3: Average Noise Results for each location

Location ID	Location Description	LAeq, dB(A)
NMP 01	Project Site – Southern Boundary	59.8
NMP 02	Project Site – Eastern Boundary	48.2
NMP 03	Project Site - Northern Boundary	49.5
NMP 04	Magram Water Bottling Company	64.4
NMP 05	Government Independent Memorial Secondary School (GIMSS)	63.1
NMP 06	Shell Lane – Off Parsonage Street	69.0
NMP 07	Bai Bureh Road/ Africanus Road	75.1

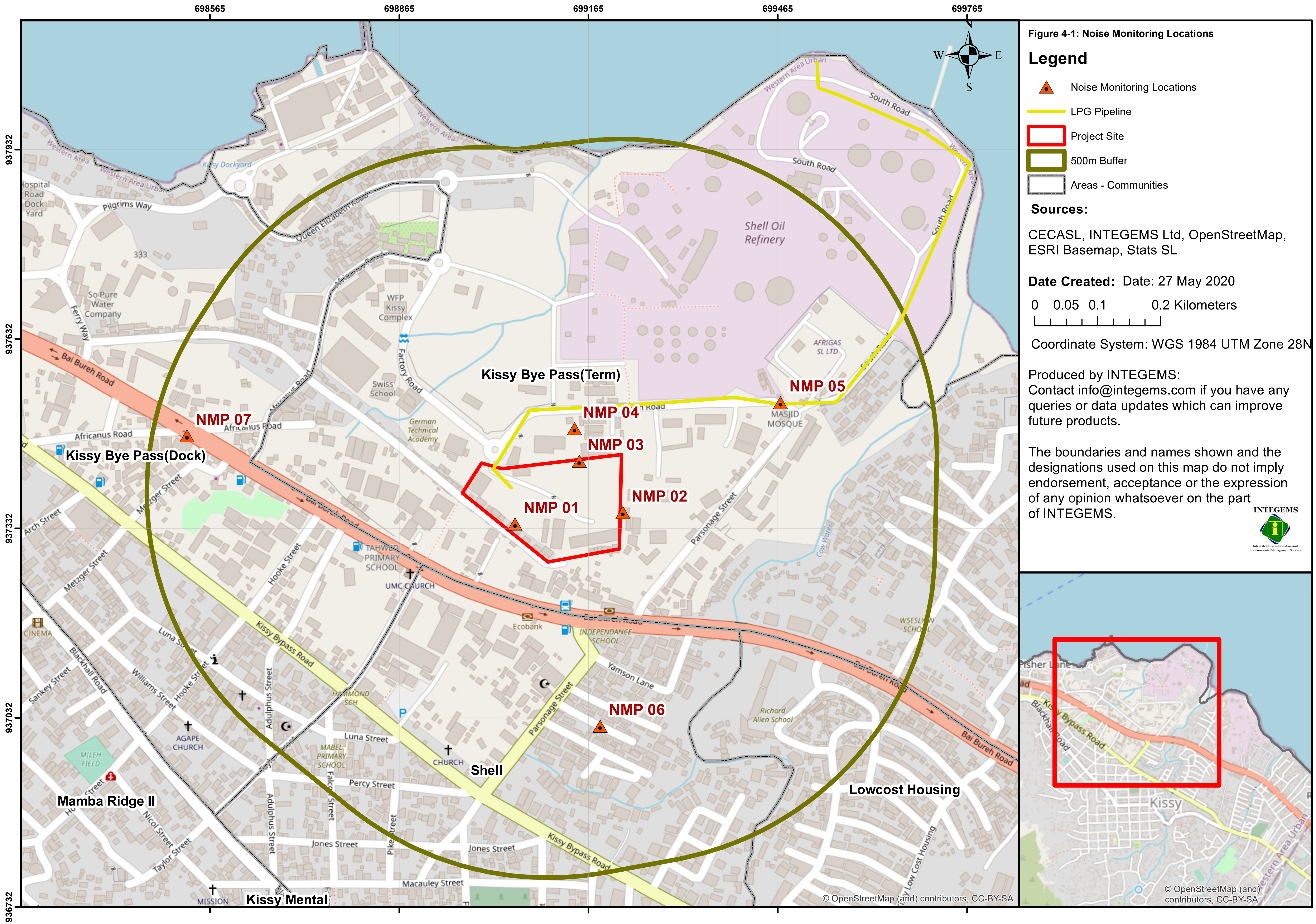


Figure 4-1: Noise Monitoring Locations
Legend
Noise Monitoring Locations
LPG Pipeline
Project Site
500m Buffer
Areas - Communities
Sources:
CECASL, INTEGEMS Ltd, OpenStreetMap, ESRI Basemap, Stats SL
Date Created: Date: 27 May 2020
0 0.05 0.1 0.2 Kilometers
Coordinate System: WGS 1984 UTM Zone 28N
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Shell Oil Refinery
Shell
Lowcost Housing
Mamba Ridge II
Kissy Mental
Bai Bureh Road
Kissy Bypass Road
Africanus Road
Parsonage Street
South Road
Factory Road
Yamson Lane
Luna Street
Percy Street
Jones Street
Macauley Street
MASJID MOSQUE
AFRIGAS SL LTD
German Technical Academy
WFP Kissy Complex
Swiss School
TAHWID PRIMARY SCHOOL
UMC CHURCH
INDEPENDANCE SCHOOL
Ecobank
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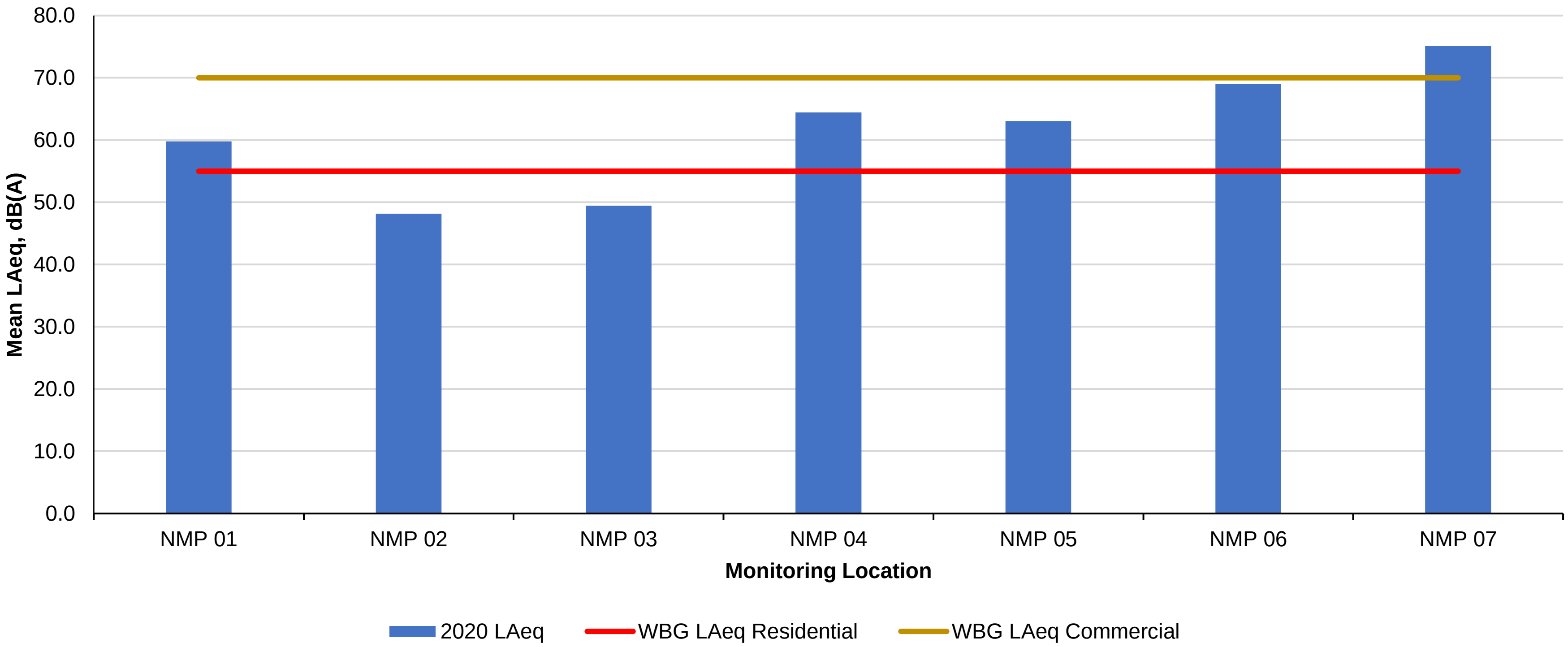
Table 4-4: Mean Daily Continuous Sound Pressure Level

Location ID	Location Name	Day	Date	Total Monitoring Duration, hrs	Average LAeq dB(A)
NMP 01	Project Site – Southern Boundary	Day 1	15 April 2020	7	62.9
		Day 2	18 April 2020	9	52.7
NMP 02	Project Site – Eastern Boundary	Day 1	16 April 2020	8	49.0
		Day 2	19 April 2020	8	47.2
NMP 03	Project Site - Northern Boundary	Day 1	17 April 2020	8	50.6
		Day 2	24 April 2020	8	47.9
NMP 04	Magram Water Bottling Company	Day 1	22 April 2020	7	51.2
		Day 2	23 April 2020	5	68.1
NMP 05	Government Independent Memorial Secondary School (GIMSS)	Day 1	20 April 2020	7	63.5
		Day 2	21 April 2020	8	62.6
NMP 06	Shell Lane – Off Parsonage Street	Day 1	25 April 2020	8	68.6
		Day 2	28 April 2020	7	68.9
NMP 07	Bai Bureh Road/ Africanus	Day 1	30 April 2020	8	75.2
		Day 2	01 May 2020	7	74.9

Figure 4-2: Mean Daily LAeq Recorded in April/May 2020



4.2.1 Location NMP 01 - Project Site (Southern Boundary)

This monitoring point is located within the project site along its southwestern boundary, which it shares with informal settlements. The point is about 100 m north of Bai Bureh Road. The major noise sources from this point are vehicular movement from Bai Bureh Road, power generators/plants from nearby industrial activities; commercial areas along Bai Bureh Road and from nearby residents.

From the data collected, NMP 01 recorded an average continuous sound pressure level (LAeq) of 62.9 dB(A) on the first day of monitoring. A significant decline was noted on the second day of monitoring with an LAeq of 52.7 dB(A). However, the second day of monitoring was undertaken on a weekend (Saturday) with less commercial and/or industrial activities as well as less road traffic. Nonetheless, these values are within WBG EHS guideline levels for day-time noise in industrial areas.

It must be noted that the highest LAeq value of 71 dB(A) was recorded between 16:55-17:55 GMT. This value is marginally above the WBG guideline noise level limit for an industrial/commercial area. Such noise levels could be of health concerns to the residents around this community as it exceeds the WBG/IFC EHS guideline of 55 dB(A) for day-time noise limit for residential areas on the first day of monitoring.

4.2.2 Location NMP 02- Project Site (Eastern Boundary)

Monitoring Location NMP 02 is situated within the project site, along its eastern boundary. The location is about 165 m north of Bai Bureh Road and 125 m southeast of lower Parsonage Street. The Major noise sources from this point include road traffic noise, noise from garage east of the project site, noise from commercial areas along Bai Bureh Road and Personage Street. The data collected shows an LAeq of 49 dB(A) on the first day and 47.2 dB(A) on the second day. Like NMP 01, the second day's monitoring for NMP 02 was undertaken on a weekend (Sunday) with less activities from all the major noise sources.

These LAeq values for both days of monitoring are below the WBG EHS guideline values for noise pollution in both commercial/industrial and residential/institutional. Therefore, it must be noted that the acoustic environment of the areas within the immediate vicinity of NMP 02 is very quiet with any increases in noise levels easily noticeable.

4.2.3 Location NMP 03- Project Site (Northern Boundary)

This location is also situated within the project site along its northern boundary, which is shared with Magram and Bollore Logistics. Monitoring Location NMP 03 is located about 75 m south of South Road. The major noise sources around the vicinity of this location include noise from Bollore Logistics' power generator other activities, traffic noise from South Road and noise from birds that nest on shrubs within the project site.

The recorded LAeq for this location was 50.6 dB(A) and 47.9 dB(A) on the first and second days, respectively. These values were much lower than the guideline level prescribed by WBG/IFC for both residential and commercial/industrial areas.

4.2.4 Location NMP 04 - Magram Water Bottling Company

Noise Monitoring Location 04 is situated in the Magram Water Bottling Company's Compound about 40 m north of the project site and 10 m west of Bollore Logistics Compound. The major noise sources from this location are the Magram generator and staff daily activities, sound of birds from trees around the monitoring point, and vehicular movement along South Road, which is about 36 m north of the location.

An average continuous sound pressure level of 51.2 dB(A) and 68.1 dB(A) on the first and second days, respectively at this monitoring location. The most significant contribution to the acoustic environment around NMP 04 is the Magram Generator/Plant, which was situated about 10 m from the point. On the first day of monitoring, it was observed that the Magram Generator/plant was intermittently turned on from 12:30-12:33 and 12:42-12:49. This contributed to that period (i.e. 12:30-13:30) recording the highest LAeq value of 56.2 dB(A) for that day. On the second day of monitoring, noise sources remained the same as the previous day. However, the contribution of the Magram generator to the acoustic environment was much more pronounced it was on for most of the monitoring period (10:10-13:33 and 15:26-16:34). However, the recorded LAeq values were lower than the WBG/IFC EHS guideline noise level for industrial/commercial settings.

4.2.5 Location NMP 05- Government Independent Memorial Secondary School

This monitoring location was situated at the Government Independent Memorial Secondary School, which is a critical receptor of day-time noise. The school is located at a distance of about 250 m east of the Project Site. The major noise sources for this location include traffic noise mainly from the movement of fuel bowsers and from the cranking of engines of bowsers parked along the Personage Street for repairs, noise from street hawkers and noise from singing birds on nearby trees. There was no school activity during the time of monitoring.

The average LAeq recorded at this monitoring location was 63.5 dB(A) and 62.6 dB(A) on days one and two, respectively. With similar weather conditions and consistent noise sources, the data shows an almost equal LAeq for the monitoring location across the two days of monitoring. The recorded LAeq values were found as prescribed by the WBG standard guideline value for residential/commercial areas.

4.2.6 Location NMP 06 - Shell Lane

This monitoring location could be described as a residential area with houses linearly placed along the Shell Lane, the monitoring location was situated at about 100 m away from Personage Street and is approximately 280 south of the project site. The major noise sources for this location are noise from domestic sources from residents (including community quarrels, low-frequency noise from daily communications, music from residents), noise from street hawkers (some use microphones) along the Shell Lane, road traffic noise from Personage Street and Shell Lane, noise commercial activities along Parsonage Street.

The data shows LAeq of 68.6 dB(A) and 69.4 dB(A) days one and two respectively. The Data shows an almost consistent LAeq for the monitoring location. However, these values were higher than the EHS guideline noise levels prescribed by WBG/IFC for residential areas but lower than the values set for industrial or commercial settings.

4.2.7 Location NMP 07 – Fisher Lane/Bai Bureh Road

This monitoring location was on Fisher Lane, along Bai Bureh Road. It could be described as a mixed commercial-residential area with residents along the fisher lane and on the adjacent side of Bai Bureh Road. Location NMP 01 is situated about 450 m west of the project site. The major noise sources within this monitoring point are the traffic noise from the Bai Bureh Road, noise from commercial activities, and noise from other small and medium scale industries around the area.

The average LAeq for this location were 75.2 dB(A) and 74.9 dB (A) for days one and two respectively. These values are above the recommended EHS guideline values for a day-time noise in both residential and commercial/industrial areas prescribed by the WBG/IFC.

4.3 Comparison with the 2015 Ambient Noise Levels

To establish the existing ambient noise environment, noise monitoring was conducted by INTEGEMS during February 2015 at the locations outlined in Table 4-5. The locations were selected with due consideration of risks around Ebola and were collected for a limited duration. While these locations were considered representative of conditions adjacent to the development site, they may not be representative of all the receptor locations in the project area.

As was the case for the April/May 2020 during COVID-19 outbreak, the conditions captured during monitoring at certain locations/days in 2015 may reflect potential reductions in ambient noise levels as a result of reduced working activities and travel within the local area under Ebola conditions. Therefore, a brief comparison of the result is presented here for measurement locations NMP 01 to NMP 04. A summary of noise data recorded at the four locations at which measurements were undertaken in 2015 is presented in Table 4-6 and graphically displayed in Figure 4-3.

Table 4-5: Noise Monitoring Locations in 2015

Measurement Location	Location Description
Point 1/ NMP 01	CRCC Compound
Point 2/ NMP 02	SLRA/MSU Compound
Point 3/ NMP 03	SLRA/MSU Compound
Point 4/ NMP 04	Magram Water Bottling Company Compound

Table 4-6: Day-time Ambient Noise Recorded in February 2015 and in April/May 2020

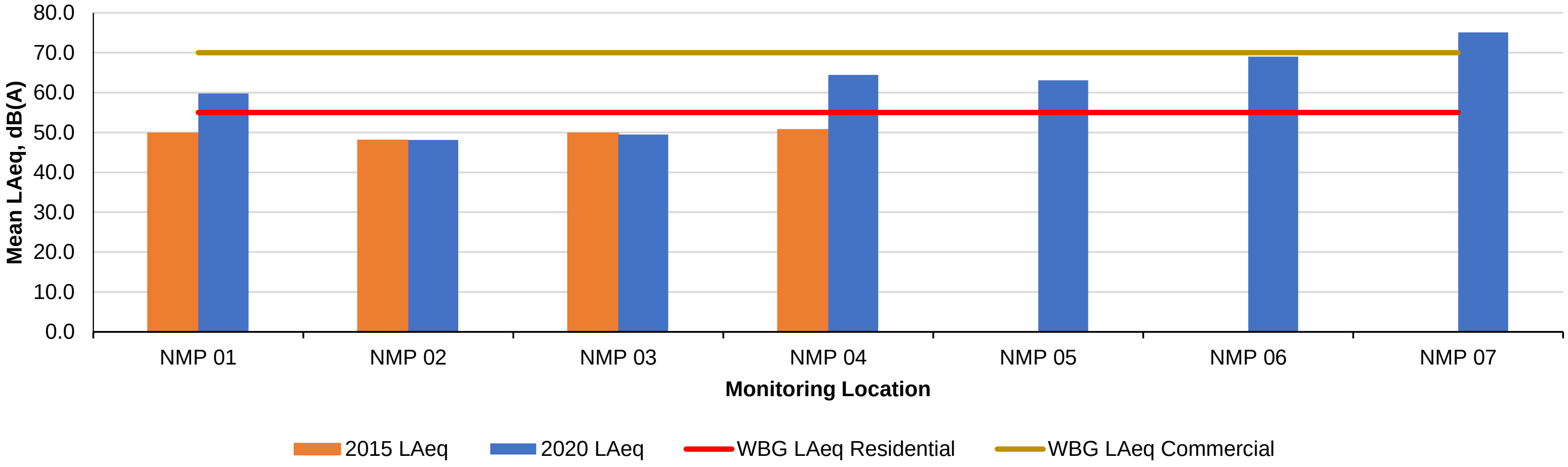
Location ID	Location Description	LAeq, dB(A)		WBG EHS Limit LAeq, dB(A)	
		2020	2015	Residential	Industrial
Point 1/ NMP 01	Project Site – Southern Boundary	59.8	49.8	55.0	70.0
Point 2/ NMP 02	Project Site – Eastern Boundary	48.2	48.0	55.0	70.0
Point 3/ NMP 03	Project Site - Northern Boundary	49.5	49.8	55.0	70.0
Point 4/ NMP 04	Magram Compound	64.4	50.6	55.0	70.0
NMP 05	GIMSS Compound	63.1	-	55.0	70.0
NMP 06	Shell Lane – Off Parsonage Street	69.0	-	55.0	70.0
NMP 07	Bai Bureh Road/ Africanus Road	75.1	-	55.0	70.0

Table 4-7: Average Night-time Noise Results for each Location

Location	2015 $LA_{eq,1h}$,dB(A)
Point 1/ NMP 01	48.6
Point 2/ NMP 02	43.8
Point 3/ NMP 03	45.3
Point 4/ NMP 04	38.9

The average noise levels measured in 2015 were below the WBG EHS Guideline limit during daytime for both industrial and residential settings. The average measured night-time noise levels around the site were well below the WBG EHS Guideline noise level for industrial areas (70 dB) but marginally exceeded the IFC night-time guideline level (45 dB) for residential areas at points 1 and 3. Comparable daytime noise levels were recorded at points 2 and 3 in April /May 2020, while the mean LAeq recorded at points 1 and 4 were significantly higher in 2020 than in 2015 (see Table 4-6). The deviations in the data from points 1 and 4 could be attributed to noise from an industrial power generator from a nearby metal works centre, which was in operation throughout the day 1 of monitoring at point 1 and from Magram's generator, which was in operation for a significant part of the day 2 of monitoring at point 4 (see Table 4-4).

Figure 4-3: Mean LAeq Recorded in February 2015 and in April/May 2020



These noise sources were not as apparent during the 2015 baseline survey as compared to the 2020 period. Therefore, it could be concluded that in the absence of the aforementioned sources, the levels recorded at points 1 and 4 could not have deviated by more than 3 dB as is seen from the data recorded on the day 2 of monitoring at point 1 (52.7 dB) and the day 1 of monitoring at point 4 (51.2 dB) in 2020.

Therefore, in the absence of night-time data due to the COVID-19 response curfews in the April/May 2020 monitoring period and with the level of similarities seen between the 2015 and 2020 day-time noise data, it is prudent to conservatively extrapolate that the night-time noise levels recorded at points 1 to 4 in February 2015 are representative of the current acoustic environment within these measurement areas. To account for the significant deviations, a penalty of 3 dB(A) has been added to the values recorded at point 1 and 4 (see Table 4-8).

However, the same cannot be inferred for NMP 05 – NMP 07 as measurements were not taken at these points in 2015. Additionally, from a qualitative point of view, the acoustic environment at these points are significantly different from that which was observed at points 1 to 4.

Thus, from the extrapolated data, the night-time noise levels ascribed to NMP 01 – NMP 04 are all below the WBG limit for industrial/commercial settings, while only levels at NMP 02 and NMP 04 were found to be lower than night-time guideline noise limits for residential/institutional settings.

Table 4-8: Average Night-time Noise Results for each Location

Location	2015 $LA_{eq,1h}$, dB(A)	Penalty, dB(A)	2020 with Penalty $LA_{eq,1h}$, dB(A)
Point 1/ NMP 01	48.6	+3	51.6
Point 2/ NMP 02	43.8	+0	43.8
Point 3/ NMP 03	45.3	+0	45.3
Point 4/ NMP 04	38.9	+3	41.9

4.4 Conclusion

The area surrounding and including the project boundary is zoned by Freetown City Council as commercial/industrial land use, according to the Director of Country Planning. It can be seen from the recorded noise monitoring results that the average measured night-time noise levels around the site are well below the WBG EHS Guideline noise level for industrial areas of 70 dB(A).

However, many of the buildings surrounding the project currently have residential, institutional or educational usage. According to the WBG EHS Guidelines, it is desirable that noise levels at these locations not exceed the lower values of 45 dB(A) during night-time and 55 dB(A) during the daytime, or result in a maximum increase in 'background' levels of 3 dB(A).

Additionally, given that night-time noise levels were derived from extrapolation of the 2015 noise data, it is recommended that night-time noise measurements are undertaken at a conducive time post-COVID-19 to describe the true acoustic environment of the project site and the area within a 500 m buffer around.

APPENDICES

Appendix A: Photographs of Air Quality and Noise Monitoring Locations

Figure 4-4: Air Quality Monitoring within and around the Project Area (1/2)

AQMP 01: Shell Police Station

AQMP 01: Shell Police Station

AQMP 02: SALHOC Gate

AQMP 02: SALHOC Gate

AQMP 03: SWISS Compound

ANMP 03: SWISS Compound

AQMP 04: Masjid IHASAN

AQMP 04: Masjid IHASAN

Figure 4-5: Air Quality Monitoring within and around the Project Area (2/2)

AQMP 05: FINIC Fence

AQMP 05: FINIC Fence

Figure 4-6: Ambient Noise Monitoring at NMP 01

Figure 4-7: Ambient Noise Monitoring at NMP 02

Figure 4-8: Ambient Noise Monitoring at NMP 03

Figure 4-9: Ambient Noise Monitoring at NMP 04

Figure 4-10: Ambient Noise Monitoring at NMP 05

Figure 4-11: Ambient Noise Monitoring at NMP 06

Figure 4-12: Ambient Noise Monitoring at NMP 07

Appendix B: Ambient Air Quality Monitoring Logs

Table 4-9: Air Quality Monitoring Logs for Shell Police Station (AQMP 01)

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
$PM_{2.5}$, µg/m^3								
Day 1	1	15/04/2020	10:50:00	11:45:00	00:55:00	12	18	27
	2	15/04/2020	15:10:00	16:05:00	00:55:00	18	25	60
Day 2	1	16/04/2020	12:41:00	13:46:00	01:05:00	15	25	49
	2	16/04/2020	17:02:00	18:02:00	01:00:00	30	42	61
Day 3	1	17/04/2020	10:10:00	10:55:00	00:45:00	11	17	32
	2	17/04/2020	13:28:00	14:28:00	01:00:00	10	18	31
PM_{10}, µg/m^3								
Day 1	1	15/04/2020	10:50:00	11:45:00	00:55:00	26	57	100
	2	15/04/2020	15:10:00	16:05:00	00:55:00	58	70	96
Day 2	1	16/04/2020	12:41:00	13:46:00	01:05:00	39	60	91
	2	16/04/2020	17:02:00	18:02:00	01:00:00	50	77	110
Day 3	1	17/04/2020	10:10:00	10:55:00	00:45:00	39	61	106
	2	17/04/2020	13:28:00	14:28:00	01:00:00	34	57	106
CO, µg/m^3								
Day 1	1	15/04/2020	11:56:00	12:51:00	00:55:00	0	0	0
	2	15/04/2020	16:16:00	17:11:00	00:55:00	0	0	0
Day 2	1	16/04/2020	10:23:00	11:23:00	01:00:00	0	345	2410
	2	16/04/2020	14:01:00	15:01:00	01:00:00	0	0	0
Day 3	1	17/04/2020	11:10:00	12:10:00	01:00:00	0	0	0
	2	17/04/2020	15:35:00	16:35:00	01:00:00	0	0	0
O_3, µg/m_3								
Day 1	1	15/04/2020	09:42:00	10:42:00	01:00:00	0	4	16
	2	15/04/2020	13:02:00	14:02:00	01:00:00	1	8	17
	3	15/04/2020	17:21:00	18:21:00	01:00:00	6	19	39
Day 2	1	16/04/2020	11:33:00	12:28:00	00:55:00	25	32	47
	2	16/04/2020	15:53:00	16:53:00	01:00:00	21	37	80
Day 3	1	17/04/2020	12:19:00	13:19:00	01:00:00	2	12	26
	2	17/04/2020	16:45:00	17:45:00	01:00:00	17	29	52
SO_2, µg/m^3								
Day 1	1	15/04/2020	11:56:00	12:51:00	00:55:00	0	0	0
	2	15/04/2020	16:15:00	17:10:00	00:55:00	0	0	0
Day 2	1	16/04/2020	10:24:00	11:24:00	01:00:00	0	0	0

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	2	16/04/2020	13:59:00	14:59:00	01:00:00	0	0	0
Day 3	1	17/04/2020	12:21:00	13:21:00	01:00:00	0	0	0
	2	17/04/2020	15:34:00	16:34:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	15/04/2020	09:42:00	10:37:00	00:55:00	0	6	32
	2	15/04/2020	13:02:00	14:02:00	01:00:00	0	4	21
	3	15/04/2020	17:21:00	18:21:00	01:00:00	0	18	91
Day 2	1	16/04/2020	11:34:00	12:34:00	01:00:00	0	30	86
	2	16/04/2020	15:53:00	16:53:00	01:00:00	0	40	111
Day 3	1	17/04/2020	11:10:00	12:10:00	01:00:00	0	0	1
	2	17/04/2020	16:45:00	17:45:00	01:00:00	3	23	59
VOCs, mg/m^3								
Day 1	1	15/04/2020	10:50:00	11:45:00	00:55:00	781	1314	2571
	2	15/04/2020	15:10:00	16:05:00	00:55:00	484	641	906
Day 2	1	16/04/2020	12:49:00	13:49:00	01:00:00	428	567	893
	2	16/04/2020	17:05:00	18:05:00	01:00:00	306	390	542
Day 3	1	17/04/2020	10:10:00	11:00:00	00:50:00	364	448	596
	2	17/04/2020	13:31:00	14:26:00	00:55:00	311	386	521
Temperature, C								
Day 1	1	15/04/2020	09:42:00	10:37:00	00:55:00	32.8	33.8	35.0
	2	15/04/2020	10:50:00	11:45:00	00:55:00	33.2	33.7	35.2
	3	15/04/2020	11:56:00	12:51:00	00:55:00	33.5	34.4	35.5
	4	15/04/2020	13:02:00	14:02:00	01:00:00	33.1	34.5	35.8
	5	15/04/2020	15:10:00	16:05:00	00:55:00	34.9	35.4	36.0
	6	15/04/2020	16:15:00	17:10:00	00:55:00	32.9	34.2	36.5
	7	15/04/2020	17:21:00	18:21:00	01:00:00	32.1	32.7	33.6
Day 2	1	16/04/2020	10:24:00	11:24:00	01:00:00	29.5	30.8	32.8
	2	16/04/2020	11:34:00	12:34:00	01:00:00	34.1	35.4	36.8
	3	16/04/2020	12:49:00	13:49:00	01:00:00	35.8	37.6	41.4
	4	16/04/2020	13:59:00	14:59:00	01:00:00	34.5	36.7	40.2
	5	16/04/2020	15:53:00	16:53:00	01:00:00	34.4	35.5	36.5
	6	16/04/2020	17:05:00	18:05:00	01:00:00	34.3	34.6	35.2
Day 3	1	17/04/2020	10:10:00	11:00:00	00:50:00	33.9	34.7	36.1
	2	17/04/2020	11:10:00	12:10:00	01:00:00	33.3	34.6	35.5
	3	17/04/2020	12:21:00	13:21:00	01:00:00	33.3	34.5	35.7
	4	17/04/2020	13:31:00	14:26:00	00:55:00	34.1	35.5	37.1

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	5	17/04/2020	16:45:00	17:45:00	01:00:00	35.1	36.6	38.4
Relative Humidity, %								
Day 1	1	15/04/2020	09:42:00	10:37:00	00:55:00	58.2	60.2	63.3
	2	15/04/2020	10:50:00	11:45:00	00:55:00	55.4	60.2	62.3
	3	15/04/2020	11:56:00	12:51:00	00:55:00	55.9	58.8	60.4
	4	15/04/2020	13:02:00	14:02:00	01:00:00	54.1	56.6	60.1
	5	15/04/2020	15:10:00	16:05:00	00:55:00	53.6	55.5	57.2
	6	15/04/2020	16:15:00	17:10:00	00:55:00	50.7	54.4	55.9
	7	15/04/2020	17:21:00	18:21:00	01:00:00	53.1	56.9	60.0
Day 2	1	16/04/2020	10:24:00	11:24:00	01:00:00	60.6	65.7	69.1
	2	16/04/2020	11:34:00	12:34:00	01:00:00	49.3	53.5	57.4
	3	16/04/2020	12:49:00	13:49:00	01:00:00	41.7	47.7	51.5
	4	16/04/2020	13:59:00	14:59:00	01:00:00	44.0	52.2	59.0
	5	16/04/2020	15:53:00	16:53:00	01:00:00	52.0	54.8	57.7
	6	16/04/2020	17:05:00	18:05:00	01:00:00	55.6	56.7	58.0
Day 3	1	17/04/2020	10:10:00	11:00:00	00:50:00	58.7	61.3	63.6
	2	17/04/2020	11:10:00	12:10:00	01:00:00	58.7	61.8	64.7
	3	17/04/2020	12:21:00	13:21:00	01:00:00	59.5	61.6	64.4
	4	17/04/2020	13:31:00	14:26:00	00:55:00	48.7	56.1	63.3
	5	17/04/2020	16:45:00	17:45:00	01:00:00	36.7	41.2	45.8

Table 4-10: Air Quality Monitoring Logs for SALHOC Gate (AQMP 02)

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
$PM_{2.5}$, µg/m^3								
Day 1	1	18/04/2020	10:22:00	11:22:00	01:00:00	8	13	22
	2	18/04/2020	16:59:00	17:59:00	01:00:00	19	26	38
Day 2	1	19/04/2020	12:39:00	13:39:00	01:00:00	18	79	471
	2	19/04/2020	16:58:00	17:58:00	01:00:00	31	39	57
Day 3	1	20/04/2020	10:51:00	11:51:00	01:00:00	19	39	216
	2	20/04/2020	15:05:00	16:05:00	01:00:00	20	32	51
PM_{10}, µg/m^3								
Day 1	1	18/04/2020	10:22:00	11:22:00	01:00:00	28	52	138
	2	18/04/2020	16:59:00	17:59:00	01:00:00	57	74	92
Day 2	1	19/04/2020	12:39:00	13:39:00	01:00:00	54	124	425

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	2	19/04/2020	16:58:00	17:58:00	01:00:00	72	93	129
Day 3	1	20/04/2020	10:51:00	11:51:00	01:00:00	46	73	258
	2	20/04/2020	15:05:00	16:05:00	01:00:00	61	82	120
CO, µg/m^3								
Day 1	1	18/04/2020	12:46:00	13:46:00	01:00:00	0	0	0
Day 2	1	19/04/2020	10:19:00	11:19:00	01:00:00	0	0	0
	2	19/04/2020	13:49:00	14:49:00	01:00:00	0	0	0
Day 3	1	20/04/2020	09:37:00	10:42:00	01:05:00	0	111	640
	2	20/04/2020	13:11:00	14:11:00	01:00:00	0	344	4470
O_3, µg/m^3								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	16	26	33
	2	18/04/2020	15:50:00	16:50:00	01:00:00	17	27	39
Day 2	1	19/04/2020	11:28:00	12:28:00	01:00:00	7	24	35
	2	19/04/2020	15:44:00	16:49:00	01:05:00	3	26	38
Day 3	1	20/04/2020	12:01:00	13:01:00	01:00:00	8	14	21
	2	20/04/2020	16:15:00	16:35:00	00:20:00	24	28	36
SO_2, µg/m^3								
Day 1	1	18/04/2020	13:55:00	14:55:00	01:00:00	0	0	0
Day 2	1	19/04/2020	09:10:00	10:10:00	01:00:00	0	0	0
	2	19/04/2020	13:49:00	14:49:00	01:00:00	0	0	0
Day 3	1	20/04/2020	09:37:00	10:37:00	01:00:00	0	0	0
	2	20/04/2020	13:11:00	14:11:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	0	6	34
Day 2	1	19/04/2020	12:39:00	13:39:00	01:00:00	0	5	29
	2	19/04/2020	16:58:00	17:58:00	01:00:00	0	22	44
Day 3	1	20/04/2020	10:51:00	11:51:00	01:00:00	0	4	29
	2	20/04/2020	15:05:00	16:05:00	01:00:00	0	15	56
VOCs, mg/m^3								
Day 1	1	18/04/2020	11:32:00	12:37:00	01:05:00	274	385	640
Day 2	1	19/04/2020	11:28:00	12:28:00	01:00:00	352	478	670
	2	19/04/2020	15:44:00	16:49:00	01:05:00	264	345	508
Day 3	1	20/04/2020	12:01:00	13:01:00	01:00:00	306	425	681
	2	20/04/2020	16:15:00	16:35:00	00:20:00	279	331	396
Temperature, C								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	31.1	31.9	33.2
	2	18/04/2020	11:32:00	12:37:00	01:05:00	31.6	32.7	33.6

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	3	18/04/2020	12:46:00	13:46:00	01:00:00	31.7	32.3	33.0
	4	18/04/2020	13:55:00	14:55:00	01:00:00	31.7	32.5	33.2
Day 2	1	19/04/2020	09:10:00	10:10:00	01:00:00	31.1	31.9	32.7
	2	19/04/2020	10:19:00	11:19:00	01:00:00	32.8	33.7	34.7
	3	19/04/2020	11:28:00	12:28:00	01:00:00	33.9	35.1	36.7
	4	19/04/2020	12:39:00	13:39:00	01:00:00	35.2	36.0	37.6
	5	19/04/2020	13:49:00	14:49:00	01:00:00	36.1	37.9	39.1
	6	19/04/2020	15:44:00	16:49:00	01:05:00	36.1	38.1	39.2
	7	19/04/2020	16:58:00	17:58:00	01:00:00	35.3	36.9	38.2
Day 3	1	20/04/2020	09:37:00	10:37:00	01:00:00	29.8	30.7	32.4
	2	20/04/2020	10:51:00	11:51:00	01:00:00	32.3	33.6	35.2
	3	20/04/2020	12:01:00	13:01:00	01:00:00	33.3	33.8	35.2
	4	20/04/2020	13:11:00	14:11:00	01:00:00	33.4	34.4	35.6
	5	20/04/2020	15:05:00	16:05:00	01:00:00	31.7	33.8	35.4
	6	20/04/2020	16:15:00	16:35:00	00:20:00	30.9	31.4	32.0
Relative Humidity, %								
Day 1	1	18/04/2020	09:12:00	10:12:00	01:00:00	59.3	62.3	64.2
	2	18/04/2020	11:32:00	12:37:00	01:05:00	59.0	61.2	64.2
	3	18/04/2020	12:46:00	13:46:00	01:00:00	59.6	62.6	64.3
	4	18/04/2020	13:55:00	14:55:00	01:00:00	57.8	59.7	61.0
Day 2	1	19/04/2020	09:10:00	10:10:00	01:00:00	62.7	64.4	66.2
	2	19/04/2020	10:19:00	11:19:00	01:00:00	55.5	59.0	61.6
	3	19/04/2020	11:28:00	12:28:00	01:00:00	52.6	55.8	58.1
	4	19/04/2020	12:39:00	13:39:00	01:00:00	51.4	54.5	57.0
	5	19/04/2020	13:49:00	14:49:00	01:00:00	45.4	49.0	52.7
	6	19/04/2020	15:44:00	16:49:00	01:05:00	44.2	46.5	51.3
	7	19/04/2020	16:58:00	17:58:00	01:00:00	46.1	47.9	50.5
Day 3	1	20/04/2020	09:37:00	10:37:00	01:00:00	67.3	71.5	74.6
	2	20/04/2020	10:51:00	11:51:00	01:00:00	60.2	63.8	66.7
	3	20/04/2020	12:01:00	13:01:00	01:00:00	59.8	63.5	65.0
	4	20/04/2020	13:11:00	14:11:00	01:00:00	56.5	60.1	64.7
	5	20/04/2020	15:05:00	16:05:00	01:00:00	51.8	55.7	59.8
	6	20/04/2020	16:15:00	16:35:00	00:20:00	63.1	64.9	67.4

Table 4-11: Air Quality Monitoring Logs for SWISS Compound (AQMP 03)

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
$PM_{2.5}$, µg/m³								
Day 1	1	21/04/2020	09:38:00	10:38:00	01:00:00	39	48	75
	2	21/04/2020	13:30:00	14:30:00	01:00:00	22	23	27
	3	21/04/2020	17:36:00	18:36:00	01:00:00	22	36	47
Day 2	1	22/04/2020	11:53:00	12:53:00	01:00:00	27	35	54
	2	22/04/2020	16:17:00	17:17:00	01:00:00	22	28	36
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	28	35	47
	2	23/03/2020	13:25:00	14:25:00	01:00:00	25	40	71
PM_{10}, µg/m³								
Day 1	1	21/04/2020	09:38:00	10:38:00	01:00:00	68	91	119
	2	21/04/2020	13:30:00	14:30:00	01:00:00	61	69	93
	3	21/04/2020	17:36:00	18:36:00	01:00:00	69	89	126
Day 2	1	22/04/2020	11:53:00	12:53:00	01:00:00	72	95	135
	2	22/04/2020	16:17:00	17:17:00	01:00:00	66	79	90
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	90	115	145
	2	23/03/2020	13:25:00	14:25:00	01:00:00	75	106	149
CO, µg/m³								
Day 1	1	21/04/2020	12:12:00	13:12:00	01:00:00	0	0	0
	2	21/04/2020	16:23:00	17:23:00	01:00:00	0	0	0
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	0	0	0
	2	22/04/2020	13:05:00	14:05:00	01:00:00	0	173	1380
Day 3	1	23/03/2020	12:14:00	13:14:00	01:00:00	0	0	0
O_3, µg/m³								
Day 1	1	21/04/2020	09:45:00	10:45:00	01:00:00	3	8	14
	2	21/04/2020	13:31:00	14:26:00	00:55:00	20	27	36
	3	21/04/2020	17:36:00	18:36:00	01:00:00	22	37	48
Day 2	1	22/04/2020	11:53:00	12:53:00	01:00:00	13	19	23
	2	22/04/2020	16:17:00	17:17:00	01:00:00	4	12	17
Day 3	1	23/03/2020	11:03:00	12:03:00	01:00:00	19	28	35
	2	23/03/2020	16:17:00	17:17:00	00:20:00	24	33	42

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
SO_2, µg/m^3								
Day 1	1	21/04/2020	12:12:00	13:12:00	01:00:00	0	0	0
	2	21/04/2020	16:23:00	17:23:00	01:00:00	0	0	0
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	0	0	0
	2	22/04/2020	13:05:00	14:05:00	01:00:00	0	0	0
Day 3	1	23/03/2020	12:14:00	13:14:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	21/04/2020	10:59:00	11:59:00	01:00:00	0	11	31
	2	21/04/2020	15:14:00	16:14:00	01:00:00	17	35	60
Day 2	1	22/04/2020	10:40:00	11:40:00	01:00:00	0	15	49
	2	22/04/2020	14:17:00	15:17:00	01:00:00	0	1	8
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	0	13	60
	2	23/03/2020	13:25:00	14:25:00	01:00:00	0	10	46
VOCs, mg/m^3								
Day 1	1	21/04/2020	10:59:00	11:59:00	01:00:00	282	394	625
	2	21/04/2020	15:14:00	16:14:00	01:00:00	201	249	322
Day 2	1	22/04/2020	10:40:00	11:40:00	01:00:00	277	366	542
	2	22/04/2020	14:17:00	15:17:00	01:00:00	213	259	346
Day 3	1	23/03/2020	11:03:00	12:03:00	01:00:00	239	348	573
	2	23/03/2020	16:17:00	17:17:00	01:00:00	175	223	314
Temperature, C								
Day 1	1	21/04/2020	09:45:00	10:45:00	01:00:00	31.5	32.7	34.2
	2	21/04/2020	10:59:00	11:59:00	01:00:00	33.3	34.8	36.0
	3	21/04/2020	12:12:00	13:12:00	01:00:00	35.1	36.8	38.8
	4	21/04/2020	13:31:00	14:26:00	00:55:00	35.5	37.0	39.8
	5	21/04/2020	15:14:00	16:14:00	01:00:00	34.5	36.1	37.0
	6	21/04/2020	16:23:00	17:23:00	01:00:00	33.0	33.7	35.0
	7	21/04/2020	17:36:00	18:36:00	01:00:00	30.8	31.9	32.7
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	33.6	34.7	35.2
	2	22/04/2020	10:40:00	11:40:00	01:00:00	34.3	35.5	37.7

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
	3	22/04/2020	11:53:00	12:53:00	01:00:00	34.5	35.7	37.0
	4	22/04/2020	13:05:00	14:05:00	01:00:00	33.6	35.3	36.8
	5	22/04/2020	14:17:00	15:17:00	01:00:00	34.7	36.0	37.4
	6	22/04/2020	16:17:00	17:17:00	01:00:00	32.6	33.6	34.5
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	31.8	32.9	34.4
	2	23/03/2020	11:03:00	12:03:00	01:00:00	32.0	33.1	34.0
	3	23/03/2020	12:14:00	13:14:00	01:00:00	32.2	33.2	34.9
	4	23/03/2020	13:25:00	14:25:00	01:00:00	32.2	33.2	34.8
	5	23/03/2020	16:17:00	17:17:00	01:00:00	28.6	29.3	29.9
Relative Humidity, %								
Day 1	1	21/04/2020	09:45:00	10:45:00	01:00:00	59.3	62.8	65.3
	2	21/04/2020	10:59:00	11:59:00	01:00:00	51.6	55.0	58.5
	3	21/04/2020	12:12:00	13:12:00	01:00:00	48.3	51.4	53.9
	4	21/04/2020	13:31:00	14:26:00	00:55:00	46.2	51.9	55.2
	5	21/04/2020	15:14:00	16:14:00	01:00:00	52.9	54.8	58.2
	6	21/04/2020	16:23:00	17:23:00	01:00:00	57.2	60.4	62.5
	7	21/04/2020	17:36:00	18:36:00	01:00:00	63.2	64.9	67.5
Day 2	1	22/04/2020	09:26:00	10:26:00	01:00:00	59.6	61.0	63.2
	2	22/04/2020	10:40:00	11:40:00	01:00:00	54.1	58.6	62.8
	3	22/04/2020	11:53:00	12:53:00	01:00:00	52.9	56.5	59.5
	4	22/04/2020	13:05:00	14:05:00	01:00:00	54.3	57.3	61.2
	5	22/04/2020	14:17:00	15:17:00	01:00:00	52.9	55.6	58.9
	6	22/04/2020	16:17:00	17:17:00	01:00:00	59.1	61.5	64.1
Day 3	1	23/03/2020	09:53:00	10:53:00	01:00:00	62.1	66.2	69.4
	2	23/03/2020	11:03:00	12:03:00	01:00:00	63.0	65.4	68.6
	3	23/03/2020	12:14:00	13:14:00	01:00:00	60.2	64.1	66.8
	4	23/03/2020	13:25:00	14:25:00	01:00:00	59.6	62.9	65.8
	5	23/03/2020	16:17:00	17:17:00	01:00:00	73.7	75.8	77.7

Table 4-12: Air Quality Monitoring Logs for the Masjid IHASAN Mosque (AQMP 04)

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
$PM_{2.5}$, µg/m^3								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	11	19	38
	2	24/04/2020	13:03:00	14:03:00	01:00:00	13	18	26
	3	24/04/2020	16:53:00	17:53:00	01:00:00	19	25	37
Day 2	1	25/04/2020	12:21:00	13:21:00	01:00:00	6	8	10
	2	25/04/2020	15:50:00	16:50:00	01:00:00	6	10	22
Day 1	1	28/04/2020	09:41:00	10:41:00	01:00:00	9	13	27
	2	28/04/2020	13:17:00	14:17:00	01:00:00	9	10	12
	3	28/04/2020	17:27:00	18:27:00	01:00:00	24	36	65
PM_{10}, µg/m^3								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	20	36	63
	2	24/04/2020	13:03:00	14:03:00	01:00:00	33	45	77
	3	24/04/2020	16:53:00	17:53:00	01:00:00	42	63	137
Day 2	1	25/04/2020	12:21:00	13:21:00	01:00:00	9	18	32
	2	25/04/2020	15:50:00	16:50:00	01:00:00	9	19	55
Day 3	1	28/04/2020	09:41:00	10:41:00	01:00:00	30	40	64
	2	28/04/2020	13:17:00	14:17:00	01:00:00	29	36	48
	3	28/04/2020	17:27:00	18:27:00	01:00:00	59	164	486
CO, µg/m^3								
Day 1	1	24/04/2020	11:54:00	12:54:00	01:00:00	0	0	0
	2	24/04/2020	15:45:00	16:45:00	01:00:00	0	0	0
Day 2	1	25/04/2020	10:03:00	10:58:00	00:55:00	0	0	0
	2	25/04/2020	13:30:00	14:30:00	01:00:00	0	0	0
	3	25/04/2020	16:59:00	17:29:00	00:30:00	0	0	0
Day 3	1	28/04/2020	12:10:00	13:05:00	00:55:00	0	0	0
	2	28/04/2020	16:18:00	17:18:00	01:00:00	0	0	0
O_3, µg/m^3								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	14	24	41
	2	24/04/2020	13:03:00	14:03:00	01:00:00	11	38	63
	3	24/04/2020	16:53:00	17:53:00	01:00:00	33	40	51

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
Day 2	1	25/04/2020	15:51:00	16:46:00	00:55:00	18	22	29
	2	22/04/2020	16:17:00	17:17:00	01:00:00	4	12	17
Day 3	1	28/04/2020	10:56:00	11:56:00	01:00:00	7	15	26
	2	28/04/2020	15:10:00	16:05:00	00:55:00	21	29	43
SO_2, µg/m^3								
Day 1	1	24/04/2020	11:54:00	12:54:00	01:00:00	0	0	0
	2	24/04/2020	15:45:00	16:45:00	01:00:00	0	0	0
Day 2	1	25/04/2020	16:59:00	17:59:00	01:00:00	0	0	0
Day 3	1	28/04/2020	12:10:00	13:05:00	00:55:00	0	0	0
	2	28/04/2020	16:18:00	17:18:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	24/04/2020	10:46:00	11:46:00	01:00:00	0	25	103
	2	24/04/2020	14:12:00	15:12:00	01:00:00	0	38	61
Day 2	1	25/04/2020	14:39:00	15:39:00	01:00:00	0	24	60
Day 3	1	28/04/2020	09:42:00	10:42:00	01:00:00	0	2	9
	2	28/04/2020	13:17:00	14:17:00	01:00:00	0	11	42
	3	28/04/2020	17:27:00	18:27:00	01:00:00	2	33	52
VOCs mg/m^3								
Day 1	1	24/04/2020	10:45:00	11:45:00	01:00:00	355	506	867
	2	24/04/2020	14:12:00	15:07:00	00:55:00	190	305	534
Day 2	1	25/04/2020	11:12:00	12:12:00	01:00:00	374	608	1241
	2	25/04/2020	14:39:00	15:39:00	01:00:00	243	325	551
Day 3	1	28/04/2020	10:56:00	11:56:00	01:00:00	804	1401	2772
	2	28/04/2020	15:10:00	16:05:00	00:55:00	390	556	886
Temperature, C								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	34.1	35.3	36.3
	2	24/04/2020	10:46:00	11:46:00	01:00:00	34.2	35.8	37.1
	3	24/04/2020	11:54:00	12:54:00	01:00:00	35.3	36.4	37.1
	4	24/04/2020	13:03:00	14:03:00	01:00:00	35.1	36.0	37.3
	5	24/04/2020	14:12:00	15:12:00	01:00:00	32.9	34.4	36.4
	6	24/04/2020	15:45:00	16:45:00	01:00:00	33.3	34.2	36.2

Day	Run №	Date	Time (hh:mm:ss)		Duration	Min.	Avg.	Max.
			Start	End	(hh:mm:ss)			
	7	24/04/2020	16:53:00	17:53:00	01:00:00	33.4	35.3	37.0
Day 2	1	25/04/2020	14:39:00	15:39:00	01:00:00	33.6	34.6	36.7
	2	25/04/2020	15:51:00	16:46:00	00:55:00	36.2	36.8	37.5
	3	25/04/2020	16:59:00	17:59:00	01:00:00	33.6	36.3	39.1
Day 3	1	28/04/2020	09:42:00	10:42:00	01:00:00	31.4	32.5	33.8
	2	28/04/2020	10:56:00	11:56:00	01:00:00	35.0	36.9	38.3
	3	28/04/2020	12:10:00	13:05:00	00:55:00	36.2	37.3	38.2
	4	28/04/2020	13:17:00	14:17:00	01:00:00	35.8	36.9	38.1
	5	28/04/2020	15:10:00	16:05:00	00:55:00	36.3	37.2	38.9
	6	28/04/2020	16:18:00	17:18:00	01:00:00	38.0	39.1	40.1
	7	28/04/2020	17:27:00	18:27:00	01:00:00	34.0	36.6	38.9
Relative Humidity, %								
Day 1	1	24/04/2020	09:36:00	10:36:00	01:00:00	52.9	55.3	57.7
	2	24/04/2020	10:46:00	11:46:00	01:00:00	52.7	55.3	59.0
	3	24/04/2020	11:54:00	12:54:00	01:00:00	54.2	55.6	59.2
	4	24/04/2020	13:03:00	14:03:00	01:00:00	51.1	55.4	58.0
	5	24/04/2020	14:12:00	15:12:00	01:00:00	54.1	61.5	66.5
	6	24/04/2020	15:45:00	16:45:00	01:00:00	56.1	60.8	62.8
	7	24/04/2020	16:53:00	17:53:00	01:00:00	52.7	57.2	60.4
Day 2	1	25/04/2020	14:39:00	15:39:00	01:00:00	47.0	50.8	53.5
	2	25/04/2020	15:51:00	16:46:00	00:55:00	46.0	48.8	51.8
	3	25/04/2020	16:59:00	17:59:00	01:00:00	43.6	48.8	53.9
Day 3	1	28/04/2020	09:42:00	10:42:00	01:00:00	57.2	60.1	62.6
	2	28/04/2020	10:56:00	11:56:00	01:00:00	46.4	49.7	54.3
	3	28/04/2020	12:10:00	13:05:00	00:55:00	39.3	45.6	48.9
	4	28/04/2020	13:17:00	14:17:00	01:00:00	33.6	42.8	46.7
	5	28/04/2020	15:10:00	16:05:00	00:55:00	37.3	42.6	46.2
	6	28/04/2020	16:18:00	17:18:00	01:00:00	36.6	38.0	40.1
	7	28/04/2020	17:27:00	18:27:00	01:00:00	39.1	42.7	47.0

Table 4-13: Air Quality Monitoring Logs for FINIC Fence (AQMP 05)

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
$PM_{2.5}$, µg/m³								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	16	72	611
	2	29/04/2020	14:00:00	15:00:00	01:00:00	15	25	69
Day 2	1	30/04/2020	12:21:00	13:16:00	00:55:00	23	272	943
	2	30/04/2020	16:15:00	17:15:00	01:00:00	10	13	16
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	11	20	37
	2	01/05/2020	12:54:00	13:54:00	01:00:00	5	7	11
	3	01/05/2020	17:10:00	18:05:00	00:55:00	13	16	25
PM_{10}, µg/m³								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	36	81	469
	2	29/04/2020	14:00:00	15:00:00	01:00:00	39	60	106
Day 2	1	30/04/2020	12:21:00	13:16:00	00:55:00	28	203	592
	2	30/04/2020	16:15:00	17:15:00	01:00:00	19	25	35
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	17	35	59
	2	01/05/2020	12:54:00	13:54:00	01:00:00	10	21	41
	3	01/05/2020	17:10:00	18:05:00	00:55:00	23	33	53
CO, µg/m³								
Day 1	1	29/04/2020	12:51:00	13:51:00	01:00:00	0	0	0
	2	29/04/2020	17:05:00	18:05:00	01:00:00	0	0	0
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	0	0	0
	2	30/04/2020	13:55:00	14:55:00	01:00:00	0	0	0
	3	30/04/2020	17:24:00	18:24:00	01:00:00	0	0	0
Day 3	1	01/05/2020	11:44:00	12:44:00	01:00:00	0	0	0
	2	01/05/2020	15:54:00	16:54:00	01:00:00	0	0	0
O_3, µg/m³								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	16	27	37
	2	29/04/2020	14:00:00	15:00:00	01:00:00	3	20	43
Day 2	1	30/04/2020	12:21:00	13:21:00	01:00:00	23	39	105
	2	30/04/2020	16:15:00	17:15:00	01:00:00	31	36	41
Day 3	1	01/05/2020	10:35:00	11:35:00	01:00:00	4	17	25
	2	01/05/2020	14:44:00	15:44:00	01:00:00	23	29	45
SO_2, µg/m³								
Day 1	1	29/04/2020	12:52:00	13:47:00	00:55:00	0	0	0
	2	29/04/2020	17:05:00	18:05:00	01:00:00	0	0	0
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	0	0	0

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	2	30/04/2020	13:55:00	14:55:00	01:00:00	0	0	0
	3	30/04/2020	17:24:00	18:24:00	01:00:00	0	0	0
Day 3	1	01/05/2020	11:45:00	12:45:00	01:00:00	0	0	0
	2	01/05/2020	15:54:00	16:54:00	01:00:00	0	0	0
NO_2, µg/m^3								
Day 1	1	29/04/2020	11:42:00	12:42:00	01:00:00	0	20	126
	2	29/04/2020	15:56:00	16:56:00	01:00:00	0	11	41
Day 2	1	30/04/2020	11:12:00	12:12:00	01:00:00	0	38	112
	2	30/04/2020	15:05:00	16:05:00	01:00:00	0	13	43
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	0	1	6
	2	01/05/2020	12:54:00	13:54:00	01:00:00	0	2	13
	3	01/05/2020	17:10:00	18:05:00	00:55:00	0	10	24
VOCs mg/m^3								
Day 1	1	29/04/2020	11:42:00	12:42:00	01:00:00	596	998	1926
	2	29/04/2020	15:55:00	16:55:00	01:00:00	325	505	879
Day 2	1	30/04/2020	11:12:00	12:12:00	01:00:00	400	624	1182
	2	30/04/2020	15:05:00	16:05:00	01:00:00	277	372	555
Day 3	1	01/05/2020	10:35:00	11:35:00	01:00:00	492	742	1285
	2	01/05/2020	14:44:00	15:44:00	01:00:00	403	570	810
Temperature, C								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	33.5	35.4	37.7
	2	29/04/2020	11:42:00	12:42:00	01:00:00	35.5	37.0	37.8
	3	29/04/2020	12:52:00	13:47:00	00:55:00	36.7	37.4	37.9
	4	29/04/2020	14:00:00	15:00:00	01:00:00	36.7	37.6	39.0
	5	29/04/2020	15:56:00	16:56:00	01:00:00	34.3	35.0	35.7
	6	29/04/2020	17:05:00	18:05:00	01:00:00	32.0	33.1	34.4
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	30.5	32.7	34.5
	2	30/04/2020	11:12:00	12:12:00	01:00:00	31.6	33.1	36.0
	3	30/04/2020	12:21:00	13:21:00	01:00:00	31.3	32.1	33.2
	4	30/04/2020	13:55:00	14:55:00	01:00:00	31.5	31.8	32.2
	5	30/04/2020	15:05:00	16:05:00	01:00:00	32.6	33.4	34.4
	6	30/04/2020	16:15:00	17:15:00	01:00:00	32.2	33.1	34.1
	7	30/04/2020	17:24:00	18:24:00	01:00:00	31.2	31.6	32.3
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	31.9	35.6	37.7
	2	01/05/2020	10:35:00	11:35:00	01:00:00	35.5	36.7	37.8
	3	01/05/2020	11:45:00	12:45:00	01:00:00	36.2	37.2	39.1

Day	Run №	Date	Time (hh:mm:ss)		Duration (hh:mm:ss)	Min.	Avg.	Max.
			Start	End				
	4	01/05/2020	12:54:00	13:54:00	01:00:00	36.7	37.9	39.0
	5	01/05/2020	14:44:00	15:44:00	01:00:00	36.5	37.4	38.4
	6	01/05/2020	15:54:00	16:54:00	01:00:00	35.7	36.3	36.7
	7	01/05/2020	17:10:00	18:05:00	00:55:00	33.9	34.5	35.4
Relative Humidity, %								
Day 1	1	29/04/2020	10:33:00	11:33:00	01:00:00	49.7	54.3	57.4
	2	29/04/2020	11:42:00	12:42:00	01:00:00	51.0	52.3	54.6
	3	29/04/2020	12:52:00	13:47:00	00:55:00	49.0	51.7	54.2
	4	29/04/2020	14:00:00	15:00:00	01:00:00	47.0	48.9	50.8
	5	29/04/2020	15:56:00	16:56:00	01:00:00	53.9	56.3	58.9
	6	29/04/2020	17:05:00	18:05:00	01:00:00	59.2	63.4	66.0
Day 2	1	30/04/2020	09:55:00	10:55:00	01:00:00	38.5	45.9	56.3
	2	30/04/2020	11:12:00	12:12:00	01:00:00	38.0	56.1	63.5
	3	30/04/2020	12:21:00	13:21:00	01:00:00	59.1	62.0	64.3
	4	30/04/2020	13:55:00	14:55:00	01:00:00	61.1	63.5	64.9
	5	30/04/2020	15:05:00	16:05:00	01:00:00	57.6	59.2	60.5
	6	30/04/2020	16:15:00	17:15:00	01:00:00	58.2	60.8	62.9
	7	30/04/2020	17:24:00	18:24:00	01:00:00	62.2	64.2	65.6
Day 3	1	01/05/2020	09:26:00	10:26:00	01:00:00	53.3	57.4	66.0
	2	01/05/2020	10:35:00	11:35:00	01:00:00	51.9	54.3	56.2
	3	01/05/2020	11:45:00	12:45:00	01:00:00	48.0	51.0	54.6
	4	01/05/2020	12:54:00	13:54:00	01:00:00	47.1	49.1	50.7
	5	01/05/2020	14:44:00	15:44:00	01:00:00	51.0	52.5	53.9
	6	01/05/2020	15:54:00	16:54:00	01:00:00	54.4	55.1	56.1
	7	01/05/2020	17:10:00	18:05:00	00:55:00	57.3	60.0	61.6

Appendix C: Ambient Noise Monitoring Logs

Table 4-14: Ambient Noise Monitoring Logs for NMP 01

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
15/04/2020 10:10	15/04/2020 11:10	01:00:00	51.5	77.0	46.2	53.0	49.0
15/04/2020 11:11	15/04/2020 12:11	01:00:00	50.4	67.3	45.7	51.5	48.5
15/04/2020 12:12	15/04/2020 13:12	01:00:00	51.4	73.7	45.8	53.0	48.5
15/04/2020 13:12	15/04/2020 14:12	01:00:00	51.2	72.7	45.9	52.0	49.0
15/04/2020 14:52	15/04/2020 15:52	01:00:00	53.3	84.0	47.4	53.5	50.0
15/04/2020 15:53	15/04/2020 16:53	01:00:00	52.6	76.5	47.3	53.0	49.5
15/04/2020 16:55	15/04/2020 17:55	01:00:00	71.0	110.8	46.4	52.0	48.5
18/04/2020 08:40	18/04/2020 09:40	01:00:00	51.4	74.2	45.3	51.0	48.0
18/04/2020 09:41	18/04/2020 10:41	01:00:00	53.7	84.7	45.8	52.0	48.0
18/04/2020 10:43	18/04/2020 11:43	01:00:00	56.1	75.5	47.0	59.0	51.0
18/04/2020 11:43	18/04/2020 12:43	01:00:00	53.3	70.9	47.0	56.5	49.5
18/04/2020 12:48	18/04/2020 13:48	01:00:00	53.1	78.6	47.4	55.0	49.5
18/04/2020 13:48	18/04/2020 14:48	01:00:00	52.7	78.5	46.0	52.0	49.0
18/04/2020 14:48	18/04/2020 15:48	01:00:00	50.6	71.7	44.8	52.0	47.5
18/04/2020 15:49	18/04/2020 16:49	01:00:00	50.1	67.4	44.4	52.0	48.0
18/04/2020 16:50	18/04/2020 17:50	01:00:00	48.0	64.6	42.7	50.0	45.5

Table 4-15: Ambient Noise Monitoring Logs for NMP 02

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
16/04/2020 09:54	16/04/2020 10:54	01:00:00	47.8	85.0	38.9	46.5	42.0
16/04/2020 10:56	16/04/2020 11:56	01:00:00	44.8	66.9	40.2	47.0	42.5
16/04/2020 11:56	16/04/2020 12:56	01:00:00	47.6	86.2	39.0	50.5	42.5
16/04/2020 12:56	16/04/2020 13:56	01:00:00	45.5	76.3	37.9	46.0	41.5
16/04/2020 13:56	16/04/2020 14:56	01:00:00	52.5	91.3	38.3	48.5	44.5
16/04/2020 14:56	16/04/2020 15:56	01:00:00	52.9	87.6	41.8	49.0	46.0
16/04/2020 15:56	16/04/2020 16:56	01:00:00	46.1	80.1	39.4	47.0	44.0
16/04/2020 16:56	16/04/2020 17:56	01:00:00	45.3	69.3	38.5	46.5	41.5
19/04/2020 08:33	19/04/2020 09:33	01:00:00	48.7	83.3	36.0	40.5	47.5
19/04/2020 09:34	19/04/2020 10:34	01:00:00	43.9	71.9	36.9	41.5	39.0
19/04/2020 10:46	19/04/2020 11:46	01:00:00	46.0	69.0	38.2	50.5	41.5
19/04/2020 11:46	19/04/2020 12:46	01:00:00	48.8	79.5	40.0	48.5	44.0
19/04/2020 12:49	19/04/2020 13:49	01:00:00	47.9	72.9	42.2	49.0	45.5
19/04/2020 13:52	19/04/2020 14:52	01:00:00	47.2	79.6	40.8	47.5	43.5

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
19/04/2020 15:30	19/04/2020 16:30	01:00:00	46.7	73.3	39.6	49.5	44.5
19/04/2020 16:33	19/04/2020 17:33	01:00:00	46.0	71.9	39.3	45.5	42.0

Table 4-16: Ambient Noise Monitoring Logs for NMP 03

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
17/04/2020 09:30	17/04/2020 10:30	01:00:00	50.5	68.6	44.9	54.0	47.5
17/04/2020 10:30	17/04/2020 11:30	01:00:00	50.0	79.8	44.0	50.0	47.0
17/04/2020 11:30	17/04/2020 12:30	01:00:00	49.4	72.2	43.9	50.5	46.0
17/04/2020 12:30	17/04/2020 13:30	01:00:00	51.1	80.0	44.9	56.0	48.5
17/04/2020 14:00	17/04/2020 15:00	01:00:00	51.3	86.2	44.2	51.5	47.5
17/04/2020 15:01	17/04/2020 16:01	01:00:00	49.3	77.0	43.9	49.5	46.5
17/04/2020 16:01	17/04/2020 17:01	01:00:00	51.1	85.5	44.7	52.5	47.0
17/04/2020 17:01	17/04/2020 18:01	01:00:00	51.8	81.9	45.5	51.5	47.5
24/04/2020 09:42	24/04/2020 10:42	01:00:00	46.6	73.9	38.5	45.0	40.5
24/04/2020 10:42	24/04/2020 11:42	01:00:00	47.6	74.8	39.0	54.0	41.5
24/04/2020 11:43	24/04/2020 12:43	01:00:00	45.2	66.4	37.6	44.5	41.5
24/04/2020 12:44	24/04/2020 13:44	01:00:00	43.3	63.8	35.9	46.5	37.5
24/04/2020 14:03	24/04/2020 15:03	01:00:00	44.3	63.5	38.0	47.5	41.0
24/04/2020 15:04	24/04/2020 16:04	01:00:00	51.0	70.4	39.5	55.0	47.5
24/04/2020 16:04	24/04/2020 17:04	01:00:00	50.5	68.9	44.9	53.5	47.5
24/04/2020 17:05	24/04/2020 18:05	01:00:00	48.2	66.5	42.6	49.5	44.0

Table 4-17: Ambient Noise Monitoring Logs for NMP 04

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
22/04/2020 09:29	22/04/2020 10:29	01:00:00	47.4	76.0	36.4	47.5	41.5
22/04/2020 10:29	22/04/2020 11:29	01:00:00	47.2	76.0	38.3	45.5	40.5
22/04/2020 11:30	22/04/2020 12:30	01:00:00	46.1	71.3	39.7	45.5	41.5
22/04/2020 12:30	22/04/2020 13:30	01:00:00	56.2	72.0	40.3	49.0	42.5
22/04/2020 14:00	22/04/2020 15:00	01:00:00	48.2	67.1	42.9	51.5	46.5
22/04/2020 15:00	22/04/2020 16:00	01:00:00	51.7	85.0	43.5	49.5	46.5
22/04/2020 16:01	22/04/2020 17:01	01:00:00	51.3	67.7	43.9	56.0	48.5
23/04/2020 10:00	23/04/2020 11:00	01:00:00	67.8	77.5	43.8	69.0	68.5
23/04/2020 11:00	23/04/2020 12:00	01:00:00	68.7	75.8	67.7	69.0	68.5
23/04/2020 12:00	23/04/2020 13:00	01:00:00	68.7	71.9	67.8	69.0	68.5

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
23/04/2020 13:00	23/04/2020 14:00	01:00:00	66.2	69.9	43.6	69.0	48.5
23/04/2020 15:55	23/04/2020 16:55	01:00:00	68.7	82.1	46.8	69.5	69.0

Table 4-18: Ambient Noise Monitoring Logs for NMP 05

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Pressure Level, dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
20/04/2020 09:01	20/04/2020 10:01	01:00:00	58.7	82.1	41.9	62.5	47.0
20/04/2020 10:01	20/04/2020 11:01	01:00:00	61.3	93.1	42.6	62.0	52.5
20/04/2020 11:10	20/04/2020 12:10	01:00:00	63.6	97.3	45.7	57.5	50.5
20/04/2020 12:11	20/04/2020 13:11	01:00:00	60.3	83.3	46.7	64.5	53.0
20/04/2020 14:04	20/04/2020 15:04	01:00:00	60.7	91.0	47.0	63.5	51.0
20/04/2020 15:05	20/04/2020 16:05	01:00:00	64.2	89.4	46.5	68.0	58.5
20/04/2020 16:05	20/04/2020 16:34	01:00:00	68.1	91.4	45.4	67.5	52
21/04/2020 09:32	21/04/2020 10:32	01:00:00	60.2	83.6	43.1	64.5	51.5
21/04/2020 10:32	21/04/2020 11:32	01:00:00	61.3	84.6	45.3	60.5	51.5
21/04/2020 11:32	21/04/2020 12:32	01:00:00	64.6	89.2	44.6	62.4	50.5
21/04/2020 12:32	21/04/2020 13:32	01:00:00	63.7	81.6	43.2	57.5	49.0
21/04/2020 14:36	21/04/2020 15:36	01:00:00	62.8	92.7	47.2	66.5	55.0
21/04/2020 15:36	21/04/2020 16:36	01:00:00	65.5	94.9	45.4	66.5	53.0
21/04/2020 16:37	21/04/2020 17:37	01:00:00	59.2	88.3	44.5	58.0	49.0
21/04/2020 17:37	21/04/2020 18:37	01:00:00	59.0	84.2	45.7	58.5	52.0

Table 4-19: Ambient Noise Monitoring Logs for NMP 06

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Level Pressure dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
25/04/2020 09:52	25/04/2020 10:52	01:00:00	66.5	88.2	50.6	72.0	60.0
25/04/2020 11:08	25/04/2020 12:08	01:00:00	69.3	94.0	49.8	69.5	61.0
25/04/2020 12:09	25/04/2020 13:09	01:00:00	69.3	93.1	51.4	76.0	61.0
25/04/2020 13:09	25/04/2020 14:09	01:00:00	66.3	89.1	48.5	69.5	57.5
25/04/2020 14:09	25/04/2020 15:09	01:00:00	68.8	92.1	50.5	72.5	60.0
25/04/2020 15:09	25/04/2020 16:09	01:00:00	69.8	96.0	50.6	69.5	59.0
25/04/2020 16:10	25/04/2020 17:10	01:00:00	68.6	89.5	52.2	69.5	58.5
25/04/2020 17:10	25/04/2020 18:10	01:00:00	69.0	95.0	51.8	70.0	60.5
28/04/2020 09:47	28/04/2020 10:47	01:00:00	72.6	97.6	48.3	75.0	57.5
28/04/2020 10:47	28/04/2020 11:47	01:00:00	70.6	96.9	49.4	74.5	59.5
28/04/2020 11:47	28/04/2020 12:47	01:00:00	69.4	97.5	49.5	69.5	55.0

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Level Pressure dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
28/04/2020 12:47	28/04/2020 13:47	01:00:00	68.1	93.4	46.5	61.0	52.5
28/04/2020 13:47	28/04/2020 14:47	01:00:00	67.1	93.3	46.5	66.5	56.0
28/04/2020 16:00	28/04/2020 17:00	01:00:00	59.9	68.4	51.2	64.0	54.0
28/04/2020 17:00	28/04/2020 18:00	01:00:00	70.3	95.8	50.3	69.5	57.5

Table 4-20: Ambient Noise Monitoring Logs for NMP 07

Date and Time dd/mm/yyyy hh:mm		Duration hh:mm:ss	Sound Level Pressure dB(A)				
Start	End		LAeq	LAF_{Max}	LAF_{Min}	LA_{10}	LA_{90}
30/04/2020 10:12	30/04/2020 11:12	01:00:00	75.8	102.1	62.0	77.0	68.0
30/04/2020 11:15	30/04/2020 12:15	01:00:00	74.7	95.8	59.2	76.0	66.5
30/04/2020 12:15	30/04/2020 13:15	01:00:00	75.5	102.2	59.2	77.5	67.0
30/04/2020 13:16	30/04/2020 14:16	01:00:00	75.4	104.5	59.5	77.0	67.0
30/04/2020 14:16	30/04/2020 15:16	01:00:00	74.2	98.5	60.5	76.0	66.5
30/04/2020 15:16	30/04/2020 16:16	01:00:00	74.3	96.8	58.5	76.0	67.5
30/04/2020 16:16	30/04/2020 17:16	01:00:00	75.0	97.2	59.3	77.0	67.5
30/04/2020 17:16	30/04/2020 18:16	01:00:00	76.1	99.8	60.3	77.5	68.5
01/05/2020 09:31	01/05/2020 10:31	01:00:00	74.9	102.6	59.4	75.0	68.0
01/05/2020 10:31	01/05/2020 11:31	01:00:00	75.3	100.7	59.7	77.5	67.0
01/05/2020 11:32	01/05/2020 12:32	01:00:00	73.9	94.7	59.1	75.5	68.5
01/05/2020 12:32	01/05/2020 13:32	01:00:00	73.8	93.7	56.4	76.5	68.5
01/05/2020 14:55	01/05/2020 15:55	01:00:00	75.2	101.9	56.7	76.0	66.5
01/05/2020 15:55	01/05/2020 16:55	01:00:00	75.8	101.4	57.7	76.0	67.5
01/05/2020 16:56	01/05/2020 17:56	01:00:00	75.3	106.0	59.4	76.5	66.0

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Appendix G: Land Contamination Report

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CECA Sierra Leone

HFO Thermal Power Plant

Land Contamination Factual Report

April 2015

Document Control Sheet

BPP 04 F8
Version 17; July 2014

Project:	CECA Sierra Leone HFO Thermal Power Plant		
Client:	CECA	**Project Number:**	KU075500
Document Title:	Land Contamination Factual Report		
Ref. No:	B0563700/		

	Originated by	Checked by	Reviewed by
ORIGINAL	NAME Katherine Hunt	NAME Louise Beale	NAME Louise Beale
Approved by	NAME	As Project Manager I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue**	INITIALS
DATE	**April 2015**	**Document status**	

REVISION	NAME	NAME	NAME
Approved by	NAME	As Project Manager I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I **approve them for issue**	INITIALS
DATE		**Document status**	

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1 Introduction

1.1 Introduction

Jacobs were commissioned to undertake a land quality assessment at the CEC Africa (Sierra Leone) Ltd., ("CEC") Blue Flare HFO project site in Freetown. The site is located

A ground investigation was undertaken between 28th Ocotber and 20th November 2014 by 3BMD Associates. Eight geotechnical boreholes (BH01-BH08) and three environmental boreholes (BH01ES-BH03ES) were drilled as part of this ground investigation. Twenty four soil samples from the geotechnical boreholes and three water samples from BH01ES, BH02ES and BH03ES were taken by 3BMD Associates and analysed at Alcontrol Laboratories UK.

This report presents the results of the soil and groundwater sampling.

1.2 Site Summary

The site is located in Freetown approximately 650 south west of the coast of Sierra Leone.

Apart from the areas of hard standing or cultivation, the surface of the site is primarily sand/gravel with patchy weed-type vegetation. There are areas of hard rock outcropping across the ground surface within the MSU compound which indicates that shallow hard rock is likely to be encountered across the site.

The key contamination sources on site and receptors are summarised as follows:

- The fuel supply island and fuel tanks in the MSU compound. There appears to be no interceptor drainage system, though there is apparently an oil/water separator. It was noted that fuel spills within MSU compound are contained with sand and the sand is disposed of to the Central Dump.
- Multiple point sources from the large number of vehicles not stored on hardstanding.
- Key receptors for potential contamination are shallow groundwater and adjacent land receiving runoff from the site, construction workers and furutre site users. Ultimately, the end receiving environment for groundwater and runoff is likely to be the Sierra Leone estuary.

1.3 Limitations

All samples were taken and transported to the UK laboratory by the contractors. UK laboratory Alcontrol was used for analysis in the absence of a local laboratory. Due to the length of timetaken to transport the samples to the UK laboratory holding times for VOCs and SVOCs were exceeded. Transportation restrictions meant that the correct bottles for acid fixation of metals could not be sent to the site, therefore all metals were fixed in the laboratory and not at the time of sampling.

2 Assessment Criteria

This section presents the assessment criteria used in this report. In the absence of local criteria UK standards for commercial land use, Environmental Quality Standards (EQS) and UK Drinking Water Standards (UK DWS) have been used in the assessment.

2.1 Soil

The significance of most of the analytical results in the context of risk to human health has been assessed by comparison with generic assessment criteria (GAC) for commercial end use. The GAC were produced using the Environment Agency / DEFRA Contaminated Land Exposure Assessment (CLEA) model(8). These include Soil Guideline Values (SGVs) published by the EA / DEFRA and Generic Assessment Criteria calculated using the CLEA methodology and published by authoritative sources LQM / CIEH 2nd Edition(9) and EIC/ AGS/ CL:AIRE GACs(10).

It is important to note that the SGVs and GAC are used here as generic screening criteria. Exceedance of the SGV or GAC does not mean that there is a significant possibility of significant harm to end-users, but that further assessment may be required. A table of the GAC/SGVs used in this assessment is detailed below.

Contaminant	Units	UK CLEA SGVs or UK LQM CIEH GAC- Commercial end use
Boron	mg/kg	192,000
Chromium	mg/kg	30,400
Copper	mg/kg	71,700
Mercury	mg/kg	3,600
Nickel	mg/kg	1,800
Zinc	mg/kg	665,000
Asbestos	None	Presence
Acenaphthene	mg/kg	85,000
Acenaphthylene	mg/kg	84,000
Anthracene	mg/kg	530,000
Benz[a]anthracene	mg/kg	90
Benzo[ghi]perylene	mg/kg	650
Chrysene	mg/kg	140
Dibenz[ah]anthracene	mg/kg	13
Fluoranthene	mg/kg	23,000
Fluorene	mg/kg	64,000
Indeno[123-cd]pyrene	mg/kg	60
Naphthalene	mg/kg	200
Phenanthrene	mg/kg	22,000
Pyrene	mg/kg	54,000

Table 2-A Summary of commercial GAC values

In March 2014, The Department for Environment, Food and Rural Affairs (Defra) produced ‘Category 4 Screening Levels’ (C4SLs) to provide a simple test for deciding when land is suitable for use and is “definitely not contaminated land”.

C4SLs can therefore be used as generic screening criteria, where they exist, and are generally considered more pragmatic (whilst still strongly precautionary) compared to existing GAC and SGVs. Therefore, where C4SLs exist, they will be used here instead of GAC and SGVs.

Available C4SL guideline values for commercial land use are shown in the table below.

Determinand	Units	C4SL Value
Arsenic	mg/kg	640
Benzo(a)pyrene	mg/kg	77
Cadmium	mg/kg	410
Chromium VI	mg/kg	49
Lead	mg/kg	2,300

Table 2-B Summary of C4SL guideline values

2.2 Groundwater

The existing Groundwater Directive (80/68/EEC) aims to protect groundwater from pollution by controlling discharges and disposals of certain dangerous substances to groundwater. In the UK, the directive is implemented through the Environmental Permitting Regulations (EPR) 2010 and the River Basin Management Plans.

The protection of groundwater under these regulations and plans is provided by preventing or limiting the inputs of polluting substances into groundwater.

Details of the current quality of this groundwater body G29 are provided on the Environment Agency website and in the River Basin Management Plan for the Thames River Basin District: Annex B (2011. Overall the current quantitative and chemical qualities of the groundwater body are reported as “poor” with no evidence of an upward trend in quality.

There are numerous tests that the Environment Agency undertakes to determine the status levels and the confidence levels of the groundwater bodies. One of these (the General Chemical Assessment) is through the collation of groundwater chemical data over a period of six years to enable a baseline concentration to be established. Initial data is assessed against relevant threshold values and the baseline data to determine any upward trends or deterioration in quality. The test is not intended to identify local pollution impact, rather it is intended to assess the overall groundwater quality for any deterioration that may strategically impact its use or the wider environment.

The relevant threshold values utilised by the Environment Agency for the first part of the General Chemical Assessment are the currently available Environmental Quality Standards (EQS) and where necessary UK Drinking Water Standards (DWS). Therefore the analytical results obtained during the previous and recent site investigation for the scheme have been compared to these threshold values.

EQS representing concentrations of contaminants, below which substances are not believed to be detrimental to aquatic life, have been set for a range of substances. The EQS is set for the receiving watercourse and not the discharge itself. However, when assessing risks to surface water the EA considers the point of compliance to be the pre-dilution point of entry into the receiving watercourse.

Where there is no EQS assessment criteria available groundwater contaminant levels have been screened against the current DWS. Generally, the values specified represent maximum permitted concentrations in water but for some parameters, a minimum concentration or value is given. As these values are for water “at the tap” and intended for human consumption, they are necessarily conservative. However, they do provide a useful standard against which groundwater samples can be assessed and for this reason have been referenced in this report.

3 Site Investigation Summary

Eleven boreholes were drilled as part of the site investigation by 3BMD Associates. The Borehole Locations are in Appendix A.

3.1 Borehole Logs

Borehole logs were provided by 3BMD Associates for the eleven boreholes drilled.

The borehole logs from the site investigation show the geology beneath the site to be laterite underlain by medium grained sand at approximately 5m. In some borehole logs there is 1m of lateritic gravel with topsoil at the surface. A summary of a representative borehole log is shown in the table below. Full borehole logs are in Appendix D.

Depth	Strata
0-1m	Reddish brown lateritic Gravel, top soil with occasional organic materials and rootlets. Gravel is sub rounded of Laterite
1-6m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite
6-15m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained

No evidence of contamination was noted on the borehole logs.

3.2 Samples

Sample containers were provided by Alcontrol Laboratories UK and transported back to the UK by 3BMD Associates.

Tweny four soil samples were taken between 0 and 4m deep from the lateritic gravel and hardpan laterite.

Three groundwater samples were taken from BH01ES, BH02ES and BH03ES.

4 Results

4.1 Groundwater Levels

Groundwater strike levels taken during the site investigation are listed in the table below.

BH ID	GW Strike	Ground Elevation	MAOD
BH01	8.9	35.361	26.461
BH02	15.6	34.125	18.525
BH03	-	34.62	-
BH04	7.8	32.892	25.812
BH05	7.8	35.361	27.561
BH06	7.9	32.167	24.267
BH07	7.6	34.057	26.457
BH08	-	32.907	-
BH1 ES	15.1	35.529	20.429
BH2 ES	8.2	37.175	28.975
BH3 ES	16	34.813	18.813

Table 3-A Groundwater Strike Levels

As there are a limited number of deeper strikes encountered during the site investigation there is not enough data to confirm the groundwater flow direction. the likely fractured, hard rock geology means that groundwater flow patterns may be complex and may not necessarily follow the overland drainage be towards the north. The groundwater strikes recorded during the site investigations indicate a varied water table across the site which might suggest shallower perched groundwater is present (between 7 and 9 metres below ground level) above the main water table at 15 to 16 m below ground level.

4.2 Soil Results

4.2.1 Metals

All samples were analysed for metals and assessed against the commercial GACs.

Determinand	Range (mg/kg)	GAC (mg/kg)
Arsenic	6.57 – 18.8	640
Cadmium	<0.02 – 2.61	230
Chromium III	<0.09 - 4700	30,400
Copper	<1.4 – 91.9	2,300
Lead	10.5 - 120	3,600
Mercury	<0.14	1,800
Nickel	23.7 - 119	13,000

Selenium	<1	3160
Zinc	21.8 - 318	665,000

Non of the samples exceeded the GACs.

4.2.2 Extractable Petroleum Hydrocarbons

EPH was analysed in all samples.

Determinand	Range (mg/kg)	GAC (mg/kg)
Total EPH	<35 - 1250	3400

EPH was below the GACs in all samples including total EPH which is shown in the avbove table.

4.2.3 Polyaromatic Hydrocarbons

All samples were analysed for PAHs.

Determinand	Range (ug/kg)	GAC (mg/kg)
Acenaphthene	<8 – <40	85000000
Acenaphthylene	<12 – <60	84000000
Anthracene	<16 – <80	530000000
Benz[a]anthracene	<14 – 242	90000
Benzo[a]pyrene	<15 – 269	14000
Benzo(b)fluoranthene	<15 – 439	100000
Benzo[ghi]perylene	<24 – 389	650000
Benzo(k)fluoranthene	<14 – 176	140000
Chrysene	<10 – 281	140000
Dibenzo[ah]anthracene	<23 – <115	13000
Fluoranthene	<17 – 458	23000000
Fluorene	<10 – <50	64000000
Indeno[123-cd]pyrene	<18 – 231	60000
Naphthalene	<9 – 70.8	200000
Phenanthrene	<15 – 215	22000000
Pyrene	<15 – 448	540000000

All PAHs were below the commercial GACs.

4.2.4 Volatile Organic Compounds (VOCs)

VOCs were analysed in 8 samples. VOCs were below the limit of detection in all samples.

4.2.5 Semi-Volatile Organic Compounds (SVOCs)

SVOCs were analysed in 8 samples. SVOCs were below detection limit in all samples with the exception of bis(2-Ethylhexyl) phthalate in BH02 (0-1m) and BH04 (0-1m), the concentration recorded is not considered significant.

4.2.6 Asbestos

Asbestos was analysed for in all samples. No asbestos fibres were identified in any of the samples. Non-asbestos fibres were identified in BH03 and BH05 at 2.5-3.5mThis is not widespread across the site. The presence of non-asbestos fibre at the site means that precautions may need to be taken during any works which could disturb the ground.

4.3 Groundwater Results

4.3.1 Metals

All water samples were analysed for metals.

Determinand	Range (ug/l)	EQS / DWS
Arsenic	0.416 – 0.707	50
Cadmium	<0.1	0.08
Chromium	1.21 – 2.27	3.4
Chromium, Hexavalent	<0.03	
Copper	<0.85 – 4.83	1
Lead	<0.02 – 0.428	7.2
Mercury	<0.01	0.05
Nickel	5.29 – 17.7	20
Selenium	<0.39 – 0.522	10
Zinc	0.435 – 8.14	8

All samples were below the relevant EQS with the exception of copper and zinc. These levels are well below the DWS for these determinands (2000ug copper and 3000ug zinc).

4.3.2 Extractable Petroleum Hydrocarbons (EPH)

Determinand	Range (ug/l)	EQS / DWS
EPH C10-C12	<10	10
EPH C12-C16	<10 – 33.2	10
EPH C16-C21	<10 – 63.9	10
EPH C21-C28	<10 – 112	10
EPH C28-C35	<10 – 107	10
EPH C35-C40	<10 – 55.5	10
EPH C10-C40	<46 – 351	10

EPH values exceed the standard of 10ug/l in BH01ES and BH03ES. These values may be associated with The fuel supply and fuel tanks in the MSU area. Although the values exceed the guideline levels it is noted that they are conservative and the values are not considered to represent significant contamination at the site.
In BH02 ES all samples are below the limit of detection for EPH.

4.3.1 Polycyclic Aromatic Hydrocarbons (PAH)

All samples were analysed for PAHs.

Determinand	Range (ug/l)	EQS / DWS
Acenaphthene	<0.015	10
Acenaphthylene	<0.011	1
Anthracene	<0.015	10
Benzo[a]anthracene	<0.017	0.1
Benzo[a]pyrene	<0.009	0.05
Benzo(b)fluoranthene	<0.023	0.3
Benzo[ghi]perylene	<0.016	0.1
Benzo(k)fluoranthene	<0.027	0.3
Chrysene	<0.013	1
Dibenzo[ah]anthracene	<0.016	0.01
Fluoranthene	<0.017	0.1
Fluorene	<0.014	10
Indeno[123-cd]pyrene	<0.014	0.1
Naphthalene	<0.1	2.4
Phenanthrene	<0.022	10
Pyrene	<0.015 – 0.0319	10

The majority of samples are below the limit of detection for PAHs, with the exception of pyrene. All samples were below the relevant GAC.

4.3.2 Volatile Organic Compounds (VOCs)

All samples were analysed for VOCs. The majority of samples were below the limit of detection with the exception of 1,2-Dichloroethane in BH01ES an BH03ES with a maximum value of 37000ug/l in BH01ES.

4.3.3 Semi-Volatile Organic Compounds (SVOCs)

All samples were analysed for SVOCs. Al samples were below the limits of detection.

4.3.4 pH

pH was analysed in all samples with values shown in the table below for each sample. pH values are within the normal groundwater range of pH that would be anticipated and within the UK DWS of >6 and <9.

Determinand	BH01ES	BH02ES	BH03ES
pH	7.95	7.86	7.56

JACOBS

5 Conclusions

The majority of samples were below the relevant assessment criteria. EPH in the groundwater samples from BH01ES and BH03ES were above the EQS guideline. The screening criteria was used in the absence of local criteria, however as the results are not significantly high and no evidence of contamination was noted on the borehole logs it is unlikely to represent significant contamination in the area. Workers in this area should be made aware and on alert for potential contamination whilst works are being carried out. Should different ground or groundwater conditions be encountered during works further assessment may be required.

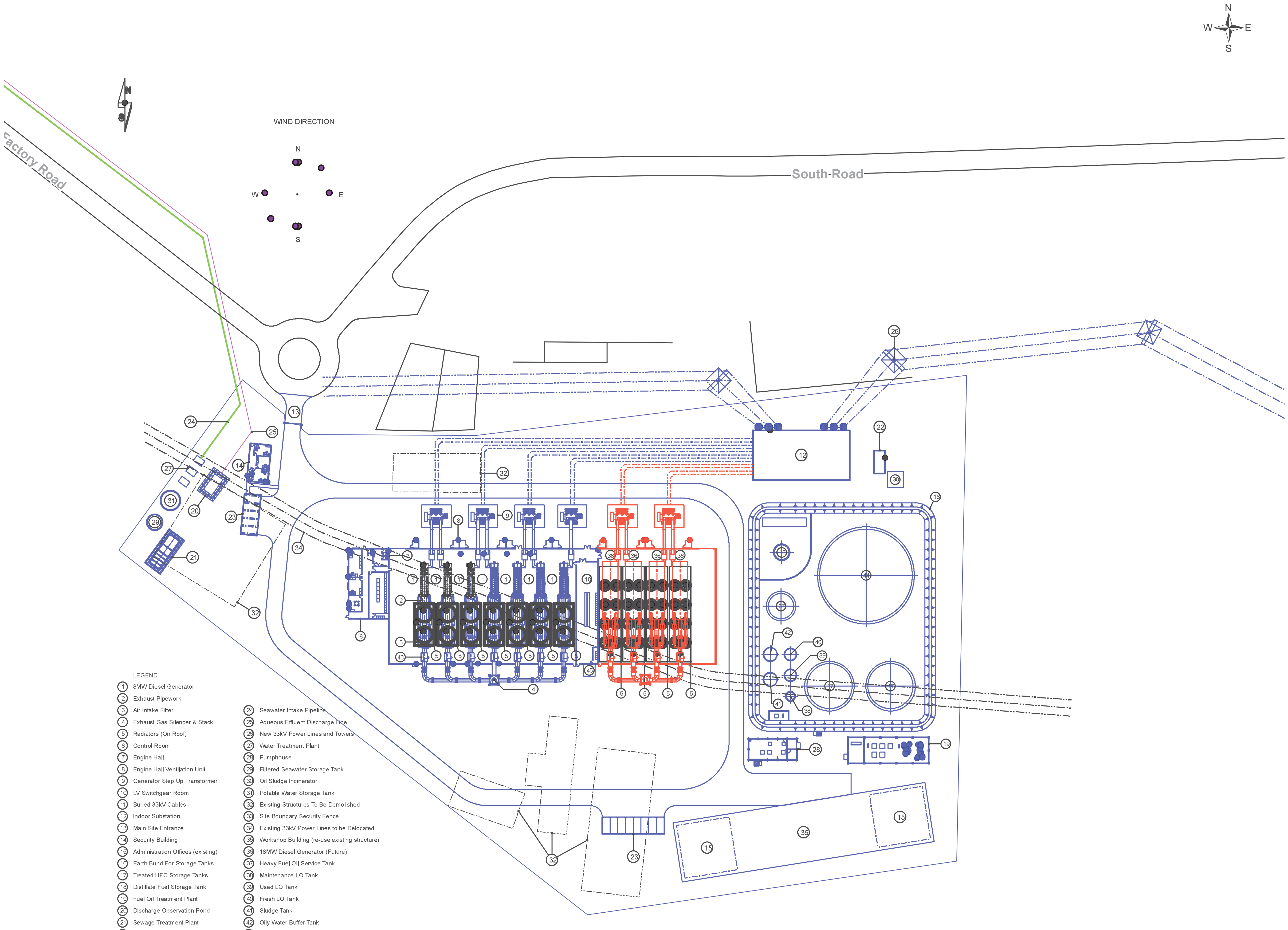
The information in this report regarding contamination should be made available to any contractors undertaking work at the site which may disturb the ground.

The presence of non-asbestos fibre at the site means that precautions may need to be taken during any works which could disturb the ground. The fibres were not found at the surface and are not widespread across the site.
Notwithstanding the results of any further testing, as a minimum, method statements for any ground works will need to be developed to minimise worker exposure to potentially contaminated soil, for example by segregating excavations from other areas and restricting access, favouring mechanical excavation techniques over hand digging in trenches where possible to minimise soil contact, implementing good site hygiene with nearby washing facilities available during excavation works and wearing PPE such as protective overalls, gloves, safety glasses and dust masks. If the material is likely to be dry during excavation works, it should be wet down to minimise dust generation. Mud on roads should be regularly removed with water used during any road sweeping operations to avoid dust being expelled from road sweeping equipment or generated by dry, manual sweeping of the road or by vehicles on the road.

A watching brief method of working should be in place during excavation works so that any suspected contaminated material is properly identified and segregated to avoid cross contamination or production of preferential pathways and sampling is undertaken to enable further assessment of risks.

Appendix A Figures

FIGURE 2.1



LEGEND

1. 8MW Diesel Generator
2. Exhaust Pipework
3. Air Intake Filter
4. Exhaust Gas Silencer & Stack
5. Radiators (On Roof)
6. Control Room
7. Engine Hall
8. Engine Hall Ventilation Unit
9. Generator Step Up Transformer
10. LV Switchgear Room
11. Buried 33kV Cables
12. Indoor Substation
13. Main Site Entrance
14. Security Building
15. Administration Offices (existing)
16. Earth Bund For Storage Tanks
17. Treated HFO Storage Tanks
18. Distillate Fuel Storage Tank
19. Fuel Oil Treatment Plant
20. Discharge Observation Pond
21. Sewage Treatment Plant
22. Emergency Generator
23. Car Parking With Sunshades
24. Seawater Intake Pipeline
25. Aqueous Effluent Discharge Line
26. New 33kV Power Lines and Towers
27. Water Treatment Plant
28. Pumphouse
29. Filtered Seawater Storage Tank
30. Oil Sludge Incinerator
31. Potable Water Storage Tank
32. Existing Structures To Be Demolished
33. Site Boundary Security Fence
34. Existing 33kV Power Lines to be Relocated
35. Workshop Building (re-use existing structure)
36. 18MW Diesel Generator (Future)
37. Heavy Fuel Oil Service Tank
38. Maintenance LO Tank
39. Used LO Tank
40. Fresh LO Tank
41. Sludge Tank
42. Oily Water Buffer Tank
43. Noise Emitting Point
44. Un-treated HFO Storage Tank (30mØ x 14m High, 9900m³)
45. Aux. Transformer

Imagery captured on 10/03/2013, WorldView-2,

Legend

Site Plan

Phase 1

Phase 2 and 3

Note : Phase 2 & 3 are indicative.
Exact layout to be defined at a future date

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	20/04/2015	Initial Issue	PW	DB	DB	DB

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Client

CEC Africa SIERRA LEONE

Project

Copperbelt Energy Corporation (CEC) Africa
Sierra Leone (SL) Limited ("CEC Africa")
HFO Thermal Power Plant

Drawing Title

Project Site Plan

Drawing Status: DRAFT FOR REVIEW

Scale @ A3	1:1,250	DO NOT SCALE
Jacobs No.	KU075500	
Client No.	N/A	

Drawing No.

Figure 2.1 Project Site Plan

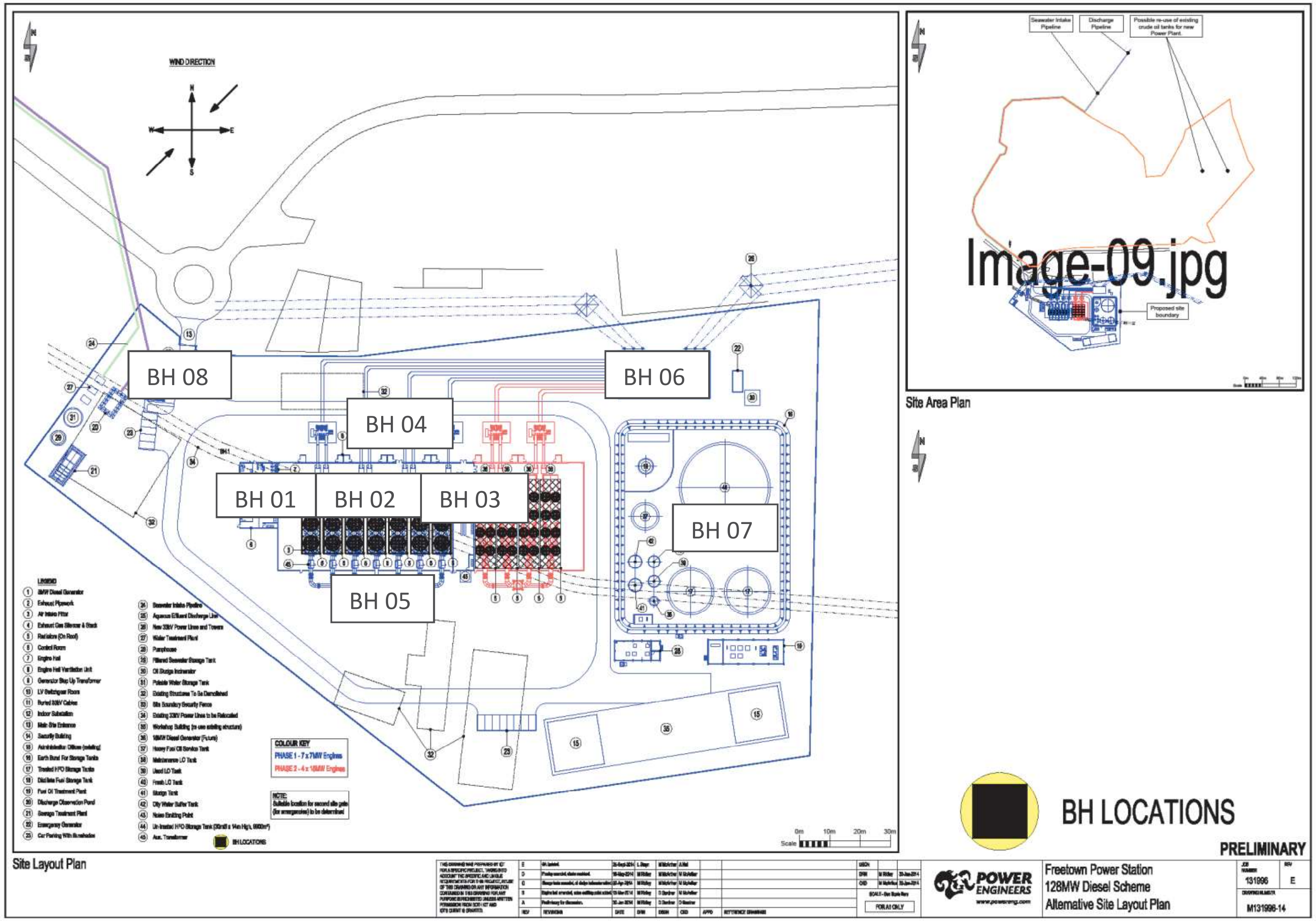
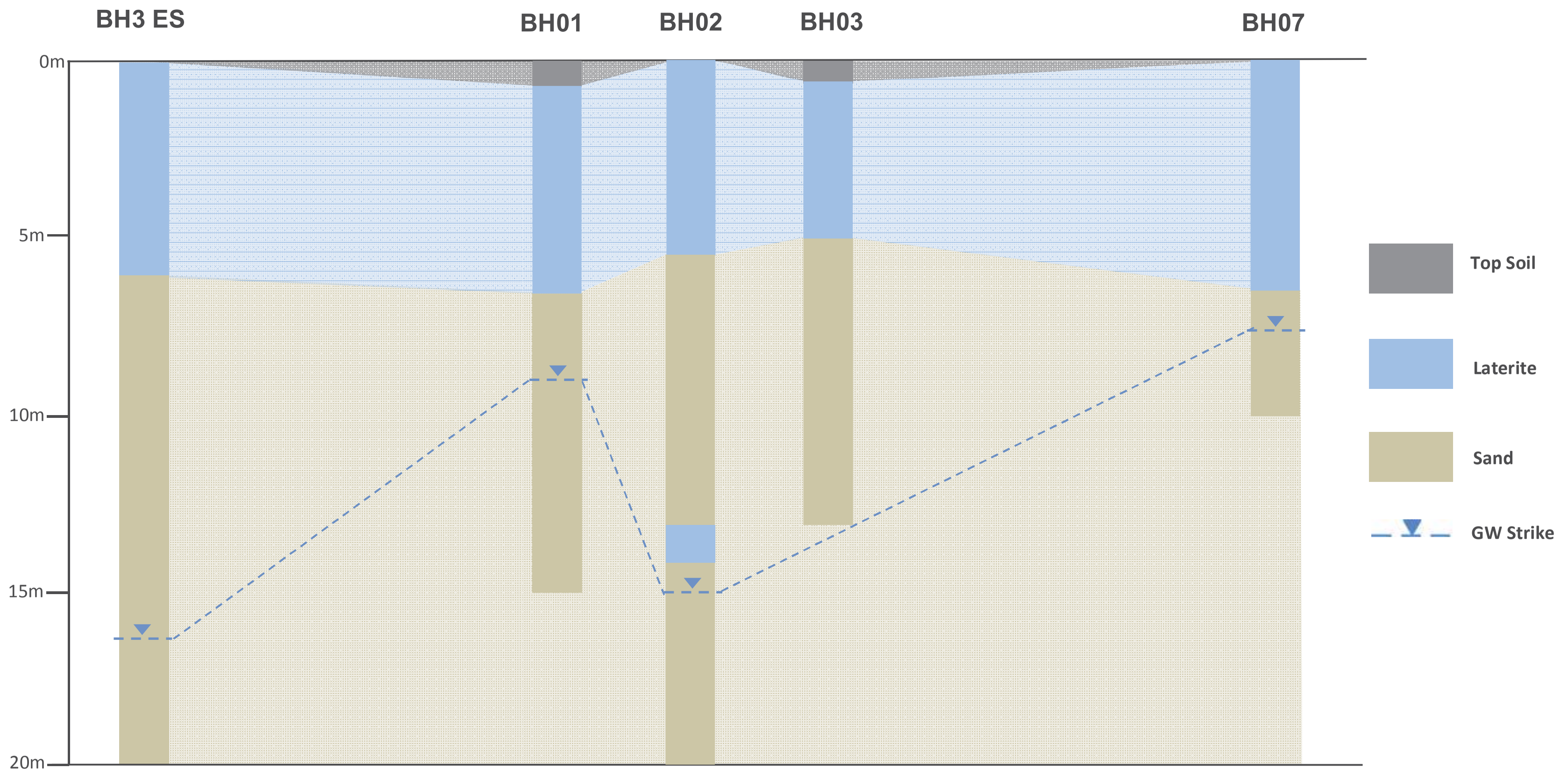


Figure:2: Location of boreholes



JACOBS	CECA Sierra Leone	Figure 3: Geological Cross-Section	Scale: Not to Scale Job Number: KU075500 Date: April 2015

Appendix B Laboratory Certificates of Analysis

ALcontrol Laboratories

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: mkt@alcontrol.com
Website: www.alcontrol.com

Jacobs Engineering UK Limited
1180 Eskdale Road
Winnersh
Wokingham
Berkshire
RG41 5TU

Attention: Katherine Hunt

CERTIFICATE OF ANALYSIS

Date:	06 March 2015
Customer:	H_JACOBS_JH_REA
Sample Delivery Group (SDG):	150213-41
Your Reference:	
Location:	HFO Project
Report No:	304415

We received 28 samples on Thursday February 12, 2015 and 28 of these samples were scheduled for analysis which was completed on Friday March 06, 2015. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

All chemical testing (unless subcontracted) is performed at ALcontrol Hawarden Laboratories.

Approved By:

Sonia McWhan
Operations Manager

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

ilac-MRA

UKAS TESTING
1291

SDG:	150213-41	Location:	HFO Project	Order Number:	
Job:	H_JACOBS_JH_REA-45	Customer:	Jacobs Engineering UK Limited	Report Number:	304415
Client Reference:		Attention:	Katherine Hunt	Superseded Report:	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
10828178	BH01		0.00 - 1.00	15/12/2014
10828481	BH01		0.00 - 1.00	11/11/2014
10828180	BH01		1.00 - 2.00	15/12/2014
10828175	BH01		14.50 - 14.90	30/01/2015
10828181	BH01		2.00 - 3.00	15/12/2014
10828482	BH01		2.50 - 3.50	11/11/2014
10828483	BH02		0.00 - 0.50	18/11/2014
10828182	BH02		0.00 - 1.00	19/12/2014
10828183	BH02		1.00 - 2.00	19/12/2014
10828184	BH02		2.00 - 3.00	19/12/2014
10828484	BH02		2.50 - 3.50	18/11/2014
10828176	BH02		8.00 - 8.20	30/01/2015
10828485	BH03		0.00 - 0.50	03/11/2014
10828186	BH03		0.50 - 1.00	09/12/2014
10828187	BH03		1.50 - 2.50	09/12/2014
10828177	BH03		15.70 - 16.10	28/01/2015
10828189	BH03		2.50 - 3.50	09/12/2014
10828487	BH03		2.50 - 3.50	01/12/2014
10828489	BH04		0.00 - 1.00	14/11/2014
10828490	BH04		2.00 - 3.00	14/11/2014
10828491	BH05		0.00 - 1.00	05/11/2014
10828492	BH05		2.50 - 3.50	05/11/2014
10828493	BH06		0.00 - 0.50	03/11/2014
10828495	BH06		2.00 - 3.00	03/11/2014
10828497	BH07		0.00 - 1.00	14/11/2014
10828499	BH07		2.00 - 3.00	14/11/2014
10828500	BH08		0.00 - 1.00	13/11/2014
10828494	BH08		2.00 - 3.00	13/11/2014

Only received samples which have had analysis scheduled will be shown on the following pages.

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

LIQUID

Results Legend

- X Test
- N No Determination Possible

	Lab Sample No(s)		10828175			10828176				10828177			
	Customer Sample Reference		BH01			BH02				BH03			
	AGS Reference												
	Depth (m)		14.50 - 14.90			8.00 - 8.20				15.70 - 16.10			
	Container		1l Glass bottle (ALE	1lplastic (ALE221)	Dissolved Metals Pr	1l Glass bottle (ALE	1lplastic (ALE221)	Dissolved Metals Pr	Vial (ALE297)	1l Glass bottle (ALE	1lplastic (ALE221)	Dissolved Metals Pr	Vial (ALE297)
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 3		X			X				X		
EPH (DRO) (C10-C40) Aqueous (W)	All	NDPs: 0 Tests: 3	X			X				X			
Hexavalent Chromium (w)	All	NDPs: 0 Tests: 3		X			X				X		
Mercury Dissolved	All	NDPs: 0 Tests: 3			X			X				X	
PAH Spec MS - Aqueous (W)	All	NDPs: 0 Tests: 3	X			X				X			
pH Value	All	NDPs: 0 Tests: 3		X			X				X		
SVOC MS (W) - Aqueous	All	NDPs: 0 Tests: 3	X			X				X			
Total Organic and Inorganic Carbon	All	NDPs: 0 Tests: 3	X			X				X			
VOC MS (W)	All	NDPs: 0 Tests: 3	X						X				X

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

SOLID

Results Legend

- **X** Test
- **N** No Determination Possible

Lab Sample No(s)		10828178	10828481	10828180	10828181	10828482	10828483	10828182	10828183	10828184	10828484	10828485	10828186	10828187	10828189	10828487	10828489	10828490	10828491	10828492	10828493	10828495	10828497	10828499	10828500	10828494
Customer Sample Reference		BH01	BH01	BH01	BH01	BH01	BH02	BH02	BH02	BH02	BH02	BH03	BH03	BH03	BH03	BH03	BH04	BH04	BH05	BH05	BH06	BH06	BH07	BH07	BH08	BH08
AGS Reference																										
Depth (m)		0.00 - 1.00	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	2.50 - 3.50	0.00 - 0.50	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	2.50 - 3.50	0.00 - 0.50	0.50 - 1.00	1.50 - 2.50	2.50 - 3.50	2.50 - 3.50	0.00 - 1.00	2.00 - 3.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50	2.00 - 3.00	0.00 - 1.00	2.00 - 3.00	0.00 - 1.00	2.00 - 3.00
Container		250g Amber Jar (AL	250g Amber Jar (AL	400g Tub (ALE214)	400g Tub (ALE214)	400g Tub (ALE214)	250g Amber Jar (AL	250g Amber Jar (AL	400g Tub (ALE214)	400g Tub (ALE214)	400g Tub (ALE214)	250g Amber Jar (AL	250g Amber Jar (AL	400g Tub (ALE214)	400g Tub (ALE214)	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)	250g Amber Jar (AL	400g Tub (ALE214)
Asbestos ID in Solid Samples	All	NDPs: 1 Tests: 24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N	X	X	X	X	X	X	X	X
EPH by FID	All	NDPs: 1 Tests: 25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N X	X	X	X	X	X	X	X	X
Hexavalent Chromium (s)	All	NDPs: 1 Tests: 24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N	X	X	X	X	X	X	X	X
Metals in solid samples by OES	All	NDPs: 1 Tests: 24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N	X	X	X	X	X	X	X	X
PAH by GCMS	All	NDPs: 1 Tests: 25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N X	X	X	X	X	X	X	X	X
pH	All	NDPs: 1 Tests: 24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N	X	X	X	X	X	X	X	X
Sample description	All	NDPs: 1 Tests: 25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N X	X	X	X	X	X	X	X	X
Semi Volatile Organic Compounds	All	NDPs: 0 Tests: 8	X						X					X				X			X	X		X			X
Total Organic Carbon	All	NDPs: 1 Tests: 24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	N	X	X	X	X	X	X	X	X
VOC MS (S)	All	NDPs: 0 Tests: 8	X						X					X				X			X	X		X			X

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Sample Descriptions

Grain Sizes

very fine	<0.063mm	fine	0.063mm - 0.1mm	medium	0.1mm - 2mm	coarse	2mm - 10mm	very coarse	>10mm

Lab Sample No(s)	Customer Sample Ref.	Depth (m)	Colour	Description	Grain size	Inclusions	Inclusions 2
10828178	BH01	0.00 - 1.00	Red	Sandy Loam	0.1 - 2 mm	Stones	None
10828180	BH01	1.00 - 2.00	Red	Gravel	2 - 10 mm	Stones	None
10828181	BH01	2.00 - 3.00	Red	Gravel	2 - 10 mm	Stones	None
10828481	BH01	0.00 - 1.00	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	None
10828482	BH01	2.50 - 3.50	Dark Brown	Sand	0.1 - 2 mm	Stones	Vegetation
10828182	BH02	0.00 - 1.00	Red	Gravel	2 - 10 mm	Stones	Paper
10828183	BH02	1.00 - 2.00	Orange	Gravel	2 - 10 mm	Stones	None
10828184	BH02	2.00 - 3.00	Dark Brown	Gravel	2 - 10 mm	Stones	None
10828483	BH02	0.00 - 0.50	Dark Brown	Sand	0.1 - 2 mm	Stones	None
10828484	BH02	2.50 - 3.50	Dark Brown	Sandy Loam	0.1 - 2 mm	Vegetation	Stones
10828186	BH03	0.50 - 1.00	Dark Brown	Sandy Loam	0.1 - 2 mm	Stones	Vegetation
10828187	BH03	1.50 - 2.50	Red	Gravel	2 - 10 mm	Stones	Vegetation
10828189	BH03	2.50 - 3.50	Dark Brown	Gravel	2 - 10 mm	Stones	Vegetation
10828485	BH03	0.00 - 0.50	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	Vegetation
10828487	BH03	2.50 - 3.50	Dark Brown	Sand	0.1 - 2 mm	Vegetation	Stones
10828489	BH04	0.00 - 1.00	Dark Brown	Sandy Loam	0.1 - 2 mm	Stones	Vegetation
10828490	BH04	2.00 - 3.00	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	None
10828491	BH05	0.00 - 1.00	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	None
10828492	BH05	2.50 - 3.50	Dark Brown	Sand	0.1 - 2 mm	Vegetation	Stones
10828493	BH06	0.00 - 0.50	Dark Brown	Sandy Loam	0.1 - 2 mm	Stones	Vegetation
10828495	BH06	2.00 - 3.00	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	Stones	None
10828497	BH07	0.00 - 1.00	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	None
10828499	BH07	2.00 - 3.00	Dark Brown	Sandy Clay Loam	0.1 - 2 mm	Stones	None
10828494	BH08	2.00 - 3.00	Dark Brown	Loamy Sand	0.1 - 2 mm	Vegetation	Stones
10828500	BH08	0.00 - 1.00	Dark Brown	Loamy Sand	0.1 - 2 mm	Stones	Vegetation

These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally ocurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.

Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

CERTIFICATE OF ANALYSIS

SDG: 150213-41
Job: H_JACOBS_JH_REA-45
Client Reference:
Location: HFO Project
Customer: Jacobs Engineering UK Limited
Attention: Katherine Hunt
Order Number:
Report Number: 304415
Superseded Report:

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R			BH01	BH01	BH01	BH01	BH01	BH01
Depth (m)			0.00 - 1.00	0.00 - 1.00	1.00 - 2.00	14.50 - 14.90	2.00 - 3.00	2.50 - 3.50
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Water(GW/SW)	Soil/Solid	Soil/Solid
Date Sampled			15/12/2014	11/11/2014	15/12/2014	30/01/2015	15/12/2014	11/11/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828178	10828481	10828180	10828175	10828181	10828482
AGS Reference								
Component	**LOD/Units**	**Method**						
Organic Carbon, Total	<3 mg/l	TM090				<3 @ #		
Arsenic (diss.filt)	<0.12 µg/l	TM152				0.416 #		
Cadmium (diss.filt)	<0.1 µg/l	TM152				<0.1 #		
Chromium (diss.filt)	<0.22 µg/l	TM152				2.27 #		
Copper (diss.filt)	<0.85 µg/l	TM152				<0.85 #		
Lead (diss.filt)	<0.02 µg/l	TM152				<0.02 #		
Nickel (diss.filt)	<0.15 µg/l	TM152				17.7 #		
Selenium (diss.filt)	<0.39 µg/l	TM152				<0.39 #		
Zinc (diss.filt)	<0.41 µg/l	TM152				0.801 #		
EPH Range >C10 - C40 (aq)	<46 µg/l	TM172				175 @ #		
EPH Band >C10-C12 (aq)	<10 µg/l	TM172				<10 @		
EPH Band >C12-C16 (aq)	<10 µg/l	TM172				33.2 @		
EPH Band >C16-C21 (aq)	<10 µg/l	TM172				43.2 @		
EPH Band >C21-C28 (aq)	<10 µg/l	TM172				<10 @		
EPH Band >C35-C40 (aq)	<10 µg/l	TM172				28.4 @		
EPH Band >C28-C35 (aq)	<10 µg/l	TM172				70.2 @		
Mercury (diss.filt)	<0.01 µg/l	TM183				<0.01 5 #		
Chromium, Hexavalent	<0.03 mg/l	TM241				<0.03 @ #		
pH	<1 pH Units	TM256				7.95 @ #		
Moisture Content Ratio (% of as received sample)	%	PM024	8.2	8.4	11		11	15
EPH Surrogate % recovery**	%	TM061	134 M	98 M	129 #		131 #	132 M
EPH Band >C10-C12	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C12-C16	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C16-C21	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C21-C28	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C28-C35	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C35-C40	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Range >C10 - C40	<35 mg/kg	TM061	65.6 @ M	<35 @ M	47 @ #		48.3 @ #	<35 @ M
Organic Carbon, Total	<0.2 %	TM132	<0.2 @ M	0.253 @ M	<0.2 @ #		<0.2 @ #	<0.2 @ M
pH	1 pH Units	TM133	6.17 @ M	8.1 @ M	6.11 @ #		5.89 @ #	6.92 @ M
Chromium, Hexavalent	<0.6 mg/kg	TM151	<0.6 @ #	<1.2 @ #	<0.6 @ #		<0.6 @ #	<0.6 @ #
Arsenic	<0.6 mg/kg	TM181	18.7 M	<0.6 M	9.39 #		<6 #	<6 M

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH01	BH01	BH01	BH01	BH01	BH01
		Depth (m)	0.00 - 1.00	0.00 - 1.00	1.00 - 2.00	14.50 - 14.90	2.00 - 3.00	2.50 - 3.50
		Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Water(GW/SW)	Soil/Solid	Soil/Solid
		Date Sampled	15/12/2014	11/11/2014	15/12/2014	30/01/2015	15/12/2014	11/11/2014
		Sampled Time	.	.	.	.	.	.
		Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
		SDG Ref	150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
		Lab Sample No.(s)	10828178	10828481	10828180	10828175	10828181	10828482
		AGS Reference						
Cadmium	<0.02 mg/kg	TM181	2.32 M	<0.02 M	2.18 #		1.58 #	1.94 M
Chromium	<0.9 mg/kg	TM181	1510 M	<0.9 M	1140 #		824 #	580 M
Copper	<1.4 mg/kg	TM181	52.5 M	<1.4 M	60.3 #		38.6 #	82.2 M
Lead	<0.7 mg/kg	TM181	19.9 M	<0.7 M	14.2 #		17 #	13.3 M
Mercury	<0.14 mg/kg	TM181	<0.14 @ M	<0.14 @ M	<0.14 @ #		<0.14 @ #	<0.14 @ M
Nickel	<0.2 mg/kg	TM181	44.5 M	<0.2 M	40.4 #		26.7 #	40.1 M
Selenium	<1 mg/kg	TM181	<10 #	<1 #	<10 #		<10 #	<10 #
Zinc	<1.9 mg/kg	TM181	45 M	<1.9 M	38.5 #		22.6 #	46.8 M

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R			BH02	BH02	BH02	BH02	BH02	BH02
Depth (m)			0.00 - 0.50	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	2.50 - 3.50	8.00 - 8.20
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Water(GW/SW)
Date Sampled			18/11/2014	19/12/2014	19/12/2014	19/12/2014	18/11/2014	30/01/2015
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828483	10828182	10828183	10828184	10828484	10828176
AGS Reference								
Component	**LOD/Units**	**Method**						
Organic Carbon, Total	<3 mg/l	TM090						3.01 @ #
Arsenic (diss.filt)	<0.12 µg/l	TM152						0.707 #
Cadmium (diss.filt)	<0.1 µg/l	TM152						<0.1 #
Chromium (diss.filt)	<0.22 µg/l	TM152						1.77 #
Copper (diss.filt)	<0.85 µg/l	TM152						3.48 #
Lead (diss.filt)	<0.02 µg/l	TM152						0.428 #
Nickel (diss.filt)	<0.15 µg/l	TM152						5.29 #
Selenium (diss.filt)	<0.39 µg/l	TM152						0.492 #
Zinc (diss.filt)	<0.41 µg/l	TM152						0.435 #
EPH Range >C10 - C40 (aq)	<46 µg/l	TM172						<46 @ #
EPH Band >C10-C12 (aq)	<10 µg/l	TM172						<10 @
EPH Band >C12-C16 (aq)	<10 µg/l	TM172						<10 @
EPH Band >C16-C21 (aq)	<10 µg/l	TM172						<10 @
EPH Band >C21-C28 (aq)	<10 µg/l	TM172						<10 @
EPH Band >C35-C40 (aq)	<10 µg/l	TM172						<10 @
EPH Band >C28-C35 (aq)	<10 µg/l	TM172						<10 @
Mercury (diss.filt)	<0.01 µg/l	TM183						<0.01 5 #
Chromium, Hexavalent	<0.03 mg/l	TM241						<0.03 @ #
pH	<1 pH Units	TM256						7.86 @ #
Moisture Content Ratio (% of as received sample)	%	PM024	5.9	3.4	5.5	4.6	9	
EPH Surrogate % recovery**	%	TM061	124 M	105 #	99 #	114 #	120 M	
EPH Band >C10-C12	<35 mg/kg	TM061	<35	<35	<35	<35	<35	
EPH Band >C12-C16	<35 mg/kg	TM061	<35	<35	<35	<35	<35	
EPH Band >C16-C21	<35 mg/kg	TM061	<35	<35	<35	<35	<35	
EPH Band >C21-C28	<35 mg/kg	TM061	<35	70.4	<35	<35	<35	
EPH Band >C28-C35	<35 mg/kg	TM061	<35	38.7	<35	<35	<35	
EPH Band >C35-C40	<35 mg/kg	TM061	<35	<35	<35	<35	<35	
EPH Range >C10 - C40	<35 mg/kg	TM061	<35 @ M	159 @ #	<35 @ #	<35 @ #	<35 @ M	
Organic Carbon, Total	<0.2 %	TM132	<0.2 @ M	0.346 @ #	<0.2 @ #	<0.2 @ #	<0.2 @ M	
pH	1 pH Units	TM133	7.52 @ M	6.87 @ #	5.74 @ #	6.31 @ #	5.33 @ M	
Chromium, Hexavalent	<0.6 mg/kg	TM151	<0.6 @ #	<0.6 @ #	<0.6 @ #	<0.6 @ #	0.887 @ #	
Arsenic	<0.6 mg/kg	TM181	13.2 M	18.8 #	9.1 #	14.1 #	<6 M	

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R			BH02	BH02	BH02	BH02	BH02	BH02
Depth (m)			0.00 - 0.50	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	2.50 - 3.50	8.00 - 8.20
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Water(GW/SW)
Date Sampled			18/11/2014	19/12/2014	19/12/2014	19/12/2014	18/11/2014	30/01/2015
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828483	10828182	10828183	10828184	10828484	10828176
AGS Reference								
Component	**LOD/Units**	**Method**						
Cadmium	<0.02 mg/kg	TM181	2.57 M	2.39 #	1.72 #	2.09 #	2.36 M	
Chromium	<0.9 mg/kg	TM181	1200 M	1890 #	4700 #	3040 #	1760 M	
Copper	<1.4 mg/kg	TM181	51.1 M	37.1 #	47.9 #	42.9 #	52.3 M	
Lead	<0.7 mg/kg	TM181	13.8 M	16.7 #	<7 #	12.2 #	13.5 M	
Mercury	<0.14 mg/kg	TM181	<0.14 @ M	<1.4 @ #	<0.14 @ #	<1.4 @ #	<0.14 @ M	
Nickel	<0.2 mg/kg	TM181	36.3 M	47.5 #	46.8 #	54.5 #	50.9 M	
Selenium	<1 mg/kg	TM181	<10 #	<10 #	<10 #	<10 #	<10 #	
Zinc	<1.9 mg/kg	TM181	36 M	51.5 #	53 #	50.8 #	36.8 M	

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Validated

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R			BH03	BH03	BH03	BH03	BH03	BH03
Depth (m)			0.00 - 0.50	0.50 - 1.00	1.50 - 2.50	15.70 - 16.10	2.50 - 3.50	2.50 - 3.50
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Water(GW/SW)	Soil/Solid	Soil/Solid
Date Sampled			03/11/2014	09/12/2014	09/12/2014	28/01/2015	09/12/2014	01/12/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828485	10828186	10828187	10828177	10828189	10828487
AGS Reference								
Component	**LOD/Units**	**Method**						
Organic Carbon, Total	<3 mg/l	TM090				4.99 @ #		
Arsenic (diss.filt)	<0.12 µg/l	TM152				0.498 #		
Cadmium (diss.filt)	<0.1 µg/l	TM152				<0.1 #		
Chromium (diss.filt)	<0.22 µg/l	TM152				1.21 #		
Copper (diss.filt)	<0.85 µg/l	TM152				4.83 #		
Lead (diss.filt)	<0.02 µg/l	TM152				0.347 #		
Nickel (diss.filt)	<0.15 µg/l	TM152				5.72 #		
Selenium (diss.filt)	<0.39 µg/l	TM152				0.522 #		
Zinc (diss.filt)	<0.41 µg/l	TM152				8.14 #		
EPH Range >C10 - C40 (aq)	<46 µg/l	TM172				351 @ #		
EPH Band >C10-C12 (aq)	<10 µg/l	TM172				<10 @		
EPH Band >C12-C16 (aq)	<10 µg/l	TM172				12.7 @		
EPH Band >C16-C21 (aq)	<10 µg/l	TM172				63.9 @		
EPH Band >C21-C28 (aq)	<10 µg/l	TM172				112 @		
EPH Band >C35-C40 (aq)	<10 µg/l	TM172				55.5 @		
EPH Band >C28-C35 (aq)	<10 µg/l	TM172				107 @		
Mercury (diss.filt)	<0.01 µg/l	TM183				<0.01 5 #		
Chromium, Hexavalent	<0.03 mg/l	TM241				<0.03 @ #		
pH	<1 pH Units	TM256				7.56 @ #		
Moisture Content Ratio (% of as received sample)	%	PM024	8.9	5	7.6		8.1	12
EPH Surrogate % recovery**	%	TM061	114 M	107 M	113 #		93 #	126 M
EPH Band >C10-C12	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C12-C16	<35 mg/kg	TM061	<35	<35	<35		<35	<35
EPH Band >C16-C21	<35 mg/kg	TM061	<35	<35	<35		37.5	<35
EPH Band >C21-C28	<35 mg/kg	TM061	<35	47.4	<35		253	<35
EPH Band >C28-C35	<35 mg/kg	TM061	<35	52.2	<35		385	<35
EPH Band >C35-C40	<35 mg/kg	TM061	<35	<35	<35		185	<35
EPH Range >C10 - C40	<35 mg/kg	TM061	<35 @ M	141 @ M	45.6 @ #		864 @ #	<35 @ M
Organic Carbon, Total	<0.2 %	TM132	0.247 @ M	0.357 @ M	<0.2 @ #		0.236 @ #	<0.2 @ M
pH	1 pH Units	TM133	7.66 @ M	8.13 @ M	6.67 @ #		8.2 @ #	7.14 @ M
Chromium, Hexavalent	<0.6 mg/kg	TM151	<0.6 @ #	<0.6 @ #	<0.6 @ #		<0.6 @ #	<0.6 @ #
Arsenic	<0.6 mg/kg	TM181	15.2 M	9.74 M	15.8 #		9.79 #	6.57 M

15:38:43 06/03/2015

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH03	BH03	BH03	BH03	BH03	BH03
Customer Sample R			BH03	BH03	BH03	BH03	BH03	BH03
Depth (m)			0.00 - 0.50	0.50 - 1.00	1.50 - 2.50	15.70 - 16.10	2.50 - 3.50	2.50 - 3.50
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Water(GW/SW)	Soil/Solid	Soil/Solid
Date Sampled			03/11/2014	09/12/2014	09/12/2014	28/01/2015	09/12/2014	01/12/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828485	10828186	10828187	10828177	10828189	10828487
AGS Reference								
Cadmium	<0.02 mg/kg	TM181	2.24 M	1.75 M	2.22 #		2.44 #	1.8 M
Chromium	<0.9 mg/kg	TM181	1300 M	1460 M	1640 #		1260 #	1260 M
Copper	<1.4 mg/kg	TM181	65.1 M	34.6 M	51.3 #		56.1 #	75.9 M
Lead	<0.7 mg/kg	TM181	40.8 M	48.5 M	13.4 #		10.5 #	12.2 M
Mercury	<0.14 mg/kg	TM181	<1.4 @ M	<1.4 @ M	<1.4 @ #		<0.14 @ #	<0.14 @ M
Nickel	<0.2 mg/kg	TM181	42.1 M	64.8 M	45.3 #		37.2 #	30.1 M
Selenium	<1 mg/kg	TM181	<10 #	<10 #	<10 #		<10 #	<10 #
Zinc	<1.9 mg/kg	TM181	72.7 M	83.8 M	43.5 #		34.7 #	28.3 M

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH04	BH04	BH05	BH05	BH06	BH06
Customer Sample R			BH04	BH04	BH05	BH05	BH06	BH06
Depth (m)			0.00 - 1.00	2.00 - 3.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50	2.00 - 3.00
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled			14/11/2014	14/11/2014	05/11/2014	05/11/2014	03/11/2014	03/11/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828489	10828490	10828491	10828492	10828493	10828495
AGS Reference								
Moisture Content Ratio (% of as received sample)	%	PM024	12	4.5	9.6	8.9	20	11
EPH Surrogate % recovery**	%	TM061	105 M	131 M	107 M	123 M	121 M	116 M
EPH Band >C10-C12	<35 mg/kg	TM061	<35	<35	<35	<35	<35	<35
EPH Band >C12-C16	<35 mg/kg	TM061	<35	<35	<35	<35	<35	<35
EPH Band >C16-C21	<35 mg/kg	TM061	<35	<35	<35	<35	<35	<35
EPH Band >C21-C28	<35 mg/kg	TM061	212	<35	<35	<35	<35	<35
EPH Band >C28-C35	<35 mg/kg	TM061	541	<35	<35	<35	36.3	<35
EPH Band >C35-C40	<35 mg/kg	TM061	460	<35	<35	<35	<35	<35
EPH Range >C10 - C40	<35 mg/kg	TM061	1250 @ M	<35 @ M	40.4 @ M	<35 M	86.9 @ M	<35 @ M
Organic Carbon, Total	<0.2 %	TM132	1.86 @ M		0.311 @ M	<0.2 M	2.5 @ M	<0.2 @ M
pH	1 pH Units	TM133	7.9 @ M		7.75 @ M	6.79 M	7.89 @ M	7.38 @ M
Chromium, Hexavalent	<0.6 mg/kg	TM151	<0.6 @ #		<1.2 @ #	<0.6 #	<1.2 @ #	<0.6 @ #
Arsenic	<0.6 mg/kg	TM181	<6 M		7.85 M	11.2 M	<6 M	8.19 M
Cadmium	<0.02 mg/kg	TM181	1.51 M		1.66 M	2.16 M	1.47 M	1.81 M
Chromium	<0.9 mg/kg	TM181	470 M		1340 M	3360 M	567 M	1150 M
Copper	<1.4 mg/kg	TM181	91.9 M		53.9 M	65 M	<14 M	43.4 M
Lead	<0.7 mg/kg	TM181	120 M		19.3 M	12.1 M	32.3 M	16 M
Mercury	<0.14 mg/kg	TM181	<0.14 @ M		<1.4 @ M	<0.14 M	<0.14 @ M	<1.4 @ M
Nickel	<0.2 mg/kg	TM181	119 M		37.7 M	54.6 M	36.8 M	23.7 M
Selenium	<1 mg/kg	TM181	<10 #		<10 #	<10 #	<10 #	<10 #
Zinc	<1.9 mg/kg	TM181	318 M		66.8 M	45.6 M	33.9 M	21.8 M

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH07	BH07	BH08	BH08		
		Customer Sample R	BH07	BH07	BH08	BH08		
		Depth (m)	0.00 - 1.00	2.00 - 3.00	0.00 - 1.00	2.00 - 3.00		
		Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid		
		Date Sampled	14/11/2014	14/11/2014	13/11/2014	13/11/2014		
		Sampled Time	.	.	.	.		
		Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015		
		SDG Ref	150213-41	150213-41	150213-41	150213-41		
		Lab Sample No.(s)	10828497	10828499	10828500	10828494		
		AGS Reference						
Moisture Content Ratio (% of as received sample)	%	PM024	4.4	10	6.3	8.9		
EPH Surrogate % recovery**	%	TM061	116 M	112 M	118 M	120 M		
EPH Band >C10-C12	<35 mg/kg	TM061	<35	<35	<35	<35		
EPH Band >C12-C16	<35 mg/kg	TM061	<35	<35	<35	<35		
EPH Band >C16-C21	<35 mg/kg	TM061	<35	<35	<35	<35		
EPH Band >C21-C28	<35 mg/kg	TM061	<35	<35	<35	<35		
EPH Band >C28-C35	<35 mg/kg	TM061	<35	<35	<35	<35		
EPH Band >C35-C40	<35 mg/kg	TM061	<35	<35	<35	<35		
EPH Range >C10 - C40	<35 mg/kg	TM061	<35 @ M	46.2 @ M	<35 @ M	<35 @ M		
Organic Carbon, Total	<0.2 %	TM132	<0.2 @ M	<0.2 @ M	<0.2 @ M	<0.2 @ M		
pH	1 pH Units	TM133	7.14 @ M	5.76 @ M	6.43 @ M	6.45 @ M		
Chromium, Hexavalent	<0.6 mg/kg	TM151	<0.6 @ #	<0.6 @ #	<0.6 @ #	<0.6 @ #		
Arsenic	<0.6 mg/kg	TM181	13.4 M	12.8 M	10.2 M	16.5 M		
Cadmium	<0.02 mg/kg	TM181	2.08 M	1.99 M	2.18 M	2.61 M		
Chromium	<0.9 mg/kg	TM181	1130 M	1000 M	2240 M	1240 M		
Copper	<1.4 mg/kg	TM181	62.2 M	79 M	22.4 M	51 M		
Lead	<0.7 mg/kg	TM181	13.8 M	15.5 M	11.2 M	14.8 M		
Mercury	<0.14 mg/kg	TM181	<1.4 @ M	<1.4 @ M	<1.4 @ M	<0.14 @ M		
Nickel	<0.2 mg/kg	TM181	52.1 M	27.4 M	52.6 M	31.5 M		
Selenium	<1 mg/kg	TM181	<10 #	<10 #	<10 #	<10 #		
Zinc	<1.9 mg/kg	TM181	66.7 M	38.2 M	43.5 M	27.6 M		

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CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

		Customer Sample R	BH01	BH01	BH01	BH01	BH01	BH02
		Depth (m)	0.00 - 1.00	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	2.50 - 3.50	0.00 - 0.50
		Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
		Date Sampled	15/12/2014	11/11/2014	15/12/2014	15/12/2014	11/11/2014	18/11/2014
		Sampled Time	.	.	.	.	.	.
		Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
		SDG Ref	150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
		Lab Sample No.(s)	10828178	10828481	10828180	10828181	10828482	10828483
		AGS Reference						
Component	**LOD/Units**	**Method**						
Naphthalene-d8 % recovery**	%	TM218	106	101	93.5	107	117	101
Acenaphthene-d10 % recovery**	%	TM218	104	105	91.2	106	117	106
Phenanthrene-d10 % recovery**	%	TM218	103	105	91.6	104	117	106
Chrysene-d12 % recovery**	%	TM218	94.8	107	84.7	96.5	96.7	109
Perylene-d12 % recovery**	%	TM218	96.6	103	79.7	97.6	86.8	106
Naphthalene	<9 µg/kg	TM218	<9 @ M	<9 @ M	<9 @ #	<9 @ #	<9 @ M	<9 @ M
Acenaphthylene	<12 µg/kg	TM218	<12 @ M	<12 @ M	<12 @ #	<12 @ #	<12 @ M	<12 @ M
Acenaphthene	<8 µg/kg	TM218	<8 @ M	<8 @ M	<8 @ #	<8 @ #	<8 @ M	<8 @ M
Fluorene	<10 µg/kg	TM218	<10 @ M	<10 @ M	<10 @ #	<10 @ #	<10 @ M	<10 @ M
Phenanthrene	<15 µg/kg	TM218	<15 @ M	<15 @ M	<15 @ #	<15 @ #	<15 @ M	<15 @ M
Anthracene	<16 µg/kg	TM218	<16 @ M	<16 @ M	<16 @ #	<16 @ #	<16 @ M	<16 @ M
Fluoranthene	<17 µg/kg	TM218	<17 @ M	<17 @ M	<17 @ #	<17 @ #	<17 @ M	<17 @ M
Pyrene	<15 µg/kg	TM218	<15 @ M	17.4 @ M	<15 @ #	<15 @ #	<15 @ M	<15 @ M
Benz(a)anthracene	<14 µg/kg	TM218	<14 @ M	<14 @ M	<14 @ #	<14 @ #	<14 @ M	<14 @ M
Chrysene	<10 µg/kg	TM218	<10 @ M	18.2 @ M	<10 @ #	<10 @ #	<10 @ M	<10 @ M
Benzo(b)fluoranthene	<15 µg/kg	TM218	<15 @ M	33.4 @ M	<15 @ #	<15 @ #	<15 @ M	<15 @ M
Benzo(k)fluoranthene	<14 µg/kg	TM218	<14 @ M	<14 @ M	<14 @ #	<14 @ #	<14 @ M	<14 @ M
Benzo(a)pyrene	<15 µg/kg	TM218	<15 @ M	21.8 @ M	<15 @ #	<15 @ #	<15 @ M	<15 @ M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218	<18 @ M	<18 @ M	<18 @ #	<18 @ #	<18 @ M	<18 @ M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218	<23 @ M	<23 @ M	<23 @ #	<23 @ #	<23 @ M	<23 @ M
Benzo(g,h,i)perylene	<24 µg/kg	TM218	<24 @ M	<24 @ M	<24 @ #	<24 @ #	<24 @ M	<24 @ M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218	<118	<118	<118	<118	<118	<118

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Validated

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH02	BH02	BH02	BH02	BH03	BH03
Customer Sample R			BH02	BH02	BH02	BH02	BH03	BH03
Depth (m)			0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	2.50 - 3.50	0.00 - 0.50	0.50 - 1.00
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled			19/12/2014	19/12/2014	19/12/2014	18/11/2014	03/11/2014	09/12/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828182	10828183	10828184	10828484	10828485	10828186
AGS Reference								
Naphthalene-d8 % recovery**	%	TM218	109	107	109	109	109	105
Acenaphthene-d10 % recovery**	%	TM218	106	104	107	112	111	103
Phenanthrene-d10 % recovery**	%	TM218	106	102	106	111	110	102
Chrysene-d12 % recovery**	%	TM218	99.3	89.9	98.5	93.1	90.9	95.2
Perylene-d12 % recovery**	%	TM218	102	86.6	100	91.7	85.1	97.7
Naphthalene	<9 µg/kg	TM218	<9 @ #	<9 @ #	<9 @ #	<9 @ M	<9 @ M	<9 @ M
Acenaphthylene	<12 µg/kg	TM218	<12 @ #	<12 @ #	<12 @ #	<12 @ M	<12 @ M	<12 @ M
Acenaphthene	<8 µg/kg	TM218	<8 @ #	<8 @ #	<8 @ #	<8 @ M	<8 @ M	<8 @ M
Fluorene	<10 µg/kg	TM218	<10 @ #	<10 @ #	<10 @ #	<10 @ M	<10 @ M	<10 @ M
Phenanthrene	<15 µg/kg	TM218	30.4 @ #	<15 @ #	<15 @ #	<15 @ M	<15 @ M	<15 @ M
Anthracene	<16 µg/kg	TM218	<16 @ #	<16 @ #	<16 @ #	<16 @ M	<16 @ M	<16 @ M
Fluoranthene	<17 µg/kg	TM218	<17 @ #	<17 @ #	<17 @ #	<17 @ M	<17 @ M	<17 @ M
Pyrene	<15 µg/kg	TM218	20.5 @ #	<15 @ #	<15 @ #	<15 @ M	<15 @ M	<15 @ M
Benz(a)anthracene	<14 µg/kg	TM218	<14 @ #	<14 @ #	<14 @ #	<14 @ M	<14 @ M	<14 @ M
Chrysene	<10 µg/kg	TM218	12.8 @ #	<10 @ #	<10 @ #	<10 @ M	<10 @ M	<10 @ M
Benzo(b)fluoranthene	<15 µg/kg	TM218	20.4 @ #	<15 @ #	<15 @ #	<15 @ M	<15 @ M	<15 @ M
Benzo(k)fluoranthene	<14 µg/kg	TM218	<14 @ #	<14 @ #	<14 @ #	<14 @ M	<14 @ M	<14 @ M
Benzo(a)pyrene	<15 µg/kg	TM218	<15 @ #	<15 @ #	<15 @ #	<15 @ M	<15 @ M	<15 @ M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218	<18 @ #	<18 @ #	<18 @ #	<18 @ M	<18 @ M	<18 @ M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218	<23 @ #	<23 @ #	<23 @ #	<23 @ M	<23 @ M	<23 @ M
Benzo(g,h,i)perylene	<24 µg/kg	TM218	<24 @ #	<24 @ #	<24 @ #	<24 @ M	<24 @ M	<24 @ M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218	<118	<118	<118	<118	<118	<118

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH03	BH03	BH03	BH04	BH04	BH05
Customer Sample R			BH03	BH03	BH03	BH04	BH04	BH05
Depth (m)			1.50 - 2.50	2.50 - 3.50	2.50 - 3.50	0.00 - 1.00	2.00 - 3.00	0.00 - 1.00
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled			09/12/2014	09/12/2014	01/12/2014	14/11/2014	14/11/2014	05/11/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828187	10828189	10828487	10828489	10828490	10828491
AGS Reference								
Naphthalene-d8 % recovery**	%	TM218	104	107	109	99.2	93.8	104
Acenaphthene-d10 % recovery**	%	TM218	101	104	111	105	93.1	111
Phenanthrene-d10 % recovery**	%	TM218	101	104	110	102	92.1	110
Chrysene-d12 % recovery**	%	TM218	92.9	99.1	89	100	88.4	116
Perylene-d12 % recovery**	%	TM218	95.7	105	80.9	91.4	89.5	114
Naphthalene	<9 µg/kg	TM218	<9 @ #	<9 @ #	<9 @ M	70.8 @ M	<9 @ M	<9 @ M
Acenaphthylene	<12 µg/kg	TM218	<12 @ #	<12 @ #	<12 @ M	<60 @ M	<12 @ M	13.8 @ M
Acenaphthene	<8 µg/kg	TM218	<8 @ #	<8 @ #	<8 @ M	<40 @ M	<8 @ M	<8 @ M
Fluorene	<10 µg/kg	TM218	<10 @ #	<10 @ #	<10 @ M	<50 @ M	<10 @ M	<10 @ M
Phenanthrene	<15 µg/kg	TM218	<15 @ #	<15 @ #	<15 @ M	215 @ M	<15 @ M	80.9 @ M
Anthracene	<16 µg/kg	TM218	<16 @ #	<16 @ #	<16 @ M	<80 @ M	<16 @ M	<16 @ M
Fluoranthene	<17 µg/kg	TM218	<17 @ #	<17 @ #	<17 @ M	458 @ M	<17 @ M	293 @ M
Pyrene	<15 µg/kg	TM218	<15 @ #	104 @ #	<15 @ M	448 @ M	<15 @ M	255 @ M
Benz(a)anthracene	<14 µg/kg	TM218	<14 @ #	53.9 @ #	<14 @ M	242 @ M	<14 @ M	237 @ M
Chrysene	<10 µg/kg	TM218	<10 @ #	31.7 @ #	<10 @ M	281 @ M	<10 @ M	222 @ M
Benzo(b)fluoranthene	<15 µg/kg	TM218	<15 @ #	42 @ #	<15 @ M	439 @ M	<15 @ M	369 @ M
Benzo(k)fluoranthene	<14 µg/kg	TM218	<14 @ #	<14 @ #	<14 @ M	176 @ M	<14 @ M	152 @ M
Benzo(a)pyrene	<15 µg/kg	TM218	<15 @ #	48.3 @ #	<15 @ M	269 @ M	<15 @ M	229 @ M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218	<18 @ #	<18 @ #	<18 @ M	231 @ M	<18 @ M	159 @ M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218	<23 @ #	<23 @ #	<23 @ M	<115 @ M	<23 @ M	59.7 @ M
Benzo(g,h,i)perylene	<24 µg/kg	TM218	<24 @ #	52.6 @ #	<24 @ M	389 @ M	<24 @ M	191 @ M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218	<118	332	<118	3220	<118	2260

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

		Customer Sample R	BH05	BH06	BH06	BH07	BH07	BH08
		Depth (m)	2.50 - 3.50	0.00 - 0.50	2.00 - 3.00	0.00 - 1.00	2.00 - 3.00	0.00 - 1.00
		Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
		Date Sampled	05/11/2014	03/11/2014	03/11/2014	14/11/2014	14/11/2014	13/11/2014
		Sampled Time	.	.	.	.	.	.
		Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
		SDG Ref	150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
		Lab Sample No.(s)	10828492	10828493	10828495	10828497	10828499	10828500
		AGS Reference						
Component	**LOD/Units**	**Method**						
Naphthalene-d8 % recovery**	%	TM218	109	114	99.3	102	100	107
Acenaphthene-d10 % recovery**	%	TM218	110	109	97.6	106	97.8	108
Phenanthrene-d10 % recovery**	%	TM218	109	112	96.6	105	97.4	107
Chrysene-d12 % recovery**	%	TM218	88.4	104	89.9	108	92	85.8
Perylene-d12 % recovery**	%	TM218	80.4	97.7	84.2	103	87.7	76.1
Naphthalene	<9 µg/kg	TM218	<9 M	<9 @ M	<9 @ M	<9 @ M	<9 @ M	<9 @ M
Acenaphthylene	<12 µg/kg	TM218	<12 M	<12 @ M	<12 @ M	<12 @ M	<12 @ M	<12 @ M
Acenaphthene	<8 µg/kg	TM218	<8 M	<8 @ M	<8 @ M	<8 @ M	<8 @ M	<8 @ M
Fluorene	<10 µg/kg	TM218	<10 M	<10 @ M	<10 @ M	<10 @ M	<10 @ M	<10 @ M
Phenanthrene	<15 µg/kg	TM218	<15 M	<15 @ M	<15 @ M	<15 @ M	<15 @ M	<15 @ M
Anthracene	<16 µg/kg	TM218	<16 M	<16 @ M	<16 @ M	<16 @ M	<16 @ M	<16 @ M
Fluoranthene	<17 µg/kg	TM218	<17 M	29.9 @ M	<17 @ M	<17 @ M	<17 @ M	<17 @ M
Pyrene	<15 µg/kg	TM218	<15 M	27.3 @ M	<15 @ M	<15 @ M	<15 @ M	<15 @ M
Benz(a)anthracene	<14 µg/kg	TM218	<14 M	<14 @ M	<14 @ M	<14 @ M	<14 @ M	<14 @ M
Chrysene	<10 µg/kg	TM218	<10 M	<10 @ M	<10 @ M	<10 @ M	<10 @ M	<10 @ M
Benzo(b)fluoranthene	<15 µg/kg	TM218	<15 M	<15 @ M	<15 @ M	<15 @ M	<15 @ M	<15 @ M
Benzo(k)fluoranthene	<14 µg/kg	TM218	<14 M	<14 @ M	<14 @ M	<14 @ M	<14 @ M	<14 @ M
Benzo(a)pyrene	<15 µg/kg	TM218	<15 M	<15 @ M	<15 @ M	<15 @ M	<15 @ M	<15 @ M
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218	<18 M	<18 @ M	<18 @ M	<18 @ M	<18 @ M	<18 @ M
Dibenzo(a,h)anthracene	<23 µg/kg	TM218	<23 M	<23 @ M	<23 @ M	<23 @ M	<23 @ M	<23 @ M
Benzo(g,h,i)perylene	<24 µg/kg	TM218	<24 M	<24 @ M	<24 @ M	<24 @ M	<24 @ M	<24 @ M
PAH, Total Detected USEPA 16	<118 µg/kg	TM218	<118	<118	<118	<118	<118	<118

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH by GCMS

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH08					
Customer Sample R			BH08					
Depth (m)			2.00 - 3.00					
Sample Type			Soil/Solid					
Date Sampled			13/11/2014					
Sampled Time			.					
Date Received			12/02/2015					
SDG Ref			150213-41					
Lab Sample No.(s)			10828494					
AGS Reference								
Naphthalene-d8 % recovery**	%	TM218	110					
Acenaphthene-d10 % recovery**	%	TM218	111					
Phenanthrene-d10 % recovery**	%	TM218	110					
Chrysene-d12 % recovery**	%	TM218	87.6					
Perylene-d12 % recovery**	%	TM218	76.1					
Naphthalene	<9 µg/kg	TM218	<9 @ M					
Acenaphthylene	<12 µg/kg	TM218	<12 @ M					
Acenaphthene	<8 µg/kg	TM218	<8 @ M					
Fluorene	<10 µg/kg	TM218	<10 @ M					
Phenanthrene	<15 µg/kg	TM218	<15 @ M					
Anthracene	<16 µg/kg	TM218	<16 @ M					
Fluoranthene	<17 µg/kg	TM218	<17 @ M					
Pyrene	<15 µg/kg	TM218	<15 @ M					
Benz(a)anthracene	<14 µg/kg	TM218	<14 @ M					
Chrysene	<10 µg/kg	TM218	<10 @ M					
Benzo(b)fluoranthene	<15 µg/kg	TM218	<15 @ M					
Benzo(k)fluoranthene	<14 µg/kg	TM218	<14 @ M					
Benzo(a)pyrene	<15 µg/kg	TM218	<15 @ M					
Indeno(1,2,3-cd)pyrene	<18 µg/kg	TM218	<18 @ M					
Dibenzo(a,h)anthracene	<23 µg/kg	TM218	<23 @ M					
Benzo(g,h,i)perylene	<24 µg/kg	TM218	<24 @ M					
PAH, Total Detected USEPA 16	<118 µg/kg	TM218	<118					

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH Spec MS - Aqueous (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH01	BH02	BH03			
Customer Sample R			BH01	BH02	BH03			
Depth (m)			14.50 - 14.90	8.00 - 8.20	15.70 - 16.10			
Sample Type			Water(GW/SW)	Water(GW/SW)	Water(GW/SW)			
Date Sampled			30/01/2015	30/01/2015	28/01/2015			
Sampled Time			.	.	.			
Date Received			12/02/2015	12/02/2015	12/02/2015			
SDG Ref			150213-41	150213-41	150213-41			
Lab Sample No.(s)			10828175	10828176	10828177			
AGS Reference								
Naphthalene (aq)	<0.1 µg/l	TM178	<0.1 @ #	<0.1 @ #	<0.1 @ #			
Acenaphthene (aq)	<0.015 µg/l	TM178	<0.015 @ #	<0.015 @ #	<0.015 @ #			
Acenaphthylene (aq)	<0.011 µg/l	TM178	<0.011 @ #	<0.011 @ #	<0.011 @ #			
Fluoranthene (aq)	<0.017 µg/l	TM178	<0.017 @ #	<0.017 @ #	<0.017 @ #			
Anthracene (aq)	<0.015 µg/l	TM178	<0.015 @ #	<0.015 @ #	<0.015 @ #			
Phenanthrene (aq)	<0.022 µg/l	TM178	<0.022 @ #	<0.022 @ #	<0.022 @ #			
Fluorene (aq)	<0.014 µg/l	TM178	<0.014 @ #	<0.014 @ #	<0.014 @ #			
Chrysene (aq)	<0.013 µg/l	TM178	<0.013 @ #	<0.013 @ #	<0.013 @ #			
Pyrene (aq)	<0.015 µg/l	TM178	<0.015 @ #	0.0319 @ #	<0.015 @ #			
Benzo(a)anthracene (aq)	<0.017 µg/l	TM178	<0.017 @ #	<0.017 @ #	<0.017 @ #			
Benzo(b)fluoranthene (aq)	<0.023 µg/l	TM178	<0.023 @ #	<0.023 @ #	<0.023 @ #			
Benzo(k)fluoranthene (aq)	<0.027 µg/l	TM178	<0.027 @ #	<0.027 @ #	<0.027 @ #			
Benzo(a)pyrene (aq)	<0.009 µg/l	TM178	<0.009 @ #	<0.009 @ #	<0.009 @ #			
Dibenzo(a,h)anthracene (aq)	<0.016 µg/l	TM178	<0.016 @ #	<0.016 @ #	<0.016 @ #			
Benzo(g,h,i)perylene (aq)	<0.016 µg/l	TM178	<0.016 @ #	<0.016 @ #	<0.016 @ #			
Indeno(1,2,3-cd)pyrene (aq)	<0.014 µg/l	TM178	<0.014 @ #	<0.014 @ #	<0.014 @ #			
PAH, Total Detected USEPA 16 (aq)	<0.344 µg/l	TM178	<0.344 @	<0.344 @	<0.344 @			

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Semi Volatile Organic Compounds

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R	BH01	BH02	BH03	BH04	BH05	BH06
Depth (m)	0.00 - 1.00	0.00 - 1.00	0.50 - 1.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50
Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled	15/12/2014	19/12/2014	09/12/2014	14/11/2014	05/11/2014	03/11/2014
Sampled Time	.	.	.	.	.	.
Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref	150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)	10828178	10828182	10828186	10828489	10828492	10828493
AGS Reference						

Component	LOD/Units	Method	BH01	BH02	BH03	BH04	BH05	BH06
Phenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Pentachlorophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
n-Nitroso-n-dipropylamine	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Nitrobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Isophorone	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Hexachloroethane	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Hexachlorocyclopentadiene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Hexachlorobutadiene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Hexachlorobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
n-Dioctyl phthalate	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Dimethyl phthalate	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Diethyl phthalate	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
n-Dibutyl phthalate	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Dibenzofuran	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Carbazole	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Butylbenzyl phthalate	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
bis(2-Ethylhexyl) phthalate	<100 µg/kg	TM157	<100	316	<100	231	<100	<100
bis(2-Chloroethoxy)methane	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
bis(2-Chloroethyl)ether	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Azobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Nitrophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Nitroaniline	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Methylphenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Chlorophenylphenylether	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Chloroaniline	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Chloro-3-methylphenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
4-Bromophenylphenylether	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
3-Nitroaniline	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2-Nitrophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2-Nitroaniline	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2-Methylphenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
1,2,4-Trichlorobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Semi Volatile Organic Compounds

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R			BH01	BH02	BH03	BH04	BH05	BH06
Depth (m)			0.00 - 1.00	0.00 - 1.00	0.50 - 1.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled			15/12/2014	19/12/2014	09/12/2014	14/11/2014	05/11/2014	03/11/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828178	10828182	10828186	10828489	10828492	10828493
AGS Reference								
Component	**LOD/Units**	**Method**						
2-Chlorophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2,6-Dinitrotoluene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2,4-Dinitrotoluene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2,4-Dimethylphenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2,4-Dichlorophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2,4,6-Trichlorophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2,4,5-Trichlorophenol	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
1,4-Dichlorobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
1,3-Dichlorobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
1,2-Dichlorobenzene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2-Chloronaphthalene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
2-Methylnaphthalene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100
Benzo(a)anthracene	<100 µg/kg	TM157	<100	<100	<100	184	<100	<100
Chrysene	<100 µg/kg	TM157	<100	<100	<100	218	<100	<100
Naphthalene	<100 µg/kg	TM157	<100	<100	<100	<100	<100	<100

Semi Volatile Organic Compounds

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH07	BH08				
Customer Sample R			BH07	BH08				
Depth (m)			0.00 - 1.00	2.00 - 3.00				
Sample Type			Soil/Solid	Soil/Solid				
Date Sampled			14/11/2014	13/11/2014				
Sampled Time			.	.				
Date Received			12/02/2015	12/02/2015				
SDG Ref			150213-41	150213-41				
Lab Sample No.(s)			10828497	10828494				
AGS Reference								
Phenol	<100 µg/kg	TM157	<100	<100				
Pentachlorophenol	<100 µg/kg	TM157	<100	<100				
n-Nitroso-n-dipropylamine	<100 µg/kg	TM157	<100	<100				
Nitrobenzene	<100 µg/kg	TM157	<100	<100				
Isophorone	<100 µg/kg	TM157	<100	<100				
Hexachloroethane	<100 µg/kg	TM157	<100	<100				
Hexachlorocyclopentadiene	<100 µg/kg	TM157	<100	<100				
Hexachlorobutadiene	<100 µg/kg	TM157	<100	<100				
Hexachlorobenzene	<100 µg/kg	TM157	<100	<100				
n-Dioctyl phthalate	<100 µg/kg	TM157	<100	<100				
Dimethyl phthalate	<100 µg/kg	TM157	<100	<100				
Diethyl phthalate	<100 µg/kg	TM157	<100	<100				
n-Dibutyl phthalate	<100 µg/kg	TM157	<100	<100				
Dibenzofuran	<100 µg/kg	TM157	<100	<100				
Carbazole	<100 µg/kg	TM157	<100	<100				
Butylbenzyl phthalate	<100 µg/kg	TM157	<100	<100				
bis(2-Ethylhexyl) phthalate	<100 µg/kg	TM157	<100	<100				
bis(2-Chloroethoxy)methane	<100 µg/kg	TM157	<100	<100				
bis(2-Chloroethyl)ether	<100 µg/kg	TM157	<100	<100				
Azobenzene	<100 µg/kg	TM157	<100	<100				
4-Nitrophenol	<100 µg/kg	TM157	<100	<100				
4-Nitroaniline	<100 µg/kg	TM157	<100	<100				
4-Methylphenol	<100 µg/kg	TM157	<100	<100				
4-Chlorophenylphenylether	<100 µg/kg	TM157	<100	<100				
4-Chloroaniline	<100 µg/kg	TM157	<100	<100				
4-Chloro-3-methylphenol	<100 µg/kg	TM157	<100	<100				
4-Bromophenylphenylether	<100 µg/kg	TM157	<100	<100				
3-Nitroaniline	<100 µg/kg	TM157	<100	<100				
2-Nitrophenol	<100 µg/kg	TM157	<100	<100				
2-Nitroaniline	<100 µg/kg	TM157	<100	<100				
2-Methylphenol	<100 µg/kg	TM157	<100	<100				
1,2,4-Trichlorobenzene	<100 µg/kg	TM157	<100	<100				

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Semi Volatile Organic Compounds

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH07	BH08				
		Depth (m)	0.00 - 1.00	2.00 - 3.00				
		Sample Type	Soil/Solid	Soil/Solid				
		Date Sampled	14/11/2014	13/11/2014				
		Sampled Time	.	.				
		Date Received	12/02/2015	12/02/2015				
		SDG Ref	150213-41	150213-41				
		Lab Sample No.(s)	10828497	10828494				
		AGS Reference						
2-Chlorophenol	<100 µg/kg	TM157	<100	<100				
2,6-Dinitrotoluene	<100 µg/kg	TM157	<100	<100				
2,4-Dinitrotoluene	<100 µg/kg	TM157	<100	<100				
2,4-Dimethylphenol	<100 µg/kg	TM157	<100	<100				
2,4-Dichlorophenol	<100 µg/kg	TM157	<100	<100				
2,4,6-Trichlorophenol	<100 µg/kg	TM157	<100	<100				
2,4,5-Trichlorophenol	<100 µg/kg	TM157	<100	<100				
1,4-Dichlorobenzene	<100 µg/kg	TM157	<100	<100				
1,3-Dichlorobenzene	<100 µg/kg	TM157	<100	<100				
1,2-Dichlorobenzene	<100 µg/kg	TM157	<100	<100				
2-Chloronaphthalene	<100 µg/kg	TM157	<100	<100				
2-Methylnaphthalene	<100 µg/kg	TM157	<100	<100				
Benzo(a)anthracene	<100 µg/kg	TM157	<100	<100				
Chrysene	<100 µg/kg	TM157	<100	<100				
Naphthalene	<100 µg/kg	TM157	<100	<100				

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

SVOC MS (W) - Aqueous

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R	BH01	BH02	BH03			
Depth (m)	14.50 - 14.90	8.00 - 8.20	15.70 - 16.10			
Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)			
Date Sampled	30/01/2015	30/01/2015	28/01/2015			
Sampled Time	.	.	.			
Date Received	12/02/2015	12/02/2015	12/02/2015			
SDG Ref	150213-41	150213-41	150213-41			
Lab Sample No.(s)	10828175	10828176	10828177			
AGS Reference						

Component	LOD/Units	Method	BH01	BH02	BH03			
1,2,4-Trichlorobenzene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
1,2-Dichlorobenzene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
1,3-Dichlorobenzene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
1,4-Dichlorobenzene (aq)	<1 µg/l	TM176	<1 @	<1 @	<1 @			
2,4,5-Trichlorophenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2,4,6-Trichlorophenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2,4-Dichlorophenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2,4-Dimethylphenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2,4-Dinitrotoluene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2,6-Dinitrotoluene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2-Chloronaphthalene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2-Chlorophenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2-Methylnaphthalene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2-Methylphenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2-Nitroaniline (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
2-Nitrophenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
3-Nitroaniline (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
4-Bromophenylphenylether (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
4-Chloro-3-methylphenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
4-Chloroaniline (aq)	<1 µg/l	TM176	<1	<1	<1			
4-Chlorophenylphenylether (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
4-Methylphenol (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
4-Nitroaniline (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
4-Nitrophenol (aq)	<1 µg/l	TM176	<1	<1	<1			
Azobenzene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
bis(2-Chloroethyl)ether (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
bis(2-Chloroethoxy)methane (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
bis(2-Ethylhexyl) phthalate (aq)	<2 µg/l	TM176	<2 @ #	<2 @ #	<2 @ #			
Butylbenzyl phthalate (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Carbazole (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Dibenzofuran (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
n-Dibutyl phthalate (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

SVOC MS (W) - Aqueous

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R	BH01	BH02	BH03			
Depth (m)	14.50 - 14.90	8.00 - 8.20	15.70 - 16.10			
Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)			
Date Sampled	30/01/2015	30/01/2015	28/01/2015			
Sampled Time	.	.	.			
Date Received	12/02/2015	12/02/2015	12/02/2015			
SDG Ref	150213-41	150213-41	150213-41			
Lab Sample No.(s)	10828175	10828176	10828177			
AGS Reference						

Component	LOD/Units	Method	BH01	BH02	BH03			
Diethyl phthalate (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Dimethyl phthalate (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
n-Dioctyl phthalate (aq)	<5 µg/l	TM176	<5 @ #	<5 @ #	<5 @ #			
Hexachlorobenzene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Hexachlorobutadiene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Pentachlorophenol (aq)	<1 µg/l	TM176	<1	<1	<1			
Phenol (aq)	<1 µg/l	TM176	<1	<1	<1			
n-Nitroso-n-dipropylamine (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Hexachloroethane (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Nitrobenzene (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Isophorone (aq)	<1 µg/l	TM176	<1 @ #	<1 @ #	<1 @ #			
Hexachlorocyclopentadiene (aq)	<1 µg/l	TM176	<1	<1	<1			

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (S)

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Customer Sample R	BH01	BH02	BH03	BH04	BH05	BH06
Depth (m)	0.00 - 1.00	0.00 - 1.00	0.50 - 1.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50
Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled	15/12/2014	19/12/2014	09/12/2014	14/11/2014	05/11/2014	03/11/2014
Sampled Time	.	.	.	.	.	.
Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref	150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)	10828178	10828182	10828186	10828489	10828492	10828493
AGS Reference						

Component	LOD/Units	Method	BH01	BH02	BH03	BH04	BH05	BH06
Dibromofluoromethane**	%	TM116	101 2	102 2	103 2	108 2	109 2	111 2
Toluene-d8**	%	TM116	98.8 2	95.5 2	96.7 2	98 2	102 2	100 2
4-Bromofluorobenzene**	%	TM116	101 2	93.9 2	92.2 2	87 2	96.2 2	92.8 2
Dichlorodifluoromethane	<6 µg/kg	TM116	<6 2 M	<6 2 #	<6 2 M	<60 2 M	<6 2 M	<60 2 M
Chloromethane	<7 µg/kg	TM116	<7 2 #	<7 2 #	<7 2 #	<70 2 #	<7 2 #	<70 2 #
Vinyl Chloride	<6 µg/kg	TM116	<6 2 M	<6 2 #	<6 2 M	<60 2 M	<6 2 M	<60 2 M
Bromomethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Chloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Trichlorofluorormethane	<6 µg/kg	TM116	<6 2 M	<6 2 #	<6 2 M	<60 2 M	<6 2 M	<60 2 M
1,1-Dichloroethene	<10 µg/kg	TM116	<10 2 #	<10 2 #	<10 2 #	<100 2 #	<10 2 #	<100 2 #
Carbon Disulphide	<7 µg/kg	TM116	<7 2 M	<7 2 #	<7 2 M	<70 2 M	<7 2 M	<70 2 M
Dichloromethane	<10 µg/kg	TM116	<10 2 #	<10 2 #	<10 2 #	<100 2 #	<10 2 #	<100 2 #
Methyl Tertiary Butyl Ether	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
trans-1,2-Dichloroethene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
1,1-Dichloroethane	<8 µg/kg	TM116	<8 2 M	<8 2 #	<8 2 M	<80 2 M	<8 2 M	<80 2 M
cis-1,2-Dichloroethene	<6 µg/kg	TM116	<6 2 M	<6 2 #	<6 2 M	<60 2 M	<6 2 M	<60 2 M
2,2-Dichloropropane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Bromochloromethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Chloroform	<8 µg/kg	TM116	<8 2 M	<8 2 #	<8 2 M	<80 2 M	<8 2 M	<80 2 M
1,1,1-Trichloroethane	<7 µg/kg	TM116	<7 2 M	<7 2 #	<7 2 M	<70 2 M	<7 2 M	<70 2 M
1,1-Dichloropropene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Carbontetrachloride	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
1,2-Dichloroethane	<5 µg/kg	TM116	<5 2 M	<5 2 #	<5 2 M	<50 2 M	<5 2 M	<50 2 M
Benzene	<9 µg/kg	TM116	<9 2 M	<9 2 #	<9 2 M	<90 2 M	<9 2 M	<90 2 M
Trichloroethene	<9 µg/kg	TM116	<9 2 #	<9 2 #	<9 2 #	<90 2 #	<9 2 #	<90 2 #
1,2-Dichloropropane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Dibromomethane	<9 µg/kg	TM116	<9 2 M	<9 2 #	<9 2 M	<90 2 M	<9 2 M	<90 2 M
Bromodichloromethane	<7 µg/kg	TM116	<7 2 M	<7 2 #	<7 2 M	<70 2 M	<7 2 M	<70 2 M
cis-1,3-Dichloropropene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Toluene	<7 µg/kg	TM116	<7 2 M	<7 2 #	<7 2 M	<70 2 M	<7 2 M	<70 2 M
trans-1,3-Dichloropropene	<10 µg/kg	TM116	<10 2	<10 2	<10 2	<100 2	<10 2	<100 2
1,1,2-Trichloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (S)

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R	BH01	BH02	BH03	BH04	BH05	BH06
Depth (m)	0.00 - 1.00	0.00 - 1.00	0.50 - 1.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50
Sample Type	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled	15/12/2014	19/12/2014	09/12/2014	14/11/2014	05/11/2014	03/11/2014
Sampled Time	.	.	.	.	.	.
Date Received	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref	150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)	10828178	10828182	10828186	10828489	10828492	10828493
AGS Reference						

Component	LOD/Units	Method	BH01	BH02	BH03	BH04	BH05	BH06
1,3-Dichloropropane	<7 µg/kg	TM116	<7 2 M	<7 2 #	<7 2 M	<70 2 M	<7 2 M	<70 2 M
Tetrachloroethene	<5 µg/kg	TM116	<5 2 M	<5 2 #	<5 2 M	<50 2 M	<5 2 M	<50 2 M
Dibromochloromethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
1,2-Dibromoethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Chlorobenzene	<5 µg/kg	TM116	<5 2 M	<5 2 #	<5 2 M	<50 2 M	<5 2 M	<50 2 M
1,1,1,2-Tetrachloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Ethylbenzene	<4 µg/kg	TM116	<4 2 M	<4 2 #	<4 2 M	<40 2 M	<4 2 M	<40 2 M
p/m-Xylene	<10 µg/kg	TM116	<10 2 #	<10 2 #	<10 2 #	<100 2 #	<10 2 #	<100 2 #
o-Xylene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Styrene	<10 µg/kg	TM116	<10 2 #	<10 2 #	<10 2 #	<100 2 #	<10 2 #	<100 2 #
Bromoform	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Isopropylbenzene	<5 µg/kg	TM116	<5 2 #	<5 2 #	<5 2 #	<50 2 #	<5 2 #	<50 2 #
1,1,2,2-Tetrachloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
1,2,3-Trichloropropane	<16 µg/kg	TM116	<16 2 M	<16 2 #	<16 2 M	<160 2 M	<16 2 M	<160 2 M
Bromobenzene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
Propylbenzene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
2-Chlorotoluene	<9 µg/kg	TM116	<9 2 M	<9 2 #	<9 2 M	<90 2 M	<9 2 M	<90 2 M
1,3,5-Trimethylbenzene	<8 µg/kg	TM116	<8 2 M	<8 2 #	<8 2 M	<80 2 M	<8 2 M	<80 2 M
4-Chlorotoluene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
tert-Butylbenzene	<14 µg/kg	TM116	<14 2 M	<14 2 #	<14 2 M	<140 2 M	<14 2 M	<140 2 M
1,2,4-Trimethylbenzene	<9 µg/kg	TM116	<9 2 #	<9 2 #	<9 2 #	<90 2 #	<9 2 #	<90 2 #
sec-Butylbenzene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
4-Isopropyltoluene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
1,3-Dichlorobenzene	<8 µg/kg	TM116	<8 2 M	<8 2 #	<8 2 M	<80 2 M	<8 2 M	<80 2 M
1,4-Dichlorobenzene	<5 µg/kg	TM116	<5 2 M	<5 2 #	<5 2 M	<50 2 M	<5 2 M	<50 2 M
n-Butylbenzene	<11 µg/kg	TM116	<11 2	<11 2	<11 2	<110 2	<11 2	<110 2
1,2-Dichlorobenzene	<10 µg/kg	TM116	<10 2 M	<10 2 #	<10 2 M	<100 2 M	<10 2 M	<100 2 M
1,2-Dibromo-3-chloropropane	<14 µg/kg	TM116	<14 2 M	<14 2 #	<14 2 M	<140 2 M	<14 2 M	<140 2 M
Tert-amyl methyl ether	<10 µg/kg	TM116	<10 2 #	<10 2 #	<10 2 #	<100 2 #	<10 2 #	<100 2 #
1,2,4-Trichlorobenzene	<20 µg/kg	TM116	<20 2	<20 2	<20 2	<200 2	<20 2	<200 2
Hexachlorobutadiene	<20 µg/kg	TM116	<20 2	<20 2	<20 2	<200 2	<20 2	<200 2
Naphthalene	<13 µg/kg	TM116	<13 2 M	<13 2 #	<13 2 M	<130 2 M	<13 2 M	<130 2 M

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (S)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH01	BH02	BH03	BH04	BH05	BH06
Customer Sample R			BH01	BH02	BH03	BH04	BH05	BH06
Depth (m)			0.00 - 1.00	0.00 - 1.00	0.50 - 1.00	0.00 - 1.00	2.50 - 3.50	0.00 - 0.50
Sample Type			Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid	Soil/Solid
Date Sampled			15/12/2014	19/12/2014	09/12/2014	14/11/2014	05/11/2014	03/11/2014
Sampled Time			.	.	.	.	.	.
Date Received			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
SDG Ref			150213-41	150213-41	150213-41	150213-41	150213-41	150213-41
Lab Sample No.(s)			10828178	10828182	10828186	10828489	10828492	10828493
AGS Reference								
1,2,3-Trichlorobenzene	<20 µg/kg	TM116	<20 2 #	<20 2 #	<20 2 #	<200 2 #	<20 2 #	<200 2 #

SDG:	150213-41	Location:	HFO Project	Order Number:	
Job:	H_JACOBS_JH_REA-45	Customer:	Jacobs Engineering UK Limited	Report Number:	304415
Client Reference:		Attention:	Katherine Hunt	Superseded Report:	

VOC MS (S)

Results Legend	
#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH07	BH08				
Customer Sample R			BH07	BH08				
Depth (m)			0.00 - 1.00	2.00 - 3.00				
Sample Type			Soil/Solid	Soil/Solid				
Date Sampled			14/11/2014	13/11/2014				
Sampled Time			.	.				
Date Received			12/02/2015	12/02/2015				
SDG Ref			150213-41	150213-41				
Lab Sample No.(s)			10828497	10828494				
AGS Reference								
Dibromofluoromethane**	%	TM116	108 2	110 2				
Toluene-d8**	%	TM116	102 2	103 2				
4-Bromofluorobenzene**	%	TM116	96.7 2	95.1 2				
Dichlorodifluoromethane	<6 µg/kg	TM116	<6 2 M	<6 2 M				
Chloromethane	<7 µg/kg	TM116	<7 2 #	<7 2 #				
Vinyl Chloride	<6 µg/kg	TM116	<6 2 M	<6 2 M				
Bromomethane	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Chloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Trichlorofluorormethane	<6 µg/kg	TM116	<6 2 M	<6 2 M				
1,1-Dichloroethene	<10 µg/kg	TM116	<10 2 #	<10 2 #				
Carbon Disulphide	<7 µg/kg	TM116	<7 2 M	<7 2 M				
Dichloromethane	<10 µg/kg	TM116	<10 2 #	<10 2 #				
Methyl Tertiary Butyl Ether	<10 µg/kg	TM116	<10 2 M	<10 2 M				
trans-1,2-Dichloroethene	<10 µg/kg	TM116	<10 2 M	<10 2 M				
1,1-Dichloroethane	<8 µg/kg	TM116	<8 2 M	<8 2 M				
cis-1,2-Dichloroethene	<6 µg/kg	TM116	<6 2 M	<6 2 M				
2,2-Dichloropropane	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Bromochloromethane	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Chloroform	<8 µg/kg	TM116	<8 2 M	<8 2 M				
1,1,1-Trichloroethane	<7 µg/kg	TM116	<7 2 M	<7 2 M				
1,1-Dichloropropene	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Carbontetrachloride	<10 µg/kg	TM116	<10 2 M	<10 2 M				
1,2-Dichloroethane	<5 µg/kg	TM116	<5 2 M	<5 2 M				
Benzene	<9 µg/kg	TM116	<9 2 M	<9 2 M				
Trichloroethene	<9 µg/kg	TM116	<9 2 #	<9 2 #				
1,2-Dichloropropane	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Dibromomethane	<9 µg/kg	TM116	<9 2 M	<9 2 M				
Bromodichloromethane	<7 µg/kg	TM116	<7 2 M	<7 2 M				
cis-1,3-Dichloropropene	<10 µg/kg	TM116	<10 2 M	<10 2 M				
Toluene	<7 µg/kg	TM116	<7 2 M	<7 2 M				
trans-1,3-Dichloropropene	<10 µg/kg	TM116	<10 2	<10 2				
1,1,2-Trichloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 M				

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (S)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R			BH07	BH08					
Depth (m)			0.00 - 1.00	2.00 - 3.00					
Sample Type			Soil/Solid	Soil/Solid					
Date Sampled			14/11/2014	13/11/2014					
Sampled Time			.	.					
Date Received			12/02/2015	12/02/2015					
SDG Ref			150213-41	150213-41					
Lab Sample No.(s)			10828497	10828494					
AGS Reference									
Component	**LOD/Units**	**Method**							
1,3-Dichloropropane	<7 µg/kg	TM116	<7 2 M	<7 2 M					
Tetrachloroethene	<5 µg/kg	TM116	<5 2 M	<5 2 M					
Dibromochloromethane	<10 µg/kg	TM116	<10 2 M	<10 2 M					
1,2-Dibromoethane	<10 µg/kg	TM116	<10 2 M	<10 2 M					
Chlorobenzene	<5 µg/kg	TM116	<5 2 M	<5 2 M					
1,1,1,2-Tetrachloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 M					
Ethylbenzene	<4 µg/kg	TM116	<4 2 M	<4 2 M					
p/m-Xylene	<10 µg/kg	TM116	<10 2 #	<10 2 #					
o-Xylene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
Styrene	<10 µg/kg	TM116	<10 2 #	<10 2 #					
Bromoform	<10 µg/kg	TM116	<10 2 M	<10 2 M					
Isopropylbenzene	<5 µg/kg	TM116	<5 2 #	<5 2 #					
1,1,2,2-Tetrachloroethane	<10 µg/kg	TM116	<10 2 M	<10 2 M					
1,2,3-Trichloropropane	<16 µg/kg	TM116	<16 2 M	<16 2 M					
Bromobenzene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
Propylbenzene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
2-Chlorotoluene	<9 µg/kg	TM116	<9 2 M	<9 2 M					
1,3,5-Trimethylbenzene	<8 µg/kg	TM116	<8 2 M	<8 2 M					
4-Chlorotoluene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
tert-Butylbenzene	<14 µg/kg	TM116	<14 2 M	<14 2 M					
1,2,4-Trimethylbenzene	<9 µg/kg	TM116	<9 2 #	<9 2 #					
sec-Butylbenzene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
4-Isopropyltoluene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
1,3-Dichlorobenzene	<8 µg/kg	TM116	<8 2 M	<8 2 M					
1,4-Dichlorobenzene	<5 µg/kg	TM116	<5 2 M	<5 2 M					
n-Butylbenzene	<11 µg/kg	TM116	<11 2	<11 2					
1,2-Dichlorobenzene	<10 µg/kg	TM116	<10 2 M	<10 2 M					
1,2-Dibromo-3-chloropropane	<14 µg/kg	TM116	<14 2 M	<14 2 M					
Tert-amyl methyl ether	<10 µg/kg	TM116	<10 2 #	<10 2 #					
1,2,4-Trichlorobenzene	<20 µg/kg	TM116	<20 2	<20 2					
Hexachlorobutadiene	<20 µg/kg	TM116	<20 2	<20 2					
Naphthalene	<13 µg/kg	TM116	<13 2 M	<13 2 M					

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (S)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

		Customer Sample R	BH07	BH08				
		Depth (m)	0.00 - 1.00	2.00 - 3.00				
		Sample Type	Soil/Solid	Soil/Solid				
		Date Sampled	14/11/2014	13/11/2014				
		Sampled Time	.	.				
		Date Received	12/02/2015	12/02/2015				
		SDG Ref	150213-41	150213-41				
		Lab Sample No.(s)	10828497	10828494				
		AGS Reference						
Component	**LOD/Units**	**Method**						
1,2,3-Trichlorobenzene	<20 µg/kg	TM116	<20 2 #	<20 2 #				

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R	BH01	BH02	BH03			
Depth (m)	14.50 - 14.90	8.00 - 8.20	15.70 - 16.10			
Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)			
Date Sampled	30/01/2015	30/01/2015	28/01/2015			
Sampled Time	.	.	.			
Date Received	12/02/2015	12/02/2015	12/02/2015			
SDG Ref	150213-41	150213-41	150213-41			
Lab Sample No.(s)	10828175	10828176	10828177			
AGS Reference						

Component	LOD/Units	Method	BH01	BH02	BH03			
Dibromofluoromethane**	%	TM208	108 1	109	108			
Toluene-d8**	%	TM208	97.9 1	99.1	98.8			
4-Bromofluorobenzene**	%	TM208	98.4 1	99.3	99.8			
Dichlorodifluoromethane	<1 µg/l	TM208	<1 1	<1	<1			
Chloromethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Vinyl chloride	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Bromomethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Chloroethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Trichlorofluoromethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,1-Dichloroethene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Carbon disulphide	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Dichloromethane	<3 µg/l	TM208	<3 1 @ #	<3 @ #	<3 @ #			
Methyl tertiary butyl ether (MTBE)	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
trans-1,2-Dichloroethene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,1-Dichloroethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
cis-1,2-Dichloroethene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
2,2-Dichloropropane	<1 µg/l	TM208	<1 1	<1	<1			
Bromochloromethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Chloroform	<1 µg/l	TM208	1.7 1 @ #	<1 @ #	<1 @ #			
1,1,1-Trichloroethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,1-Dichloropropene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Carbontetrachloride	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,2-Dichloroethane	<1 µg/l	TM208	37000 1 @	<1 @	86.7 @			
Benzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Trichloroethene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,2-Dichloropropane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Dibromomethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Bromodichloromethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
cis-1,3-Dichloropropene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Toluene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
trans-1,3-Dichloropropene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,1,2-Trichloroethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (W)

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH01	BH02	BH03			
Customer Sample R			BH01	BH02	BH03			
Depth (m)			14.50 - 14.90	8.00 - 8.20	15.70 - 16.10			
Sample Type			Water(GW/SW)	Water(GW/SW)	Water(GW/SW)			
Date Sampled			30/01/2015	30/01/2015	28/01/2015			
Sampled Time			.	.	.			
Date Received			12/02/2015	12/02/2015	12/02/2015			
SDG Ref			150213-41	150213-41	150213-41			
Lab Sample No.(s)			10828175	10828176	10828177			
AGS Reference								
1,3-Dichloropropane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Tetrachloroethene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Dibromochloromethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,2-Dibromoethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Chlorobenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,1,1,2-Tetrachloroethane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Ethylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
m,p-Xylene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
o-Xylene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Styrene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Bromoform	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Isopropylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,1,2,2-Tetrachloroethane	<1 µg/l	TM208	<1 1 @	<1 @	<1 @			
1,2,3-Trichloropropane	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Bromobenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Propylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
2-Chlorotoluene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,3,5-Trimethylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
4-Chlorotoluene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
tert-Butylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,2,4-Trimethylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
sec-Butylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
4-iso-Propyltoluene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,3-Dichlorobenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,4-Dichlorobenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
n-Butylbenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,2-Dichlorobenzene	<1 µg/l	TM208	<1 1 @	<1 @	<1 @			
1,2-Dibromo-3-chloropropane	<1 µg/l	TM208	<1 1 @	<1 @	<1 @			
1,2,4-Trichlorobenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Hexachlorobutadiene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
tert-Amyl methyl ether (TAME)	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
Naphthalene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

VOC MS (W)

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	BH01	BH02	BH03			
Customer Sample R			BH01	BH02	BH03			
Depth (m)			14.50 - 14.90	8.00 - 8.20	15.70 - 16.10			
Sample Type			Water(GW/SW)	Water(GW/SW)	Water(GW/SW)			
Date Sampled			30/01/2015	30/01/2015	28/01/2015			
Sampled Time			.	.	.			
Date Received			12/02/2015	12/02/2015	12/02/2015			
SDG Ref			150213-41	150213-41	150213-41			
Lab Sample No.(s)			10828175	10828176	10828177			
AGS Reference								
1,2,3-Trichlorobenzene	<1 µg/l	TM208	<1 1 @ #	<1 @ #	<1 @ #			
1,3,5-Trichlorobenzene	<1 µg/l	TM208	<1 1	<1	<1			

SDG:	150213-41	Location:	HFO Project	Order Number:	
Job:	H_JACOBS_JH_REA-45	Customer:	Jacobs Engineering UK Limited	Report Number:	304415
Client Reference:		Attention:	Katherine Hunt	Superseded Report:	

Extractable Petroleum Hydrocarbons (EPH) By GC-FID

EPH (DRO) (C10-C40)

Sample No	Customer Sample Ref.	Depth	Matrix (mg/kg)	EPH	Interpretation
10912520	BH01	0.00 - 1.00	SOLID	65.6	no interpretation possible
10912540	BH01	1.00 - 2.00	SOLID	47.0	no interpretation possible
10912729	BH01	2.00 - 3.00	SOLID	48.3	no interpretation possible
10921568	BH02	0.00 - 1.00	SOLID	159	possible bitumen tar
10906077	BH02	1.00 - 2.00	SOLID	<35.0	no interpretation possible
10921690	BH02	2.00 - 3.00	SOLID	<35.0	no interpretation possible
10921428	BH03	0.50 - 1.00	SOLID	141	possible bitumen tar
10921356	BH03	1.50 - 2.50	SOLID	45.6	no interpretation possible
10905736	BH03	2.50 - 3.50	SOLID	864	possible bitumen tar
10905861	BH01	0.00 - 1.00	SOLID	<35.0	no interpretation possible
10915510	BH01	2.50 - 3.50	SOLID	<35.0	no interpretation possible
10912796	BH02	0.00 - 0.50	SOLID	<35.0	no interpretation possible
10915454	BH02	2.50 - 3.50	SOLID	<35.0	no interpretation possible
10921373	BH03	0.00 - 0.50	SOLID	<35.0	no interpretation possible
10915574	BH03	2.50 - 3.50	SOLID	<35.0	no interpretation possible
10913113	BH04	0.00 - 1.00	SOLID	1250	bitumen/tar/possible heavy oil
10947758	BH04	2.00 - 3.00	SOLID	<35.0	No interpretation possible
10921505	BH05	0.00 - 1.00	SOLID	40.4	no interpretation possible
10915407	BH05	2.50 - 3.50	SOLID	<35.0	no interpretation possible
10912872	BH06	0.00 - 0.50	SOLID	86.9	no interpretation possible
10915626	BH08	2.00 - 3.00	SOLID	<35.0	no interpretation possible
10921620	BH06	2.00 - 3.00	SOLID	<35.0	no interpretation possible
10921395	BH07	0.00 - 1.00	SOLID	<35.0	no interpretation possible
10921652	BH07	2.00 - 3.00	SOLID	46.2	no interpretation possible
10921327	BH08	0.00 - 1.00	SOLID	<35.0	no interpretation possible

Extractable Petroleum Hydrocarbons (formally Diesel Range Organics) :- Any compound extractable in n-hexane within the carbon range C10-C40, includes Aliphatic (Min Oil), Aromatic (PAHs) and naturally occurring compounds.

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Asbestos Identification - Soil

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	BH01 0.00 - 1.00 SOLID 15/12/2014 00:00:00 24/02/2015 10:17:22 150213-41 10828178 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	BH01 0.00 - 1.00 SOLID 11/11/2014 00:00:00 23/02/2015 13:41:38 150213-41 10828481 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	BH01 1.00 - 2.00 SOLID 15/12/2014 00:00:00 24/02/2015 12:21:46 150213-41 10828180 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	BH01 2.00 - 3.00 SOLID 15/12/2014 00:00:00 24/02/2015 12:27:30 150213-41 10828181 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Received SDG Original Sample Method Number	BH01 2.50 - 3.50 SOLID 11/11/2014 00:00:00 25/02/2015 10:07:51 150213-41 10828482 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

SDG: 150213-41
Job: H_JACOBS_JH_REA-45
Client Reference:
Location: HFO Project
Customer: Jacobs Engineering UK Limited
Attention: Katherine Hunt
Order Number:
Report Number: 304415
Superseded Report:

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH02 0.00 - 0.50 SOLID 18/11/2014 00:00:00 24/02/2015 06:20:37 150213-41 10828483 TM048	6/3/15	Kevin Hughes	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH02 0.00 - 1.00 SOLID 19/12/2014 00:00:00 24/02/2015 10:26:20 150213-41 10828182 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH02 1.00 - 2.00 SOLID 19/12/2014 00:00:00 24/02/2015 12:39:57 150213-41 10828183 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH02 2.00 - 3.00 SOLID 19/12/2014 00:00:00 24/02/2015 12:14:36 150213-41 10828184 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH02 2.50 - 3.50 SOLID 18/11/2014 00:00:00 25/02/2015 09:01:03 150213-41 10828484 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH03 0.00 - 0.50 SOLID 03/11/2014 00:00:00 25/02/2015 08:36:47 150213-41 10828485 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH03 0.50 - 1.00 SOLID 09/12/2014 00:00:00 24/02/2015 10:09:59 150213-41 10828186 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH03 1.50 - 2.50 SOLID 09/12/2014 00:00:00 24/02/2015 12:08:37 150213-41 10828187 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH03 2.50 - 3.50 SOLID 09/12/2014 00:00:00 24/02/2015 12:33:13 150213-41 10828189 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH03 2.50 - 3.50 SOLID 01/12/2014 00:00:00 25/02/2015 08:53:19 150213-41 10828487 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH04 0.00 - 1.00 SOLID 14/11/2014 00:00:00 24/02/2015 06:40:57 150213-41 10828489 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH05 0.00 - 1.00 SOLID 05/11/2014 00:00:00 23/02/2015 13:35:18 150213-41 10828491 TM048	6/3/15	Kevin Hughes	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH05 2.50 - 3.50 SOLID 05/11/2014 00:00:00 25/02/2015 09:08:20 150213-41 10828492 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH06 0.00 - 0.50 SOLID 03/11/2014 00:00:00 24/02/2015 06:32:16 150213-41 10828493 TM048	6/3/15	Kevin Hughes	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH06 2.00 - 3.00 SOLID 03/11/2014 00:00:00 23/02/2015 14:09:13 150213-41 10828495 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH07 0.00 - 1.00 SOLID 14/11/2014 00:00:00 23/02/2015 13:52:55 150213-41 10828497 TM048	6/3/15	Kevin Hughes	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH07 2.00 - 3.00 SOLID 14/11/2014 00:00:00 23/02/2015 14:19:48 150213-41 10828499 TM048	6/3/15	Simon Postlewhite	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH08 0.00 - 1.00 SOLID 13/11/2014 00:00:00 25/02/2015 08:44:28 150213-41 10828500 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

CERTIFICATE OF ANALYSIS

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

		Date of Analysis	Analysed By	Comments	Amosite (Brown) Asbestos	Chrysotile (White) Asbestos	Crocidolite (Blue) Asbestos	Fibrous Actinolite	Fibrous Anthophyllite	Fibrous Tremolite	Non-Asbestos Fibre
Cust. Sample Ref. Depth (m) Sample Type Date Sampled Date Receieved SDG Original Sample Method Number	BH08 2.00 - 3.00 SOLID 13/11/2014 00:00:00 25/02/2015 09:57:52 150213-41 10828494 TM048	5/3/15	Rebecca Rawlings	-	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected (#)	Not Detected

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Notification of NDPs (No determination possible)

Date Received : 13/02/2015 10:15:29

Sample No	Customer Sample Ref.	Depth (m)	Test	Comment
10828490	BH04	2.00 - 3.00	Asbestos ID in Solid Samples	Insufficient Sample
10828490	BH04	2.00 - 3.00	Sample description	Insufficient Sample
10828490	BH04	2.00 - 3.00	Hexavalent Chromium (s)	Insufficient Sample
10828490	BH04	2.00 - 3.00	pH	Insufficient Sample
10828490	BH04	2.00 - 3.00	PAH by GCMS	Insufficient Sample
10828490	BH04	2.00 - 3.00	EPH by FID	Insufficient Sample
10828490	BH04	2.00 - 3.00	Metals in solid samples by OES	Insufficient Sample
10828490	BH04	2.00 - 3.00	Total Organic Carbon	Insufficient Sample

Table of Results - Appendix

Method No	Reference	Description	Wet/Dry Sample [1]	Surrogate Corrected
ASB_PREP				
PM001		Preparation of Samples for Metals Analysis		
PM024	Modified BS 1377	Soil preparation including homogenisation, moisture screens of soils for Asbestos Containing Material		
TM048	HSG 248, Asbestos: The analysts' guide for sampling, analysis and clearance procedures	Identification of Asbestos in Bulk Material		
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)		
TM090	Method 5310, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 415.1 & 9060	Determination of Total Organic Carbon/Total Inorganic Carbon in Water and Waste Water		
TM116	Modified: US EPA Method 8260, 8120, 8020, 624, 610 & 602	Determination of Volatile Organic Compounds by Headspace / GC-MS		
TM132	In - house Method	ELTRA CS800 Operators Guide		
TM133	BS 1377: Part 3 1990;BS 6068-2.5	Determination of pH in Soil and Water using the GLpH pH Meter		
TM151	Method 3500D, AWWA/APHA, 20th Ed., 1999	Determination of Hexavalent Chromium using Kone analyser		
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS		
TM157	HP 6890 Gas Chromatograph (GC) system and HP 5973 Mass Selective Detector (MSD).	Determination of SVOC in Soils by GC-MS extracted by sonication in DCM/Acetone		
TM172	Analysis of Petroleum Hydrocarbons in Environmental Media – Total Petroleum Hydrocarbon Criteria	EPH in Waters		
TM176	EPA 8270D Semi-Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Determination of SVOCs in Water by GCMS		
TM178	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS in Waters		
TM181	US EPA Method 6010B	Determination of Routine Metals in Soil by iCap 6500 Duo ICP-OES		
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry		
TM208	Modified: US EPA Method 8260b & 624	Determination of Volatile Organic Compounds by Headspace / GC-MS in Waters		
TM218	Microwave extraction – EPA method 3546	Microwave extraction - EPA method 3546		
TM241	Methods for the Examination of Waters and Associated Materials; Chromium in Raw and Potable Waters and Sewage Effluents 1980.	The Determination of Hexavalent Chromium in Waters and Leachates using the Kone Analyser		
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter		

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
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Test Completion Dates

Lab Sample No(s)	10828175	10828178	10828180	10828181	10828481	10828482	10828176	10828182	10828183	10828184
Customer Sample Ref.	BH01	BH01	BH01	BH01	BH01	BH01	BH02	BH02	BH02	BH02
AGS Ref.										
Depth	14.50 - 14.90	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00	0.00 - 1.00	2.50 - 3.50	8.00 - 8.20	0.00 - 1.00	1.00 - 2.00	2.00 - 3.00
Type	LIQUID	SOLID	SOLID	SOLID	SOLID	SOLID	LIQUID	SOLID	SOLID	SOLID
Asbestos ID in Solid Samples		06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015		06-Mar-2015	06-Mar-2015	06-Mar-2015
Dissolved Metals by ICP-MS	23-Feb-2015						23-Feb-2015			
EPH (DRO) (C10-C40) Aqueous (W)	27-Feb-2015						27-Feb-2015			
EPH by FID		02-Mar-2015	02-Mar-2015	02-Mar-2015	27-Feb-2015	02-Mar-2015		02-Mar-2015	27-Feb-2015	02-Mar-2015
Hexavalent Chromium (s)		02-Mar-2015	02-Mar-2015	02-Mar-2015	27-Feb-2015	02-Mar-2015		02-Mar-2015	02-Mar-2015	02-Mar-2015
Hexavalent Chromium (w)	26-Feb-2015						26-Feb-2015			
Mercury Dissolved	24-Feb-2015						24-Feb-2015			
Metals in solid samples by OES		02-Mar-2015	02-Mar-2015	02-Mar-2015	27-Feb-2015	02-Mar-2015		02-Mar-2015	27-Feb-2015	02-Mar-2015
PAH by GCMS		28-Feb-2015	28-Feb-2015	28-Feb-2015	26-Feb-2015	27-Feb-2015		28-Feb-2015	26-Feb-2015	28-Feb-2015
PAH Spec MS - Aqueous (W)	26-Feb-2015						26-Feb-2015			
pH		27-Feb-2015	27-Feb-2015	27-Feb-2015	28-Feb-2015	28-Feb-2015		27-Feb-2015	27-Feb-2015	27-Feb-2015
pH Value	28-Feb-2015						28-Feb-2015			
Sample description		24-Feb-2015	24-Feb-2015	24-Feb-2015	23-Feb-2015	25-Feb-2015		24-Feb-2015	24-Feb-2015	24-Feb-2015
Semi Volatile Organic Compounds		27-Feb-2015						01-Mar-2015		
SVOC MS (W) - Aqueous	27-Feb-2015						27-Feb-2015			
Total Organic and Inorganic Carbon	24-Feb-2015						24-Feb-2015			
Total Organic Carbon		02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015		02-Mar-2015	02-Mar-2015	02-Mar-2015
VOC MS (S)		27-Feb-2015						28-Feb-2015		
VOC MS (W)	26-Feb-2015						25-Feb-2015			

Lab Sample No(s)	10828483	10828484	10828177	10828186	10828187	10828189	10828485	10828487	10828489	10828490
Customer Sample Ref.	BH02	BH02	BH03	BH03	BH03	BH03	BH03	BH03	BH04	BH04
AGS Ref.										
Depth	0.00 - 0.50	2.50 - 3.50	15.70 - 16.10	0.50 - 1.00	1.50 - 2.50	2.50 - 3.50	0.00 - 0.50	2.50 - 3.50	0.00 - 1.00	2.00 - 3.00
Type	SOLID	SOLID	LIQUID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID
Asbestos ID in Solid Samples	06-Mar-2015	06-Mar-2015		06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	
Dissolved Metals by ICP-MS			23-Feb-2015							
EPH (DRO) (C10-C40) Aqueous (W)			27-Feb-2015							
EPH by FID	02-Mar-2015	02-Mar-2015		02-Mar-2015	02-Mar-2015	26-Feb-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	06-Mar-2015
Hexavalent Chromium (s)	02-Mar-2015	02-Mar-2015		02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	
Hexavalent Chromium (w)			26-Feb-2015							
Mercury Dissolved			24-Feb-2015							
Metals in solid samples by OES	02-Mar-2015	02-Mar-2015		02-Mar-2015	02-Mar-2015	27-Feb-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	
PAH by GCMS	26-Feb-2015	27-Feb-2015		28-Feb-2015	28-Feb-2015	26-Feb-2015	28-Feb-2015	27-Feb-2015	26-Feb-2015	06-Mar-2015
PAH Spec MS - Aqueous (W)			26-Feb-2015							
pH	27-Feb-2015	28-Feb-2015		27-Feb-2015	27-Feb-2015	27-Feb-2015	28-Feb-2015	27-Feb-2015	27-Feb-2015	
pH Value			28-Feb-2015							
Sample description	24-Feb-2015	25-Feb-2015		24-Feb-2015	24-Feb-2015	24-Feb-2015	25-Feb-2015	25-Feb-2015	24-Feb-2015	03-Mar-2015
Semi Volatile Organic Compounds				01-Mar-2015					26-Feb-2015	
SVOC MS (W) - Aqueous			27-Feb-2015							
Total Organic and Inorganic Carbon			02-Mar-2015							
Total Organic Carbon	02-Mar-2015	02-Mar-2015		02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	
VOC MS (S)				28-Feb-2015					27-Feb-2015	
VOC MS (W)			25-Feb-2015							

Lab Sample No(s)	10828491	10828493	10828495	10828497	10828499	10828494	10828500
Customer Sample Ref.	BH05	BH06	BH06	BH07	BH07	BH08	BH08
AGS Ref.							
Depth	0.00 - 1.00	0.00 - 0.50	2.00 - 3.00	0.00 - 1.00	2.00 - 3.00	2.00 - 3.00	0.00 - 1.00
Type	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID
Asbestos ID in Solid Samples	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015	06-Mar-2015
EPH by FID	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015
Hexavalent Chromium (s)	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015
Metals in solid samples by OES	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015
PAH by GCMS	28-Feb-2015	01-Mar-2015	28-Feb-2015	28-Feb-2015	28-Feb-2015	27-Feb-2015	28-Feb-2015
pH	28-Feb-2015	27-Feb-2015	27-Feb-2015	27-Feb-2015	28-Feb-2015	28-Feb-2015	28-Feb-2015
Sample description	23-Feb-2015	24-Feb-2015	23-Feb-2015	23-Feb-2015	23-Feb-2015	25-Feb-2015	25-Feb-2015
Semi Volatile Organic Compounds		26-Feb-2015		01-Mar-2015		27-Feb-2015	
Total Organic Carbon	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015	02-Mar-2015
VOC MS (S)		27-Feb-2015		28-Feb-2015		28-Feb-2015	

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

ASSOCIATED AQC DATA

Dissolved Metals by ICP-MS

Component	Method Code	QC 1063	QC 1069
Aluminium	TM152	**102.0** 86.50 : 124.36	**100.67** 88.58 : 117.87
Antimony	TM152	**112.67** 78.35 : 107.92	**110.93** 71.92 : 116.73
Arsenic	TM152	**103.47** 91.87 : 114.58	**104.67** 89.45 : 113.51
Barium	TM152	**102.4** 88.77 : 110.63	**102.27** 90.47 : 113.85
Beryllium	TM152	**99.47** 92.42 : 117.03	**96.27** 84.68 : 120.26
Boron	TM152	**91.87** 79.53 : 125.65	**90.0** 82.95 : 121.47
Cadmium	TM152	**101.73** 90.67 : 109.35	**100.13** 90.40 : 113.29
Chromium	TM152	**103.2** 92.64 : 112.77	**101.73** 90.01 : 114.05
Cobalt	TM152	**102.67** 91.13 : 113.98	**103.07** 87.14 : 117.85
Copper	TM152	**101.47** 87.36 : 111.40	**101.47** 88.43 : 114.27
Lead	TM152	**99.47** 89.32 : 108.45	**99.2** 91.30 : 107.45
Lithium	TM152	**102.8** 82.03 : 126.72	**100.13** 84.32 : 123.11
Manganese	TM152	**104.27** 93.25 : 113.43	**102.53** 91.43 : 113.17
Molybdenum	TM152	**102.4** 86.29 : 109.15	**100.53** 80.73 : 113.85
Nickel	TM152	**101.07** 87.47 : 113.10	**101.33** 87.68 : 113.94
Phosphorus	TM152	**109.73** 92.73 : 123.63	**104.53** 86.68 : 118.34
Selenium	TM152	**103.73** 92.23 : 114.52	**102.93** 91.03 : 113.34
Strontium	TM152	**104.67** 91.17 : 114.53	**105.6** 90.44 : 114.09
Tellurium	TM152	**103.6** 91.58 : 109.94	**103.07** 80.93 : 116.91
Thallium	TM152	**98.8** 86.89 : 108.60	**97.33** 90.27 : 111.31
Tin	TM152	**99.6** 81.64 : 109.35	**98.13** 83.07 : 112.37
Titanium	TM152	**104.13** 93.55 : 112.86	**103.2** 92.65 : 111.58
Uranium	TM152	**96.8** 82.66 : 114.28	**96.13** 88.60 : 110.35
Vanadium	TM152	**108.0** 92.31 : 113.81	**103.87** 88.43 : 116.60
Zinc	TM152	**102.93** 94.07 : 110.81	**102.67** 89.84 : 113.06

EPH (DRO) (C10-C40) Aqueous (W)

Component	Method Code	QC 1001	QC 1097
EPH (DRO) (C10-C40)	TM172	**83.5** 56.50 : 116.50	**75.0** 59.22 : 112.78

EPH by FID

Component	Method Code	QC 1041	QC 1068	QC 1097	QC 1057	QC 1013
EPH (DRO) (C10-C40)	TM061	**85.0** 77.48 : 118.09	**96.25** 77.48 : 118.09	**105.63** 77.48 : 118.09	**106.25** 77.48 : 118.09	**98.75** 77.48 : 118.09

Hexavalent Chromium (s)

Component	Method Code	QC 1045	QC 1009	QC 1083	QC 1064
Hexavalent Chromium	TM151	**98.0** 94.71 : 106.89	**100.0** 94.71 : 106.89	**98.0** 94.71 : 106.89	**102.0** 94.71 : 106.89

Hexavalent Chromium (w)

Component	Method Code	QC 1059
Hexavalent Chromium	TM241	**101.4** 94.95 : 104.66

Mercury Dissolved

Component	Method Code	QC 1083	QC 1094
Mercury Dissolved (CVAF)	TM183	**99.0** 73.51 : 120.83	**105.0** 73.51 : 120.83

Metals in solid samples by OES

Component	Method Code	QC 1006	QC 1080	QC 1076	QC 1066
Aluminium	TM181	**126.92** 86.49 : 129.71	**111.54** 86.49 : 129.71	**102.31** 86.49 : 129.71	**113.85** 86.49 : 129.71
Antimony	TM181	**109.32** 77.50 : 122.50	**104.66** 77.50 : 122.50	**105.38** 77.50 : 122.50	**103.94** 77.50 : 122.50
Arsenic	TM181	**108.85** 82.63 : 117.37	**101.77** 82.63 : 117.37	**95.58** 82.63 : 117.37	**102.65** 82.63 : 117.37

Metals in solid samples by OES

		QC 1006	QC 1080	QC 1076	QC 1066
Barium	TM181	**112.03** 79.45 : 120.55	**106.02** 79.45 : 120.55	**97.74** 79.45 : 120.55	**108.27** 79.45 : 120.55
Beryllium	TM181	**118.91** 85.92 : 121.27	**111.01** 85.92 : 121.27	**106.67** 85.92 : 121.27	**110.08** 85.92 : 121.27
Boron	TM181	**157.25** 77.41 : 143.83	**124.43** 77.41 : 143.83	**110.69** 77.41 : 143.83	**129.01** 77.41 : 143.83
Cadmium	TM181	**106.22** 81.95 : 118.05	**98.66** 81.95 : 118.05	**94.12** 81.95 : 118.05	**98.82** 81.95 : 118.05
Chromium	TM181	**113.33** 81.29 : 118.71	**101.57** 81.29 : 118.71	**95.29** 81.29 : 118.71	**102.75** 81.29 : 118.71
Cobalt	TM181	**109.0** 83.86 : 116.14	**100.5** 83.86 : 116.14	**96.67** 83.86 : 116.14	**100.67** 83.86 : 116.14
Copper	TM181	**114.73** 78.57 : 121.43	**109.19** 78.57 : 121.43	**105.41** 78.57 : 121.43	**110.68** 78.57 : 121.43
Iron	TM181	**116.55** 81.74 : 118.26	**109.66** 81.74 : 118.26	**103.45** 81.74 : 118.26	**107.59** 81.74 : 118.26
Lead	TM181	**105.12** 74.18 : 117.25	**101.57** 74.18 : 117.25	**96.85** 74.18 : 117.25	**98.03** 74.18 : 117.25
Manganese	TM181	**100.0** 82.91 : 117.09	**100.0** 82.91 : 117.09	**100.0** 82.91 : 117.09	**100.0** 82.91 : 117.09
Mercury	TM181	**107.54** 81.99 : 118.01	**99.5** 81.99 : 118.01	**95.64** 81.99 : 118.01	**99.33** 81.99 : 118.01
Molybdenum	TM181	**106.85** 81.45 : 118.55	**97.29** 81.45 : 118.55	**92.52** 81.45 : 118.55	**97.77** 81.45 : 118.55
Nickel	TM181	**111.05** 79.64 : 120.36	**102.33** 79.64 : 120.36	**98.26** 79.64 : 120.36	**104.07** 79.64 : 120.36
Phosphorus	TM181	**105.37** 81.03 : 118.97	**98.66** 81.03 : 118.97	**95.38** 81.03 : 118.97	**99.85** 81.03 : 118.97
Selenium	TM181	**114.36** 75.41 : 119.20	**111.79** 75.41 : 119.20	**99.66** 75.41 : 119.20	**110.26** 75.41 : 119.20
Strontium	TM181	**117.62** 83.64 : 116.36	**105.36** 83.64 : 116.36	**97.7** 83.64 : 116.36	**107.28** 83.64 : 116.36
Thallium	TM181	**100.5** 77.50 : 122.50	**99.67** 77.50 : 122.50	**95.36** 77.50 : 122.50	**94.86** 77.50 : 122.50
Tin	TM181	**102.66** 78.30 : 113.98	**99.34** 78.30 : 113.98	**93.02** 78.30 : 113.98	**96.35** 78.30 : 113.98
Titanium	TM181	**125.0** 71.02 : 128.98	**103.13** 71.02 : 128.98	**96.09** 71.02 : 128.98	**108.59** 71.02 : 128.98
Vanadium	TM181	**109.12** 86.61 : 113.39	**99.12** 86.61 : 113.39	**92.06** 86.61 : 113.39	**99.41** 86.61 : 113.39
Zinc	TM181	**112.99** 90.81 : 120.30	**106.17** 90.81 : 120.30	**99.35** 90.81 : 120.30	**106.82** 90.81 : 120.30

PAH by GCMS

Component	Method Code	QC 1046	QC 1005	QC 1040	QC 1072	QC 1013	QC 1011
Acenaphthene	TM218	**106.5** 78.75 : 116.25	**107.0** 79.96 : 117.68	**104.0** 78.84 : 114.36	**107.5** 78.75 : 116.25	**118.0** 76.50 : 121.50	**105.0** 78.41 : 114.87
Acenaphthylene	TM218	**102.0** 76.45 : 110.05	**99.5** 76.25 : 113.75	**97.0** 65.50 : 119.50	**99.5** 76.45 : 110.05	**106.5** 73.50 : 118.50	**99.0** 72.38 : 111.60
Anthracene	TM218	**103.5** 67.15 : 124.45	**101.5** 75.14 : 109.30	**98.0** 75.54 : 110.88	**103.5** 67.15 : 124.45	**109.5** 74.25 : 117.75	**103.5** 72.78 : 117.53
Benz(a)anthracene	TM218	**112.5** 82.00 : 127.00	**112.0** 82.90 : 120.19	**108.5** 78.02 : 127.38	**107.5** 82.00 : 127.00	**100.5** 82.07 : 118.33	**96.5** 79.50 : 130.50

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

PAH by GCMS

		QC 1046	QC 1005	QC 1040	QC 1072	QC 1013	QC 1011
Benzo(a)pyrene	TM218	**109.5** 75.60 : 124.20	**109.5** 82.80 : 121.21	**108.0** 79.21 : 128.01	**110.5** 75.60 : 124.20	**96.0** 79.75 : 116.97	**92.5** 79.50 : 130.50
Benzo(b)fluoranthene	TM218	**110.5** 81.20 : 121.77	**114.5** 81.11 : 119.79	**107.5** 86.21 : 131.42	**113.5** 81.20 : 121.77	**95.5** 82.41 : 117.15	**94.0** 78.10 : 127.57
Benzo(ghi)perylene	TM218	**106.0** 77.49 : 119.12	**111.0** 81.23 : 116.67	**100.5** 80.11 : 120.52	**108.0** 77.49 : 119.12	**98.5** 77.09 : 114.38	**91.0** 81.67 : 122.61
Benzo(k)fluoranthene	TM218	**106.0** 83.50 : 116.50	**114.5** 79.07 : 114.76	**102.5** 78.77 : 120.72	**106.5** 83.50 : 116.50	**101.0** 81.43 : 115.17	**96.0** 81.20 : 118.10
Chrysene	TM218	**105.0** 78.35 : 114.42	**115.0** 77.94 : 118.46	**101.5** 78.77 : 118.99	**107.5** 78.35 : 114.42	**104.5** 82.50 : 113.51	**104.0** 80.60 : 117.80
Dibenzo(ah)anthracene	TM218	**107.5** 77.15 : 122.45	**113.5** 79.94 : 120.03	**100.5** 76.39 : 122.63	**106.0** 77.15 : 122.45	**96.0** 81.00 : 120.00	**92.0** 77.93 : 124.42
Fluoranthene	TM218	**107.5** 79.08 : 114.40	**100.0** 77.89 : 110.15	**101.5** 77.25 : 117.75	**107.5** 79.08 : 114.40	**111.5** 78.67 : 117.61	**107.0** 80.39 : 114.39
Fluorene	TM218	**105.5** 81.55 : 119.05	**109.0** 80.93 : 113.54	**103.5** 79.28 : 117.35	**106.0** 81.55 : 119.05	**116.0** 76.50 : 121.50	**107.5** 79.50 : 118.50
Indeno(123cd)pyrene	TM218	**108.0** 75.65 : 125.15	**112.0** 80.37 : 120.17	**102.0** 78.87 : 122.50	**107.0** 75.65 : 125.15	**97.5** 79.19 : 117.60	**93.0** 80.30 : 128.30
Naphthalene	TM218	**105.0** 77.25 : 112.60	**98.0** 79.70 : 112.37	**101.5** 74.75 : 118.25	**107.5** 77.25 : 112.60	**110.0** 77.00 : 117.50	**100.5** 82.25 : 118.25
Phenanthrene	TM218	**105.0** 78.25 : 115.44	**106.0** 83.66 : 111.41	**102.0** 78.61 : 113.98	**107.5** 78.25 : 115.44	**116.5** 75.00 : 123.00	**105.5** 71.53 : 114.48
Pyrene	TM218	**106.5** 78.07 : 114.06	**100.0** 81.17 : 112.33	**100.0** 76.15 : 115.26	**107.0** 78.07 : 114.06	**109.5** 77.82 : 116.98	**106.5** 79.12 : 114.39

Component	Method Code	QC 1039
Acenaphthene	TM218	**111.5** 77.34 : 118.20
Acenaphthylene	TM218	**109.0** 77.50 : 115.00
Anthracene	TM218	**109.0** 73.54 : 114.21
Benz(a)anthracene	TM218	**119.0** 74.99 : 132.24
Benzo(a)pyrene	TM218	**123.0** 80.75 : 127.25
Benzo(b)fluoranthene	TM218	**119.5** 75.84 : 127.12
Benzo(ghi)perylene	TM218	**117.5** 74.74 : 124.03
Benzo(k)fluoranthene	TM218	**116.0** 80.00 : 125.00
Chrysene	TM218	**113.5** 77.24 : 120.84
Dibenzo(ah)anthracene	TM218	**119.0** 76.00 : 122.50
Fluoranthene	TM218	**111.5** 78.51 : 118.75
Fluorene	TM218	**112.5** 76.95 : 117.18
Indeno(123cd)pyrene	TM218	**118.5** 75.34 : 127.46
Naphthalene	TM218	**107.0** 76.24 : 112.91

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
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PAH by GCMS

		QC 1039
Phenanthrene	TM218	**110.5** 76.49 : 119.30
Pyrene	TM218	**110.0** 78.25 : 118.17

PAH Spec MS - Aqueous (W)

Component	Method Code	QC 1045
Acenaphthene by GCMS	TM178	**110.0** 92.89 : 110.56
Acenaphthylene by GCMS	TM178	**109.5** 83.00 : 113.00
Anthracene by GCMS	TM178	**106.0** 91.25 : 113.75
Benz(a)anthracene by GCMS	TM178	**112.5** 81.40 : 124.90
Benzo(a)pyrene by GCMS	TM178	**121.0** 83.95 : 128.95
Benzo(b)fluoranthene by GCMS	TM178	**122.0** 87.50 : 132.50
Benzo(ghi)perylene by GCMS	TM178	**111.5** 82.05 : 112.05
Benzo(k)fluoranthene by GCMS	TM178	**122.5** 86.45 : 131.45
Chrysene by GCMS	TM178	**117.0** 85.00 : 124.00
Dibenzo(ah)anthracene by GCMS	TM178	**113.0** 82.81 : 122.26
Fluoranthene by GCMS	TM178	**109.5** 90.00 : 120.00
Fluorene by GCMS	TM178	**114.0** 86.85 : 116.85
Indeno(123cd)pyrene by GCMS	TM178	**112.0** 90.97 : 118.18
Naphthalene by GCMS	TM178	**111.5** 89.55 : 113.25
Phenanthrene by GCMS	TM178	**112.0** 86.30 : 116.30
Pyrene by GCMS	TM178	**108.5** 91.25 : 113.75

pH

Component	Method Code	QC 1011	QC 1021	QC 1094	QC 1008
pH	TM133	**100.38** 97.75 : 102.25	**99.75** 97.75 : 102.25	**100.13** 97.75 : 102.25	**100.0** 97.75 : 102.25

pH Value

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
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pH Value

Component	Method Code	QC 1042
pH	TM256	**101.35** 99.20 : 102.85

Semi Volatile Organic Compounds

Component	Method Code	QC 1035	QC 1072
4-Bromophenylphenylether (Soil)	TM157	**89.0** 49.85 : 131.15	**83.0** 71.52 : 114.03
Benzo(a)anthracene (Soil)	TM157	**86.5** 72.03 : 112.22	**83.0** 71.03 : 115.76
Hexachlorobutadiene (Soil)	TM157	**91.0** 76.50 : 118.50	**84.5** 70.16 : 115.47
Naphthalene (Soil)	TM157	**92.5** 48.65 : 128.15	**85.0** 73.66 : 124.05
Nitrobenzene (Soil)	TM157	**90.0** 49.36 : 130.14	**82.0** 69.48 : 124.95
Phenol (Soil)	TM157	**87.5** 48.50 : 126.50	**85.0** 69.91 : 111.45

SVOC MS (W) - Aqueous

Component	Method Code	QC 1015	QC 1020
4-Bromophenylphenylether	TM176	**109.6** 47.63 : 125.57	**94.4** 65.62 : 120.95
Benzo(a)anthracene	TM176	**96.8** 53.68 : 110.26	**87.2** 62.83 : 114.26
Benzo(a)pyrene	TM176	**83.2** 52.96 : 106.93	**84.0** 54.19 : 105.67
Butylbenzyl phthalate	TM176	**92.0** 42.50 : 111.50	**78.48** 51.20 : 111.20
Hexachlorobutadiene	TM176	**88.8** 38.99 : 102.80	**81.6** 43.12 : 110.32
Naphthalene	TM176	**110.4** 59.13 : 138.09	**96.8** 69.48 : 118.94
Nitrobenzene	TM176	**101.6** 66.40 : 125.20	**95.2** 69.13 : 107.62
Phenol	TM176	**57.84** 35.63 : 68.03	**53.36** 30.92 : 74.19

Total Organic and Inorganic Carbon

Component	Method Code	QC 1098	QC 1006
Total Inorganic Carbon	TM090	**101.17** 90.33 : 112.41	**101.67** 90.47 : 108.44
Total Organic Carbon	TM090	**102.33** 94.72 : 111.89	**103.33** 93.44 : 109.42

Total Organic Carbon

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
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Total Organic Carbon

Component	Method Code	QC 1097	QC 1097
Total Organic Carbon	TM132	**95.43** 88.82 : 111.18	**99.09** 88.82 : 111.18

VOC MS (S)

Component	Method Code	QC 1037	QC 1035	QC 1010
1,1,1,2-tetrachloroethane	TM116	**99.6** 76.60 : 121.00	**107.2** 83.24 : 124.28	**105.4** 83.24 : 124.28
1,1,1-Trichloroethane	TM116	**92.4** 77.80 : 123.40	**111.4** 81.77 : 121.07	**106.8** 81.77 : 121.07
1,1,2-Trichloroethane	TM116	**93.2** 75.40 : 119.80	**101.6** 76.04 : 125.90	**104.2** 76.04 : 125.90
1,1-Dichloroethane	TM116	**99.6** 80.84 : 124.49	**113.8** 77.20 : 122.80	**105.2** 77.20 : 122.80
1,2-Dichloroethane	TM116	**107.4** 91.00 : 135.67	**118.0** 88.21 : 129.81	**114.0** 88.21 : 129.81
1,4-Dichlorobenzene	TM116	**104.2** 84.93 : 111.99	**105.0** 73.23 : 116.39	**99.0** 73.23 : 116.39
2-Chlorotoluene	TM116	**99.8** 74.00 : 117.20	**104.0** 69.22 : 110.64	**99.8** 69.22 : 110.64
4-Chlorotoluene	TM116	**98.4** 71.20 : 113.20	**101.8** 68.57 : 106.26	**90.4** 68.57 : 106.26
Benzene	TM116	**101.0** 79.60 : 125.20	**108.2** 84.33 : 124.27	**108.4** 84.33 : 124.27
Carbon Disulphide	TM116	**98.4** 74.91 : 122.14	**109.6** 77.20 : 122.80	**98.6** 77.20 : 122.80
Carbontetrachloride	TM116	**103.4** 76.80 : 121.20	**104.0** 75.70 : 117.59	**104.4** 75.70 : 117.59
Chlorobenzene	TM116	**101.6** 86.65 : 119.12	**108.0** 85.28 : 129.96	**104.6** 85.28 : 129.96
Chloroform	TM116	**98.6** 82.00 : 128.80	**111.6** 83.35 : 128.49	**105.8** 83.35 : 128.49
Chloromethane	TM116	**104.8** 74.62 : 135.86	**120.2** 55.16 : 145.46	**102.8** 55.16 : 145.46
Cis-1,2-Dichloroethene	TM116	**95.4** 81.20 : 128.00	**102.6** 73.56 : 118.93	**100.8** 73.56 : 118.93
Dibromomethane	TM116	**96.2** 73.40 : 116.60	**97.4** 73.40 : 116.60	**101.0** 73.40 : 116.60
Dichloromethane	TM116	**105.2** 86.60 : 137.00	**111.4** 76.16 : 121.98	**107.6** 76.16 : 121.98
Ethylbenzene	TM116	**101.0** 73.60 : 115.60	**106.6** 80.07 : 125.98	**99.8** 80.07 : 125.98
Hexachlorobutadiene	TM116	**114.2** 33.65 : 130.56	**107.0** 30.92 : 132.28	**88.4** 30.92 : 132.28
Isopropylbenzene	TM116	**104.0** 72.52 : 117.52	**111.4** 69.27 : 125.32	**96.2** 69.27 : 125.32
Naphthalene	TM116	**100.2** 83.23 : 126.48	**106.8** 81.39 : 114.40	**108.8** 81.39 : 114.40
o-Xylene	TM116	**92.8** 69.60 : 110.40	**94.2** 75.46 : 111.52	**91.2** 75.46 : 111.52

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
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VOC MS (S)

		QC 1037	QC 1035	QC 1010
p/m-Xylene	TM116	**96.9** 71.30 : 112.70	**103.0** 76.97 : 121.75	**95.5** 76.97 : 121.75
Sec-Butylbenzene	TM116	**112.6** 59.20 : 125.20	**107.2** 49.27 : 129.90	**84.0** 49.27 : 129.90
Tetrachloroethene	TM116	**110.0** 79.80 : 125.40	**112.0** 84.48 : 129.84	**108.6** 84.48 : 129.84
Toluene	TM116	**93.0** 76.08 : 110.17	**103.4** 81.34 : 119.56	**104.0** 81.34 : 119.56
Trichloroethene	TM116	**98.0** 75.00 : 118.20	**105.4** 84.09 : 114.24	**104.4** 84.09 : 114.24
Trichlorofluoromethane	TM116	**102.0** 83.78 : 132.82	**107.6** 76.22 : 114.82	**102.2** 76.22 : 114.82
Vinyl Chloride	TM116	**101.0** 66.81 : 138.46	**107.2** 63.59 : 125.99	**96.0** 63.59 : 125.99

VOC MS (W)

Component	Method Code	QC 1092	QC 1067	QC 1092
1,1,1,2-Tetrachloroethan e	TM208	**104.5** 84.25 : 114.84	**105.5** 84.25 : 114.84	**107.0** 81.02 : 113.71
1,1,1-Trichloroethane	TM208	**98.0** 84.67 : 111.97	**100.0** 84.67 : 111.97	**109.0** 80.57 : 121.77
1,1-Dichloroethane	TM208	**100.0** 80.19 : 121.45	**103.5** 80.19 : 121.45	**110.5** 77.85 : 123.56
1,2-Dichloroethane	TM208	**109.5** 77.68 : 127.05	**111.5** 77.68 : 127.05	**115.0** 80.96 : 124.37
2-Chlorotoluene	TM208	**98.0** 85.81 : 116.77	**100.5** 85.81 : 116.77	**98.5** 87.97 : 116.90
4-Chlorotoluene	TM208	**104.0** 87.22 : 115.45	**101.5** 87.22 : 115.45	**97.5** 88.70 : 113.67
Benzene	TM208	**97.5** 84.06 : 116.43	**100.5** 84.06 : 116.43	**109.5** 82.08 : 117.93
Bromomethane	TM208	**89.0** 76.12 : 113.26	**93.0** 76.12 : 113.26	**96.5** 78.68 : 126.84
Carbontetrachloride	TM208	**101.0** 85.82 : 112.65	**103.0** 85.82 : 112.65	**111.5** 82.06 : 117.49
Chlorobenzene	TM208	**101.0** 80.71 : 128.37	**103.5** 80.71 : 128.37	**103.0** 77.50 : 122.50
Chloroform	TM208	**102.5** 84.84 : 119.97	**104.5** 84.84 : 119.97	**109.5** 77.50 : 122.50
Chloromethane	TM208	**96.5** 53.63 : 141.38	**106.5** 53.63 : 141.38	**110.5** 64.99 : 145.80
Cis-1,2-Dichloroethene	TM208	**98.0** 81.65 : 120.44	**100.5** 81.65 : 120.44	**105.0** 82.70 : 120.11
Dichloromethane	TM208	**101.5** 79.31 : 122.56	**104.5** 79.31 : 122.56	**105.0** 80.45 : 125.21
Ethylbenzene	TM208	**96.5** 84.91 : 106.66	**98.5** 84.91 : 106.66	**98.5** 81.00 : 111.00
Hexachlorobutadiene	TM208	**90.5** 68.91 : 121.59	**94.5** 68.91 : 121.59	**89.0** 79.39 : 111.07
o-Xylene	TM208	**97.5** 85.43 : 113.21	**99.0** 85.43 : 113.21	**97.5** 84.32 : 113.42
p/m-Xylene	TM208	**97.5** 80.94 : 113.51	**98.5** 80.94 : 113.51	**98.25** 82.25 : 112.25

VOC MS (W)

		QC 1092	QC 1067	QC 1092
Tert-butyl methyl ether	TM208	**95.0** 59.77 : 129.51	**100.0** 59.77 : 129.51	**106.0** 74.09 : 120.02
Tetrachloroethene	TM208	**99.0** 83.21 : 115.40	**100.5** 83.21 : 115.40	**99.0** 84.88 : 110.14
Toluene	TM208	**97.5** 86.02 : 114.04	**100.0** 86.02 : 114.04	**103.0** 85.71 : 113.18
Trichloroethene	TM208	**100.5** 83.50 : 113.50	**103.0** 83.50 : 113.50	**108.5** 82.53 : 112.59
Vinyl Chloride	TM208	**90.5** 66.57 : 130.53	**96.0** 66.57 : 130.53	**97.0** 67.57 : 130.24

The above information details the reference name of the analytical quality control sample (AQC) that has been run with the samples contained in this report for the different methods of analysis.
The figure detailed is the percentage recovery result for the AQC.
The subscript numbers below are the percentage recovery lower control limit (LCL) and the upper control limit (UCL). The percentage recovery result for the AQC should be between these limits to be statistically in control.

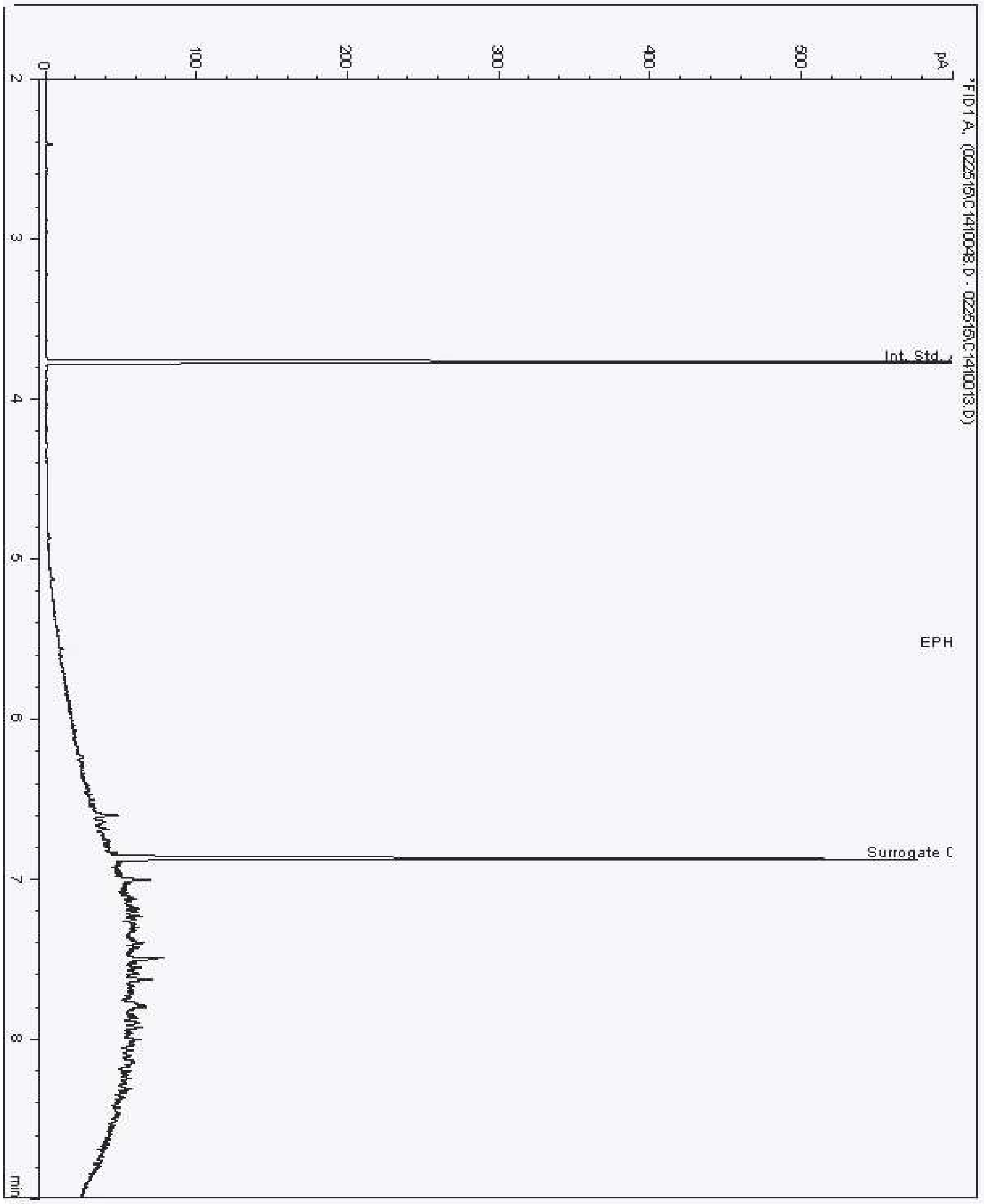
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10905736	**Depth :**	2.50 - 3.50
		Sample ID :	BH03		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341720-
Date Acquired : 26/02/15 15:36:45 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10905861	**Depth :**	0.00 - 1.00
		Sample ID :	BH01		

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341736-
Date Acquired      :  27/02/15 00:53:12 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
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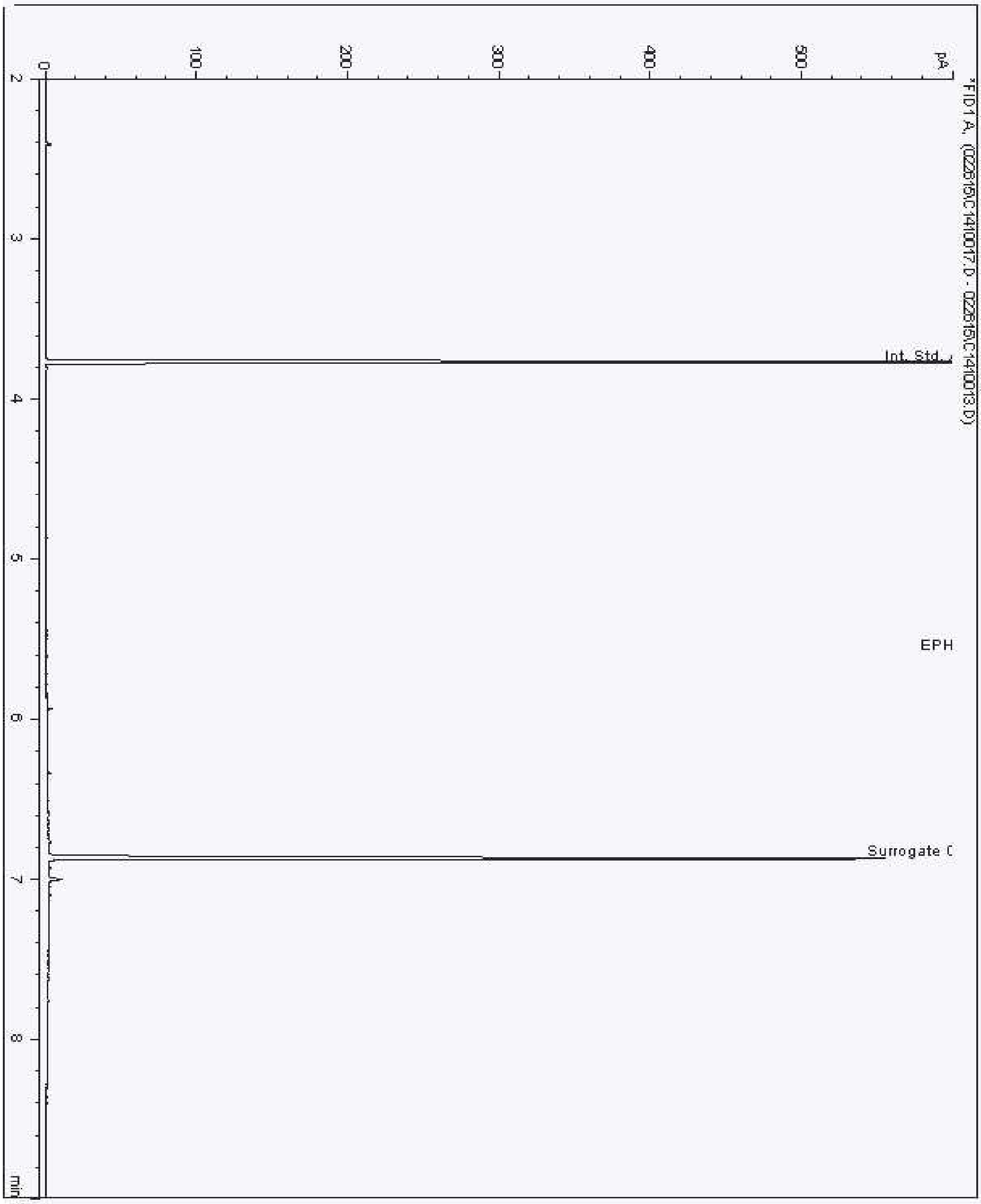


SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

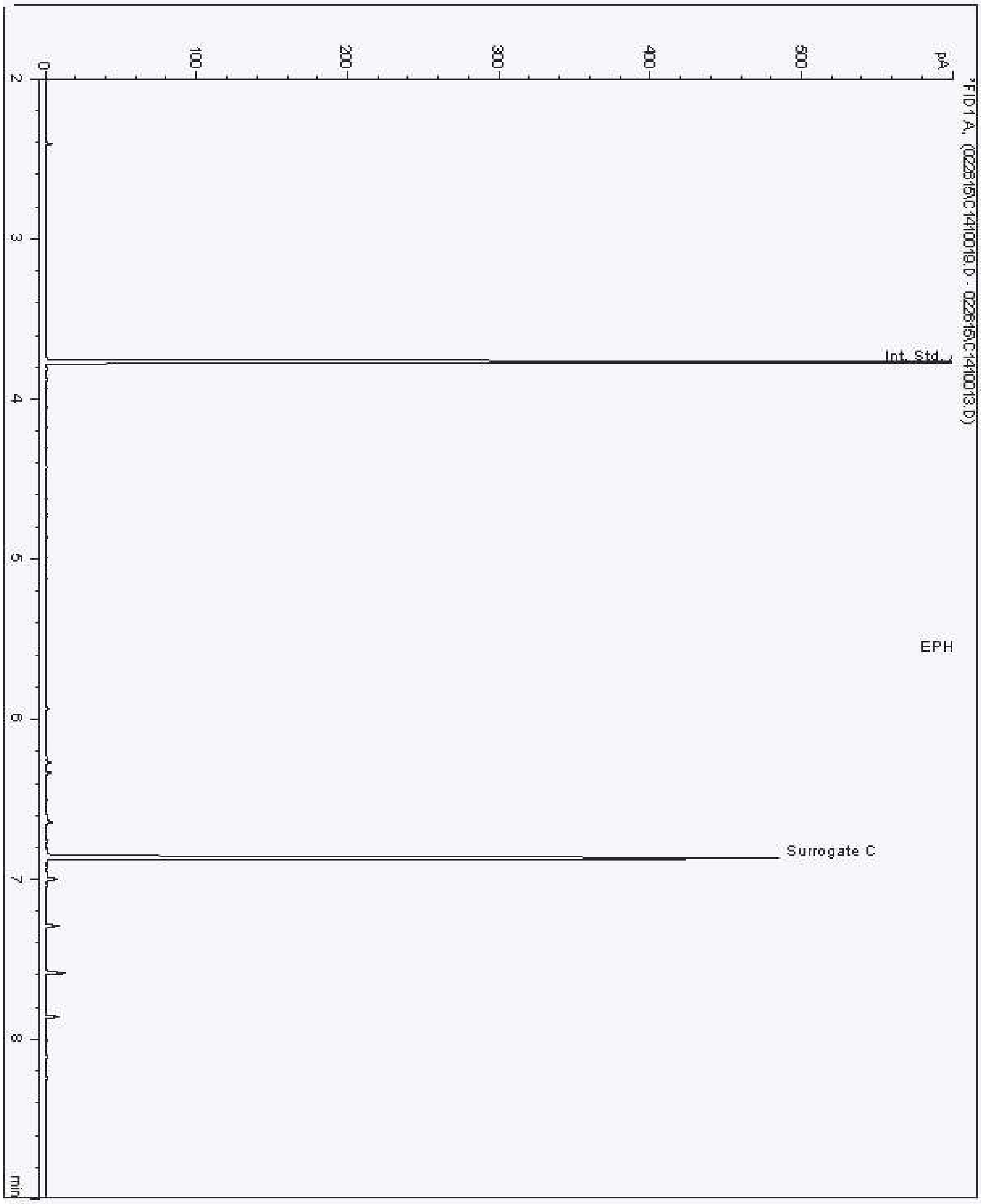
Analysis: EPH by FID

Sample No : 10906077
Sample ID : BH02

Depth : 1.00 - 2.00

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341650-
Date Acquired : 27/02/15 01:37:51 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

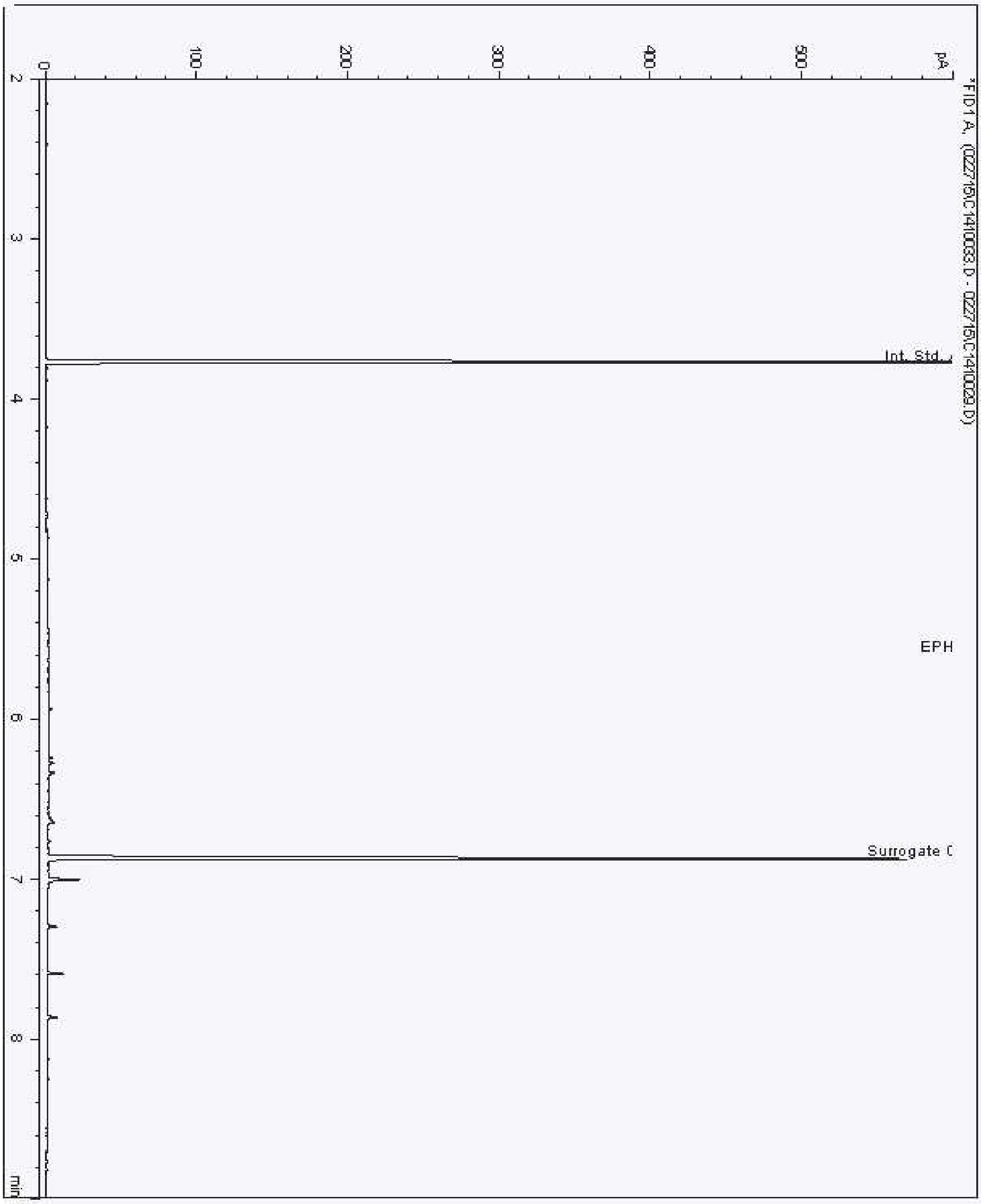
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10912520	**Depth :**	0.00 - 1.00
		Sample ID :	BH01		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity	:	10341583-
Date Acquired	:	28/02/15 04:42:26 PM
Units	:	mg/kg
Sample Multiplier	:	0.000
Dilution	:	



15:38:43 06/03/2015

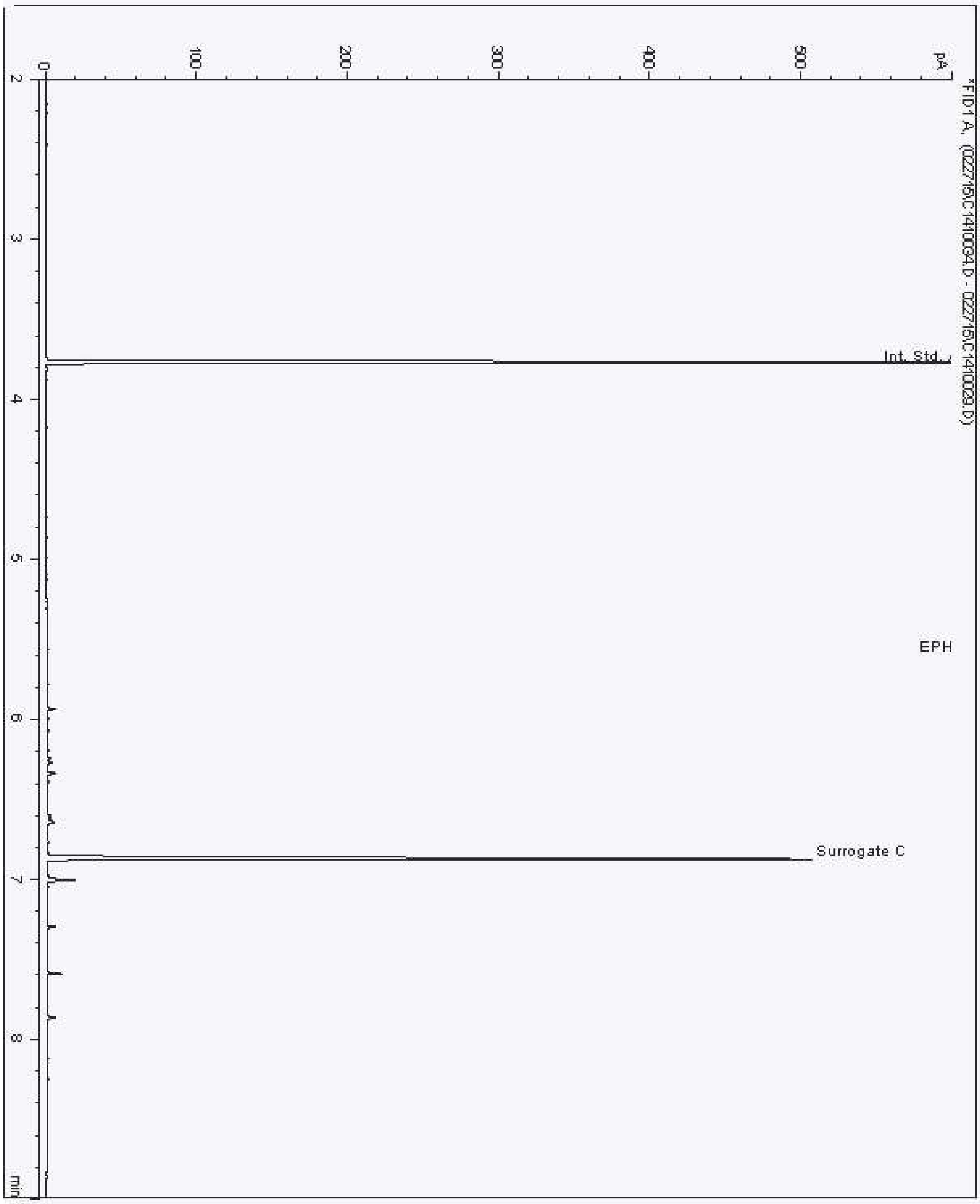
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10912540	**Depth :**	1.00 - 2.00
		Sample ID :	BH01		

```
Alcontrol/Geochem Analytical Services
  EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341594-
Date Acquired      :  28/02/15 05:05:06 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10912729	**Depth :**	2.00 - 3.00
		Sample ID :	BH01		

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Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity     :  10341606-
Date Acquired       :  28/02/15 05:27:40 PM
Units               :  mg/kg
Sample Multiplier   :  0.000
Dilution            :
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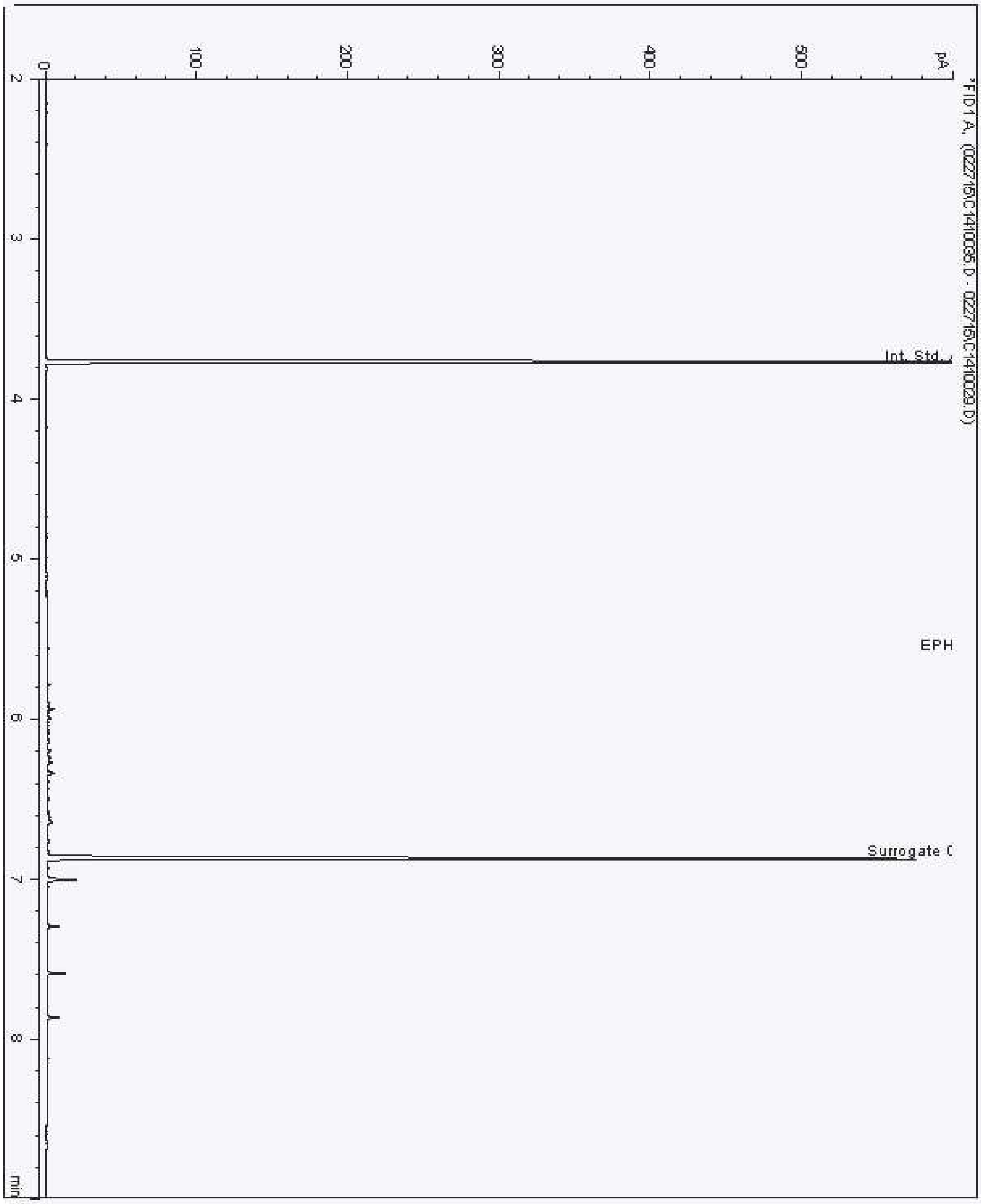

Chromatogram

Analysis: EPH by FID

Sample No : 10912796
Sample ID : BH02

Depth : 0.00 - 0.50

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

```
Sample Identity    :  10341768-
Date Acquired      :  28/02/15 05:50:11 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
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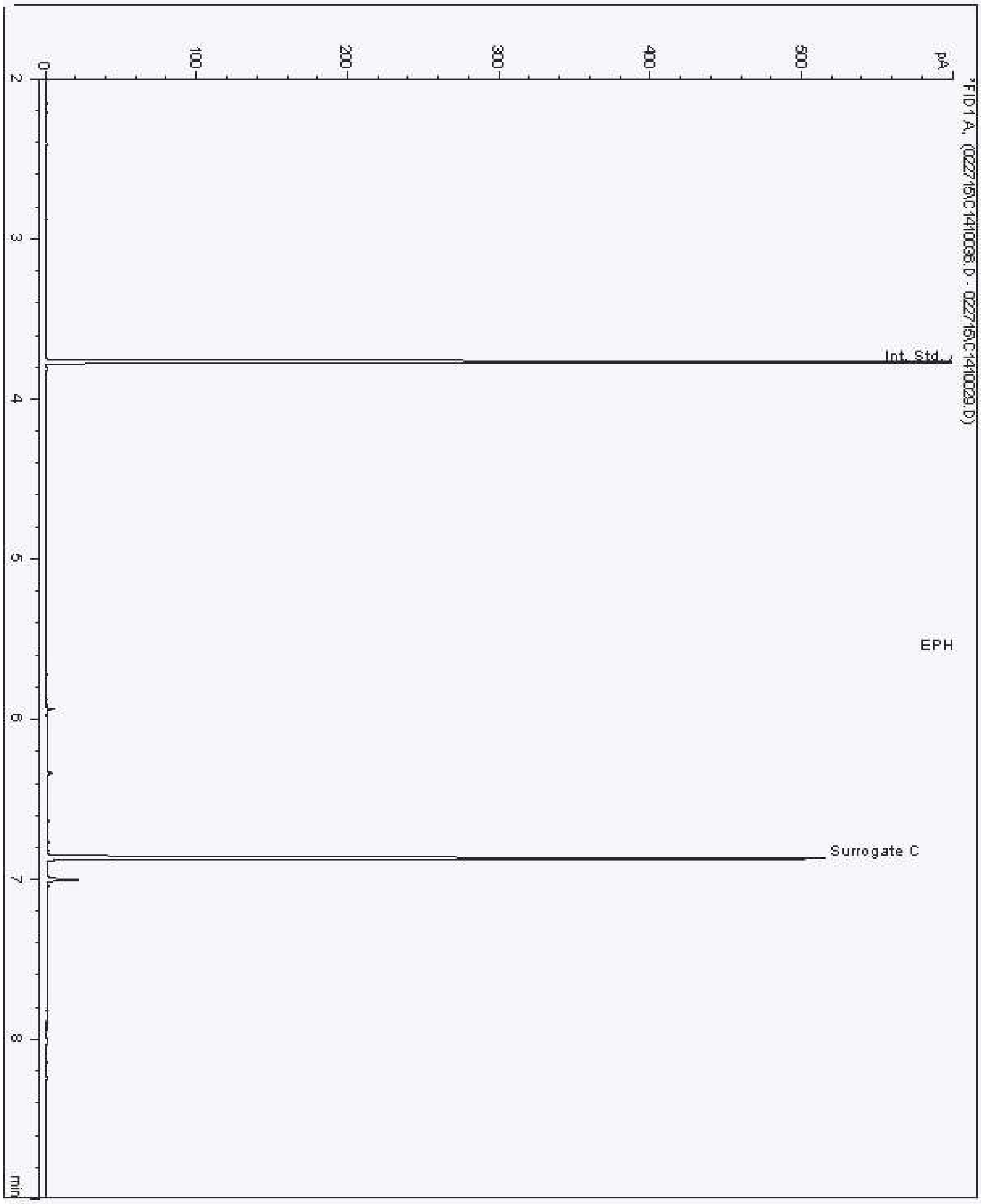


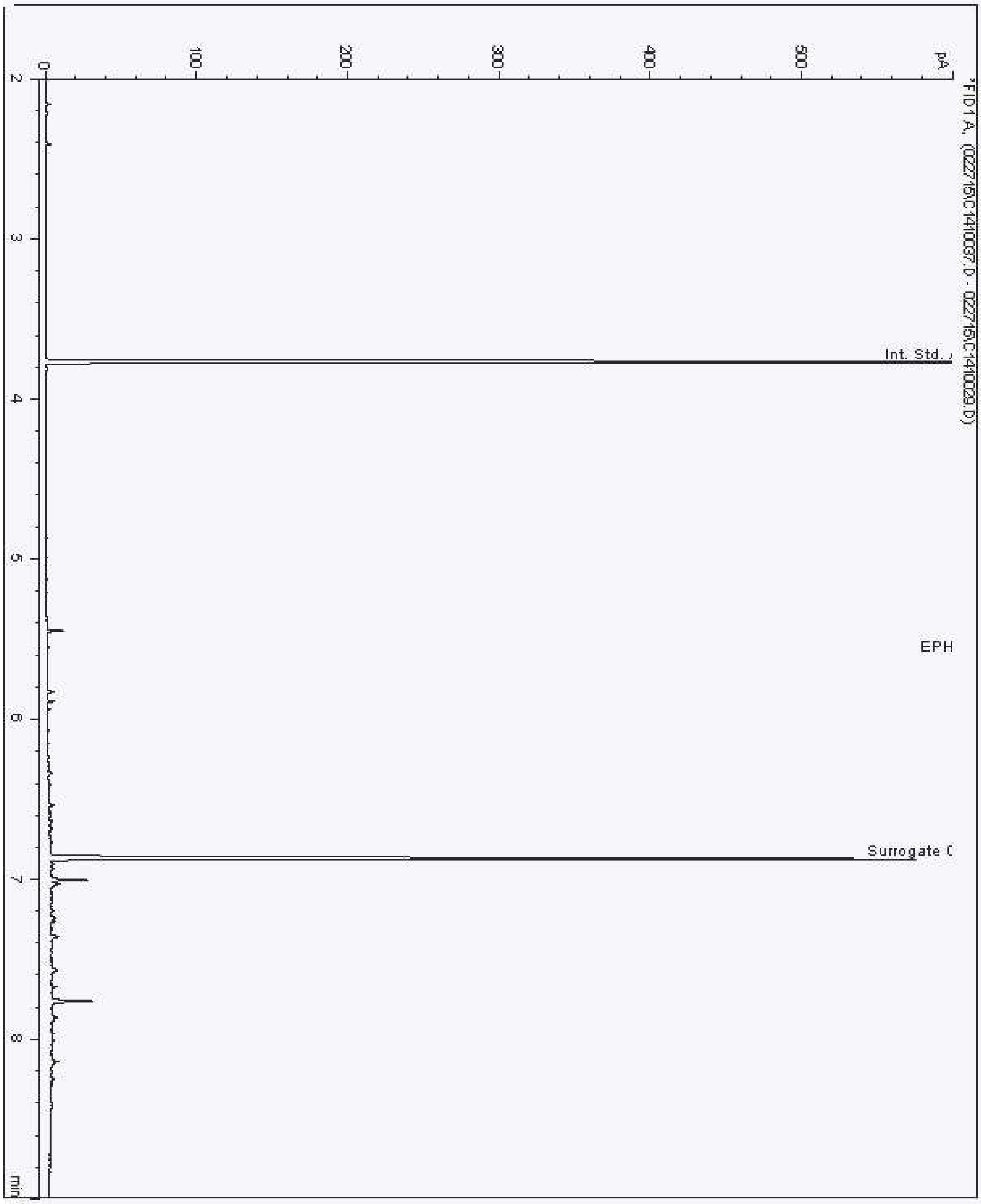
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10912872	**Depth :**	0.00 - 0.50
		Sample ID :	BH06		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341883-
Date Acquired : 28/02/15 06:12:35 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



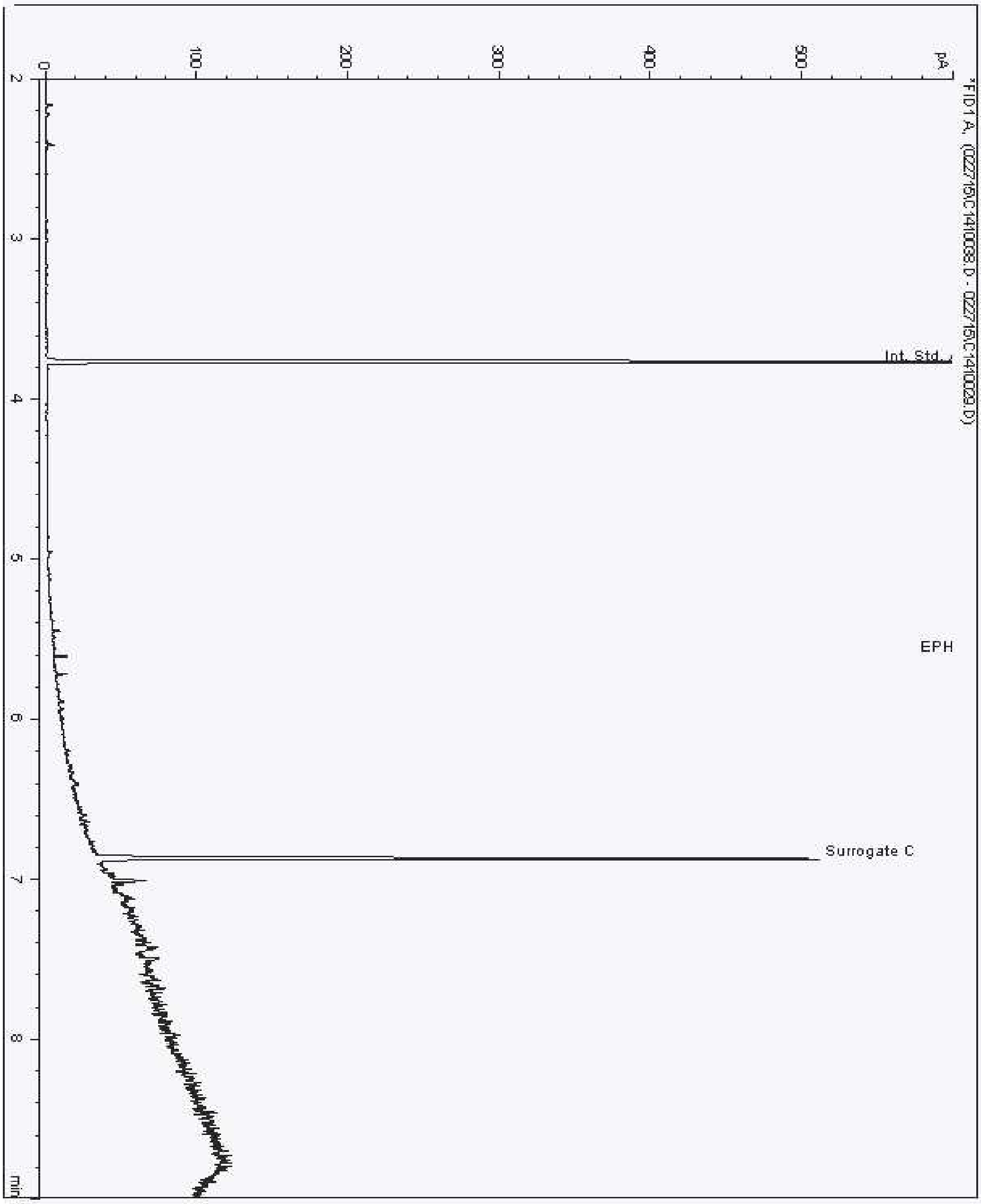
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10913113	**Depth :**	0.00 - 1.00
		Sample ID :	BH04		

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341811-
Date Acquired      :  28/02/15 06:35:02 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



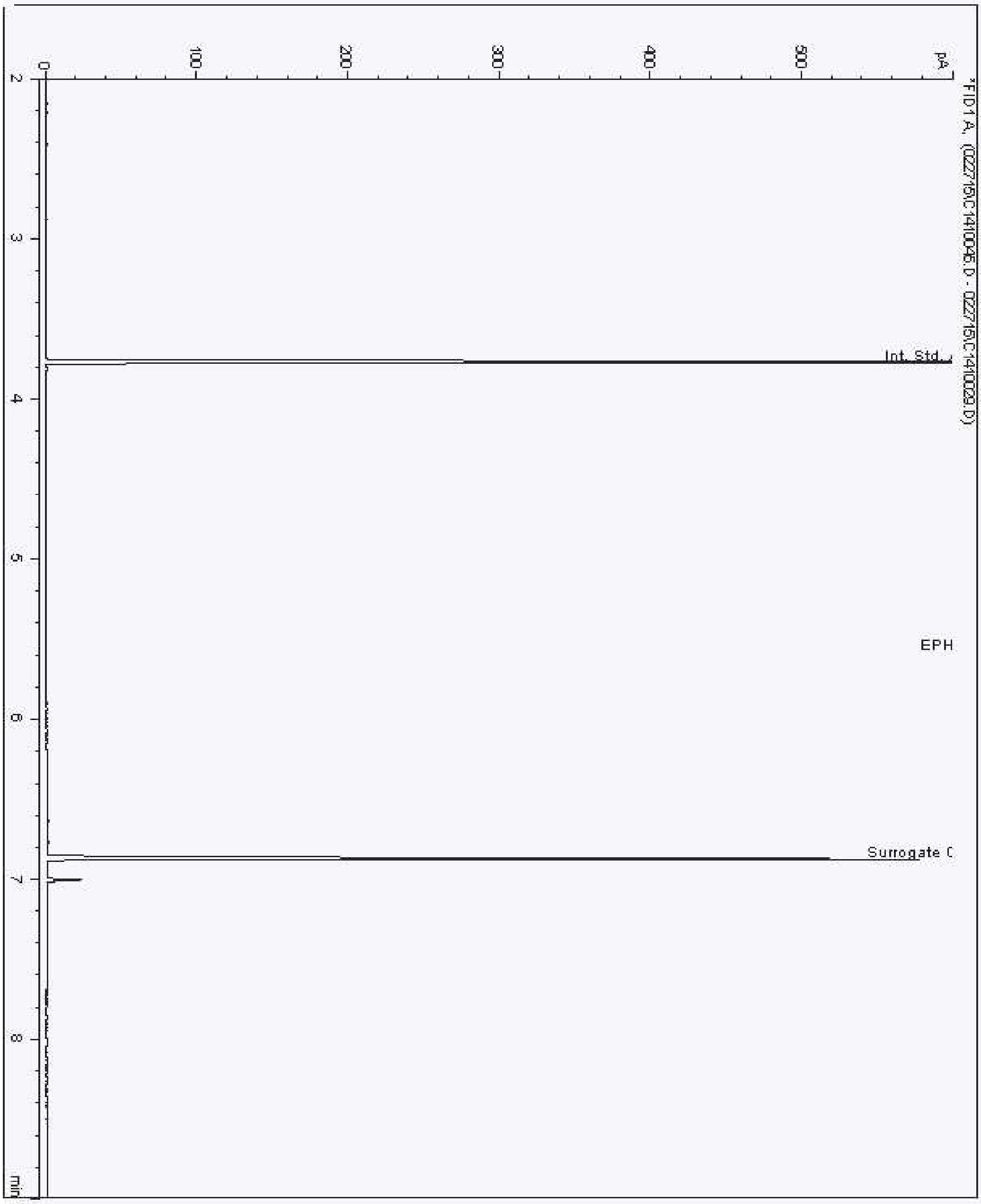
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10915407	**Depth :**	2.50 - 3.50
		Sample ID :	BH05		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

```
Sample Identity    :  10341860-
Date Acquired      :  28/02/15 09:11:38 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



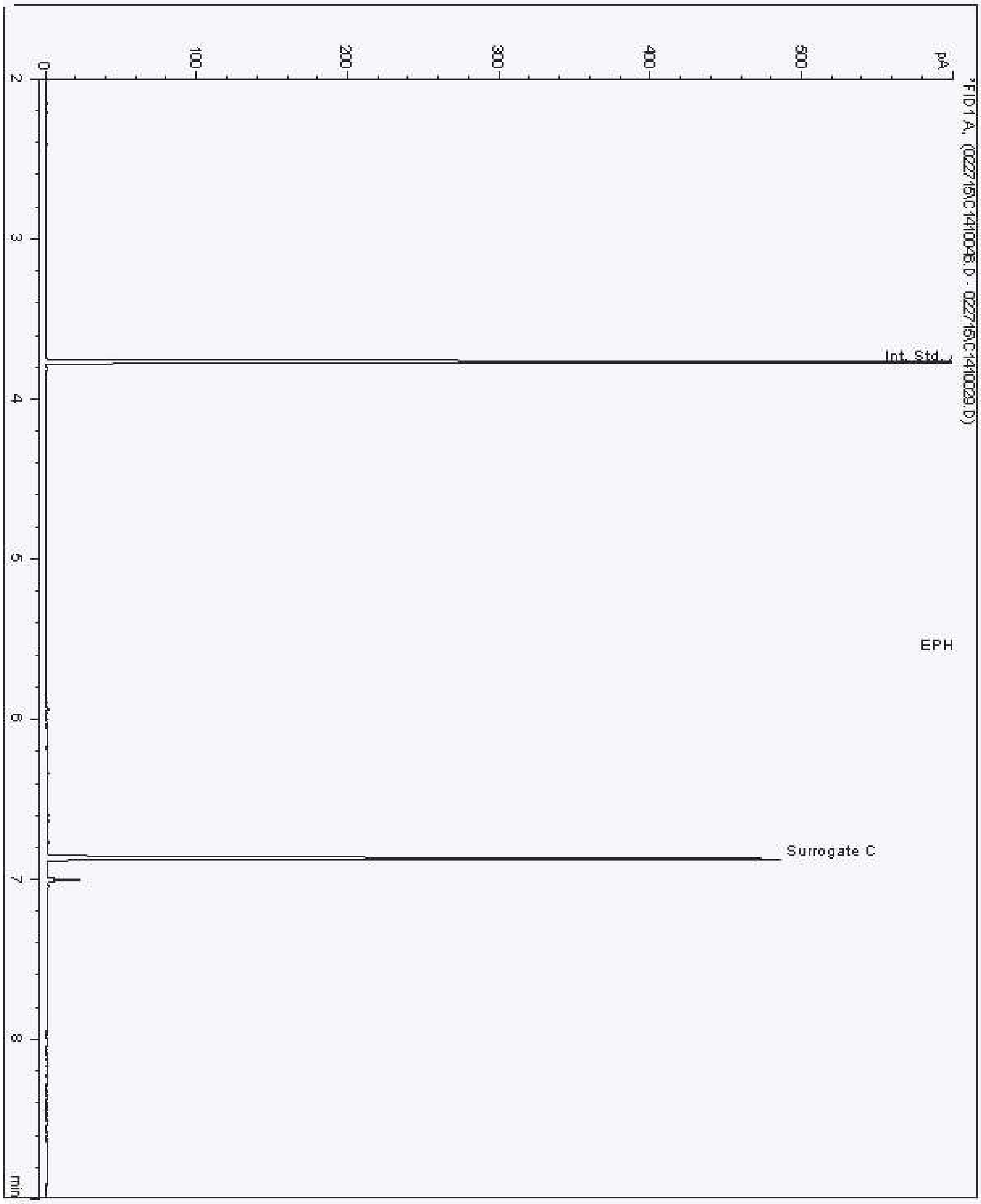
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10915454	**Depth :**	2.50 - 3.50
		Sample ID :	BH02		

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity     :  10341784-
Date Acquired       :  28/02/15 09:33:59 PM
Units               :  mg/kg
Sample Multiplier   :  0.000
Dilution            :
```



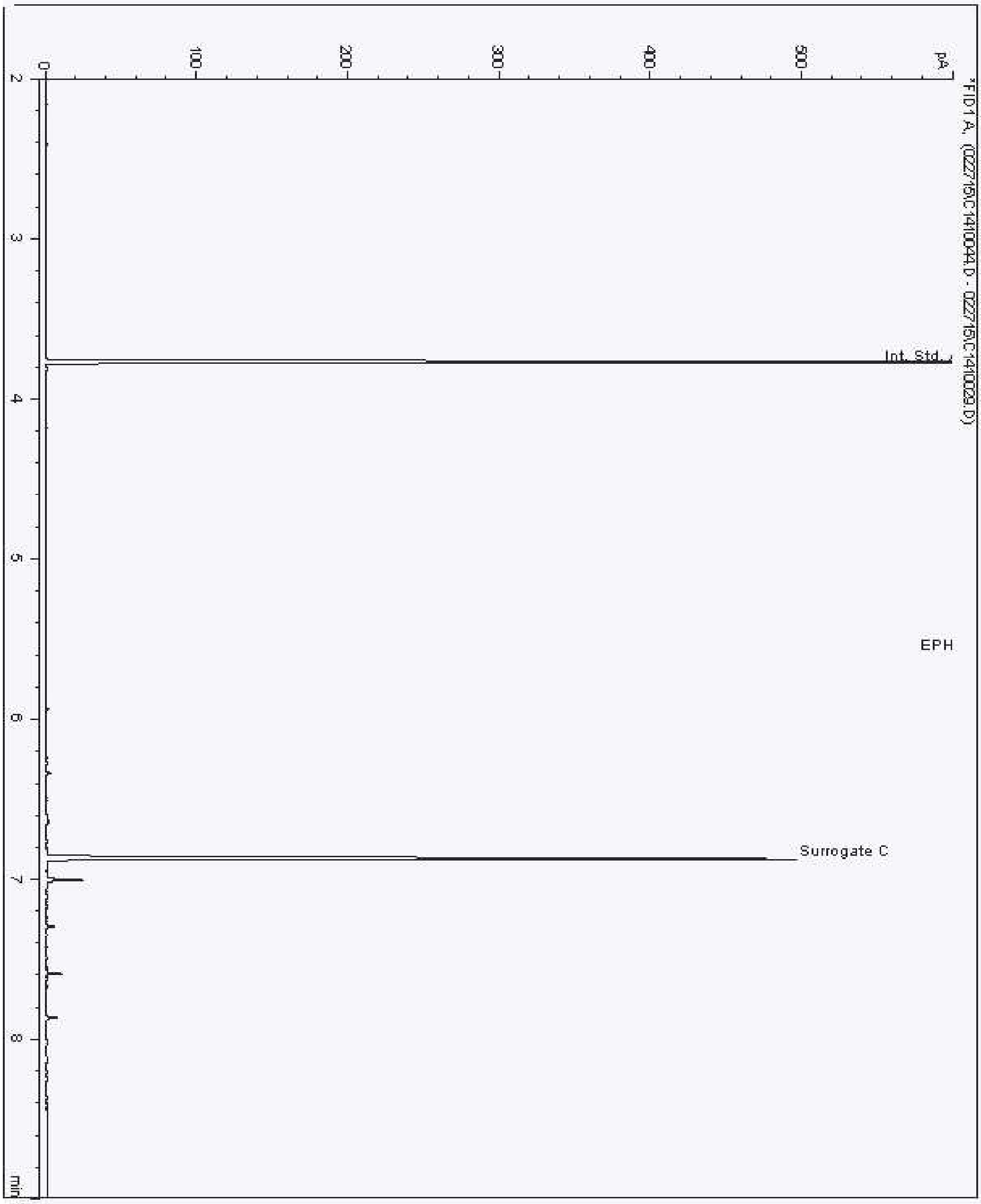
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10915510	**Depth :**	2.50 - 3.50
		Sample ID :	BH01		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341752-
Date Acquired : 28/02/15 08:49:04 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



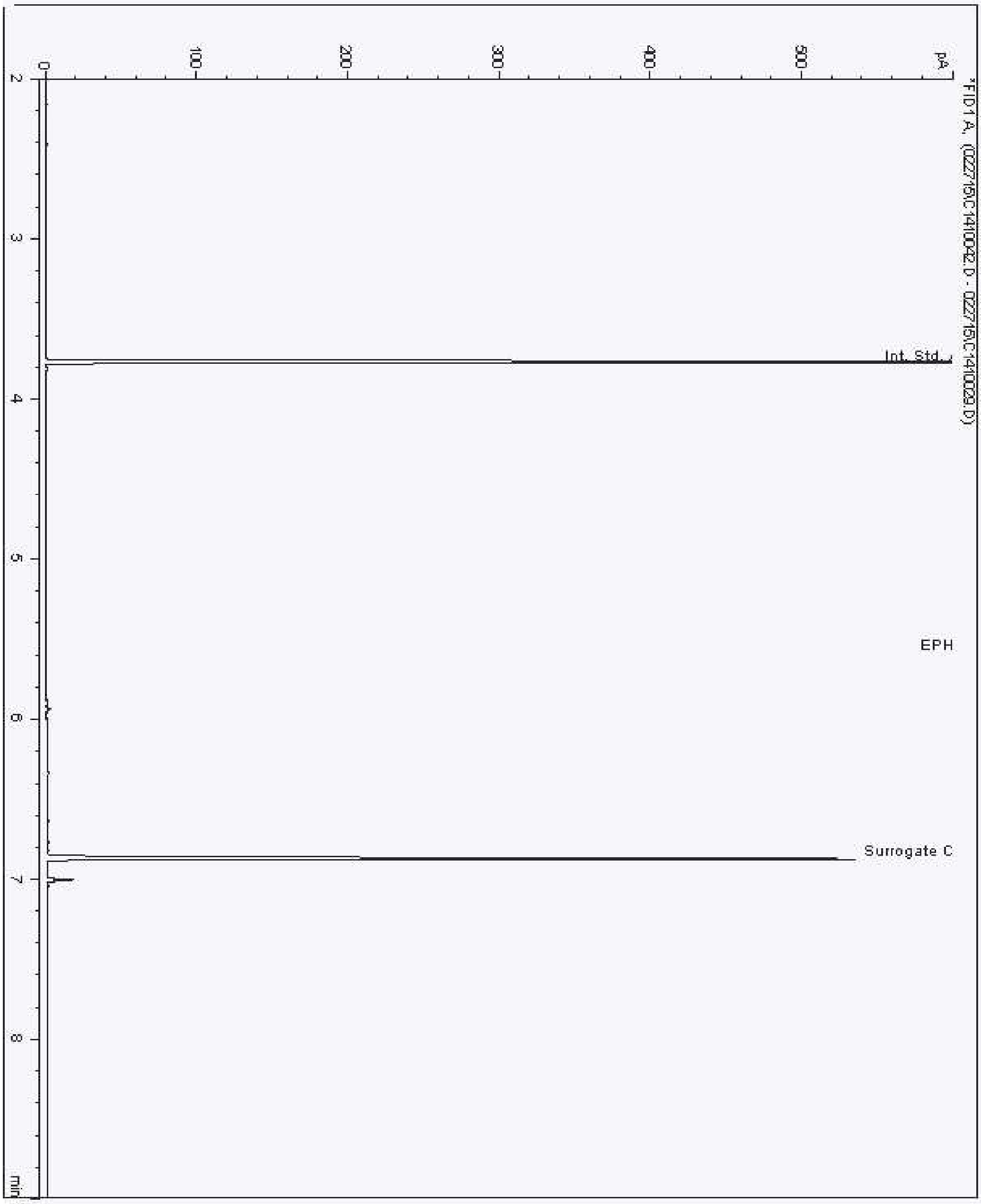
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10915574	**Depth :**	2.50 - 3.50
		Sample ID :	BH03		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341802-
Date Acquired : 28/02/15 08:04:13 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



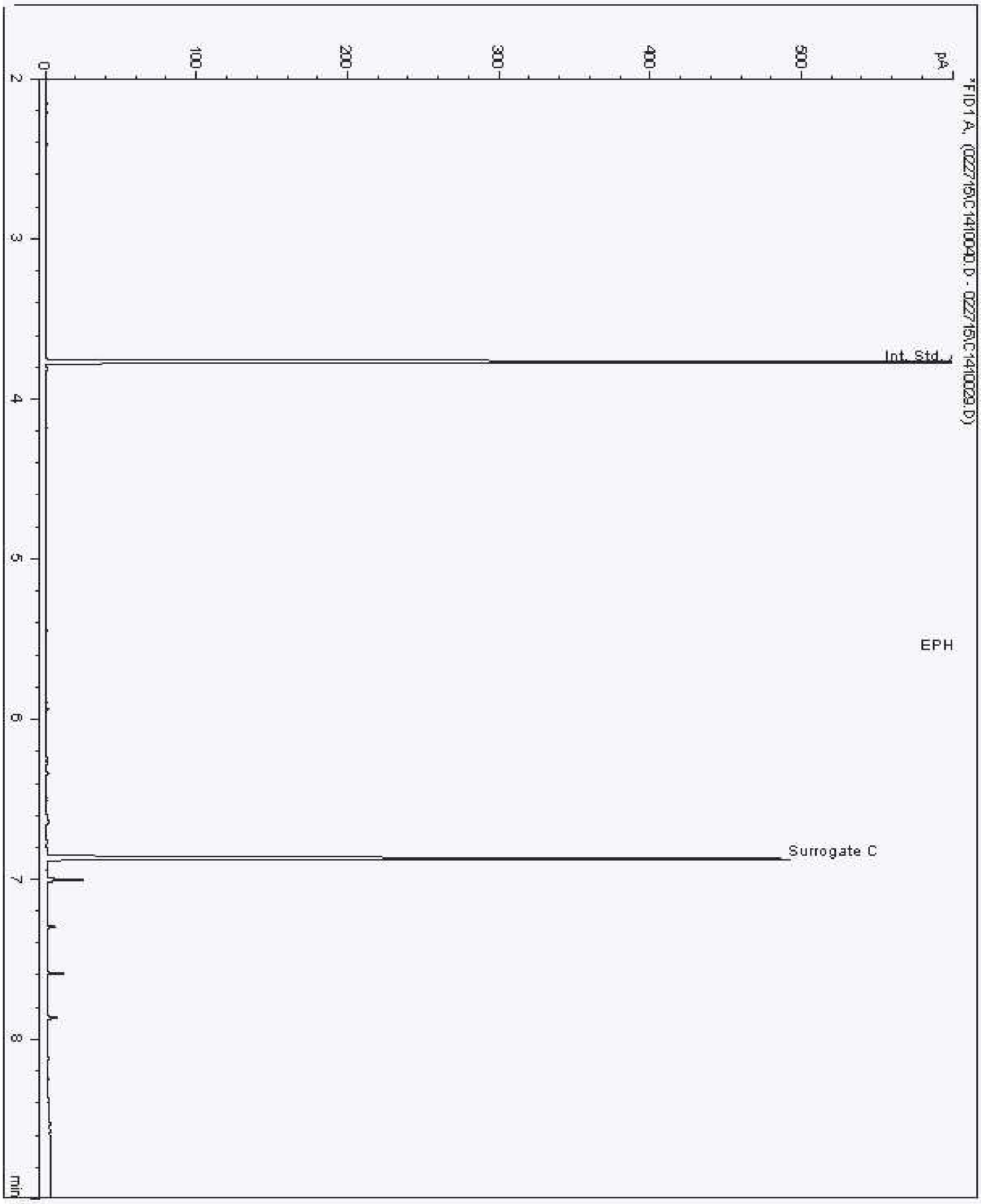
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10915626	**Depth :**	2.00 - 3.00
		Sample ID :	BH08		

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341897-
Date Acquired      :  28/02/15 07:19:52 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



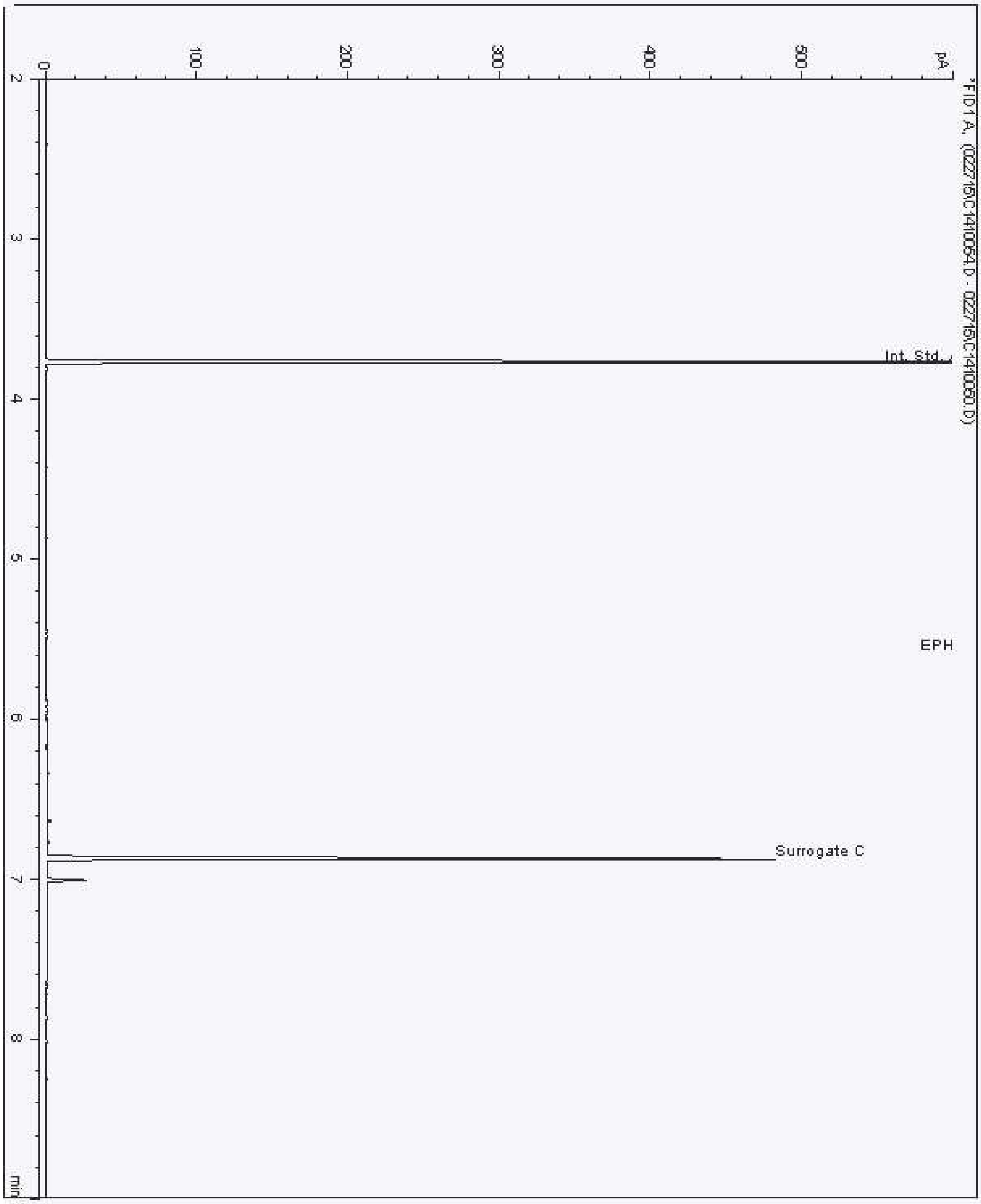
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921327	**Depth :**	0.00 - 1.00
		Sample ID :	BH08		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341943-
Date Acquired : 28/02/15 12:42:22 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



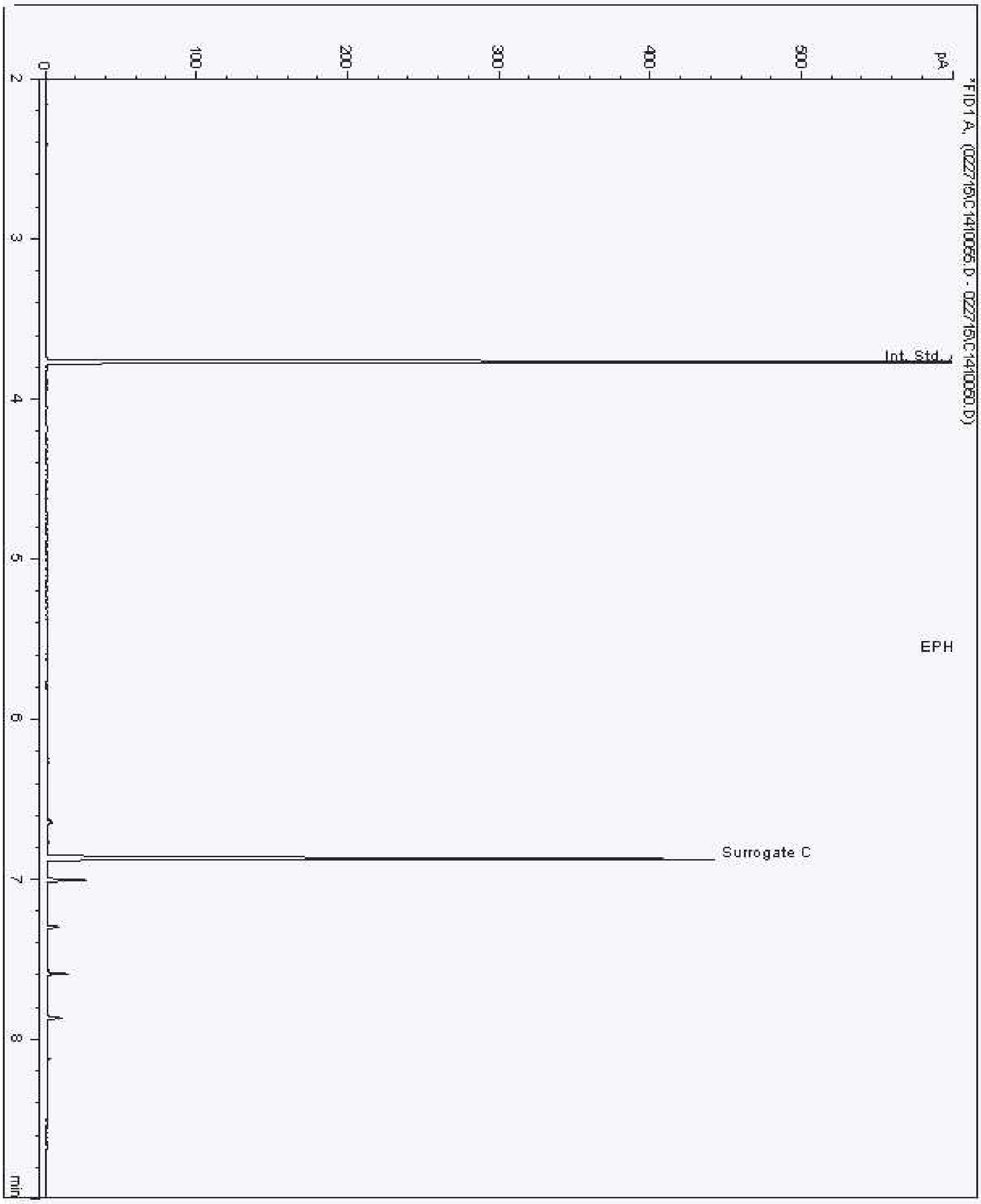
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921356	**Depth :**	1.50 - 2.50
		Sample ID :	BH03		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341705-
Date Acquired : 28/02/15 13:04:55 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



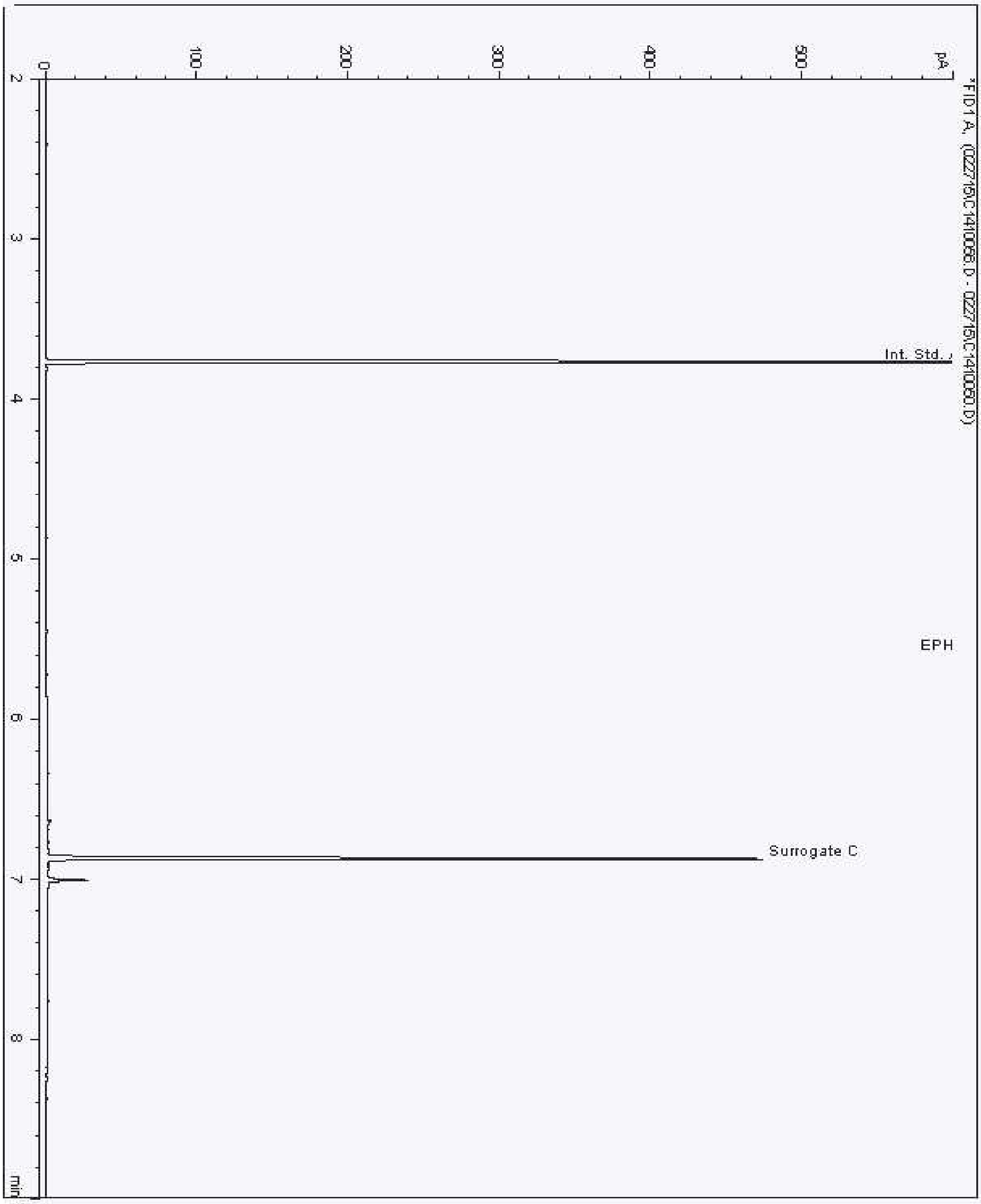
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis: EPH by FID **Sample No :** 10921373 **Depth :** 0.00 - 0.50
Sample ID : BH03

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341794-
Date Acquired      :  28/02/15 13:27:30 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



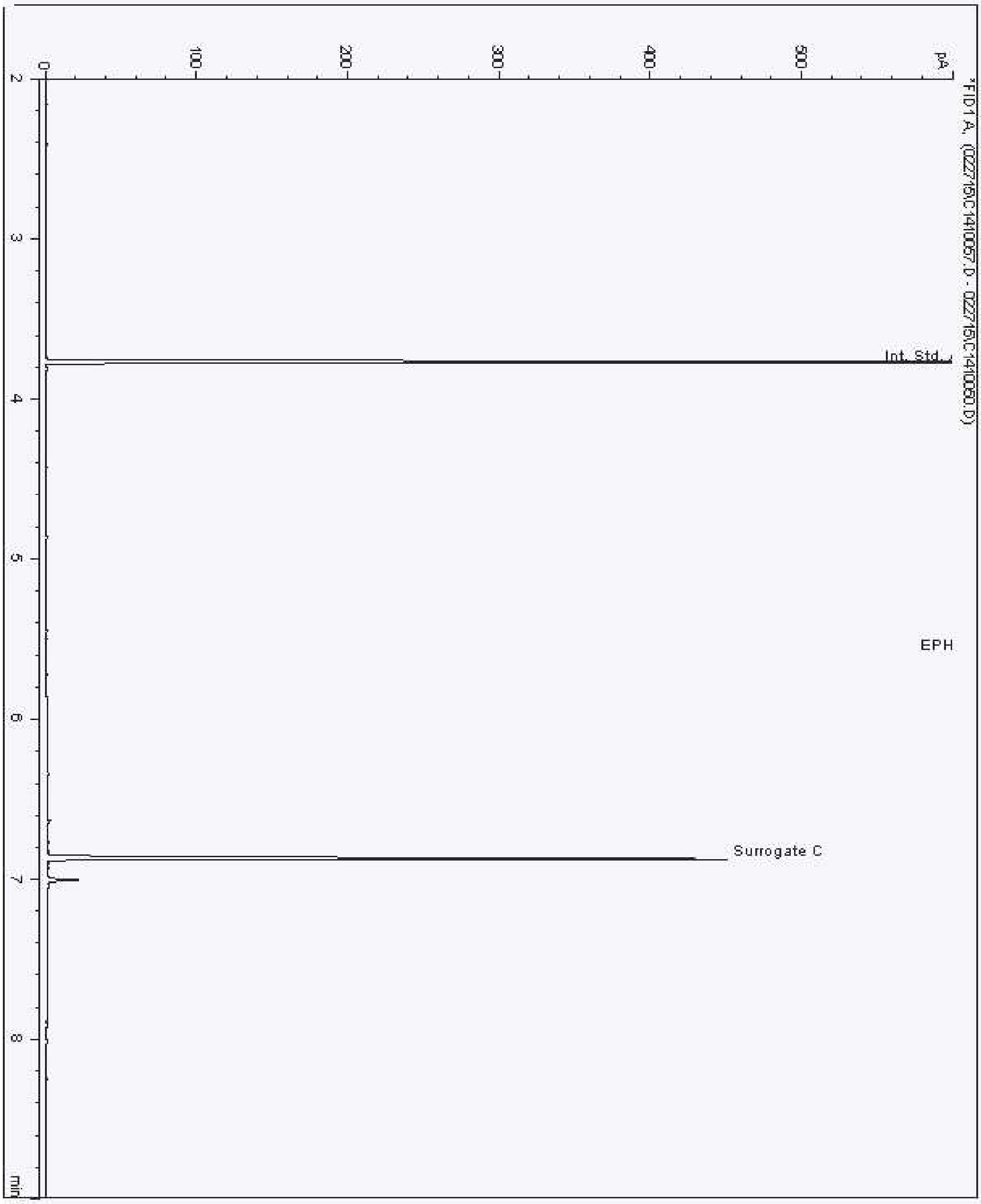
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921395	**Depth :**	0.00 - 1.00
		Sample ID :	BH07		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341922-
Date Acquired : 28/02/15 13:50:04 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

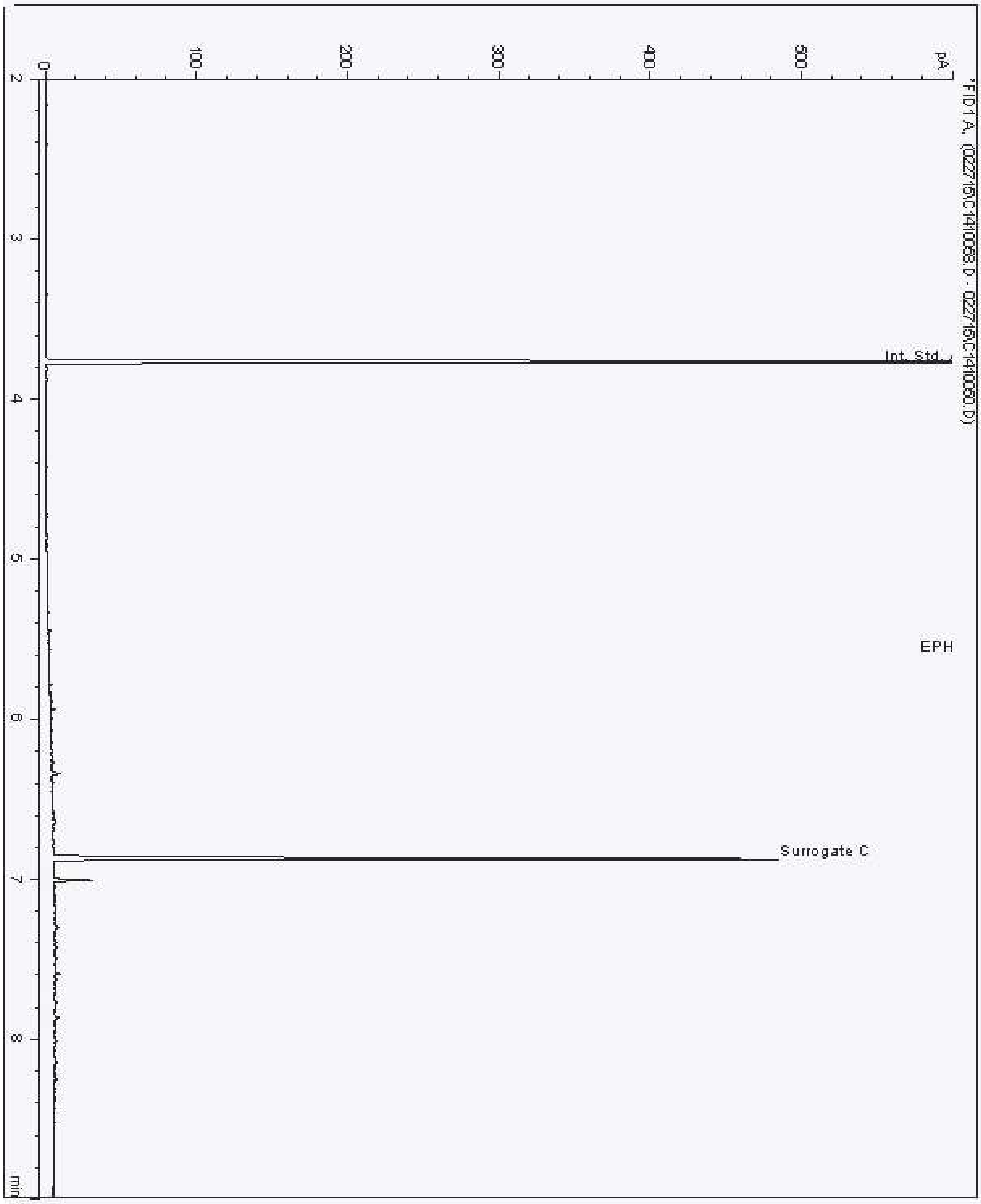
Analysis: EPH by FID

Sample No : 10921428
Sample ID : BH03

Depth : 0.50 - 1.00

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341683-
Date Acquired      :  28/02/15 14:12:30 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



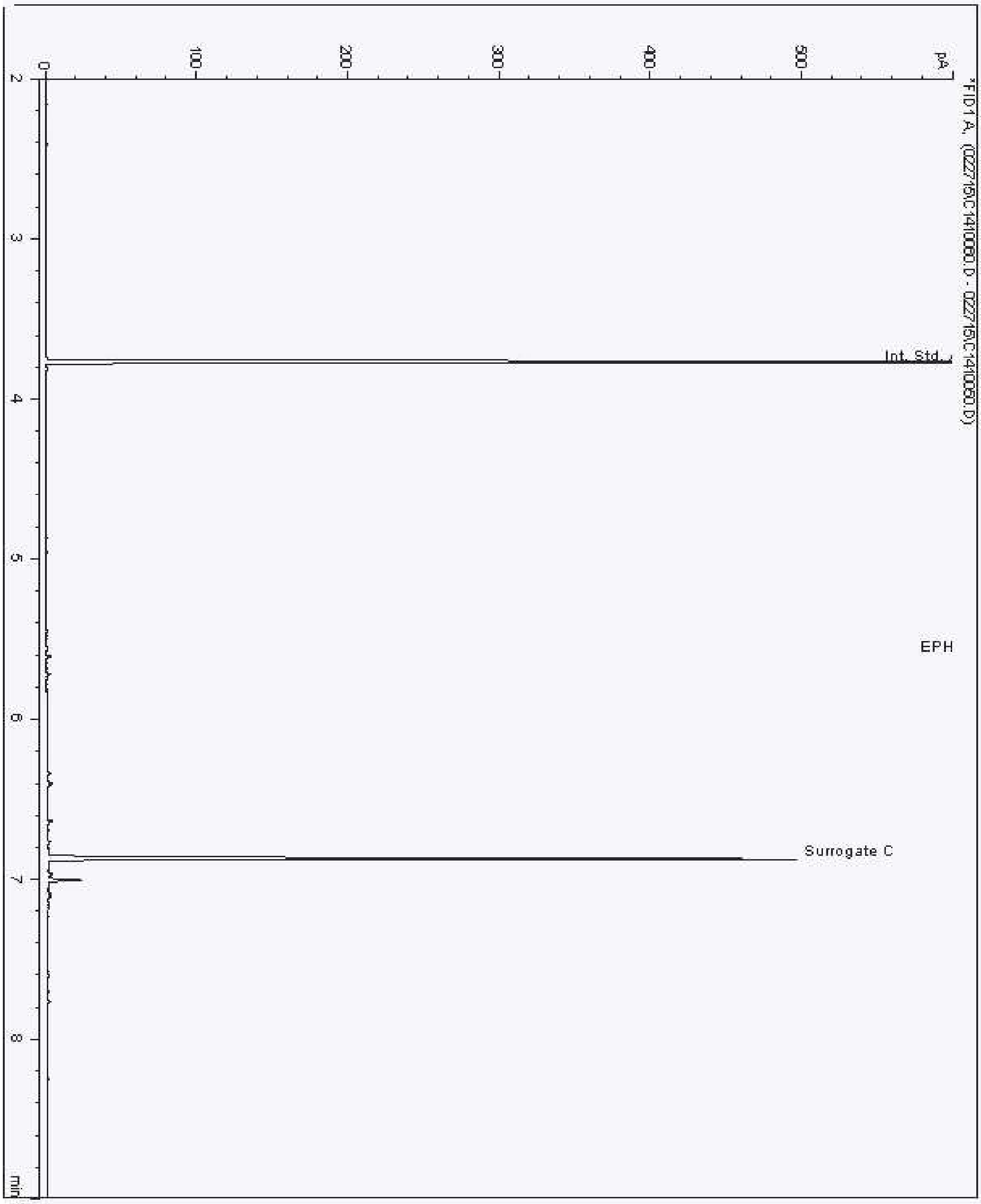
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921505	**Depth :**	0.00 - 1.00
		Sample ID :	BH05		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341840-
Date Acquired : 28/02/15 14:57:35 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



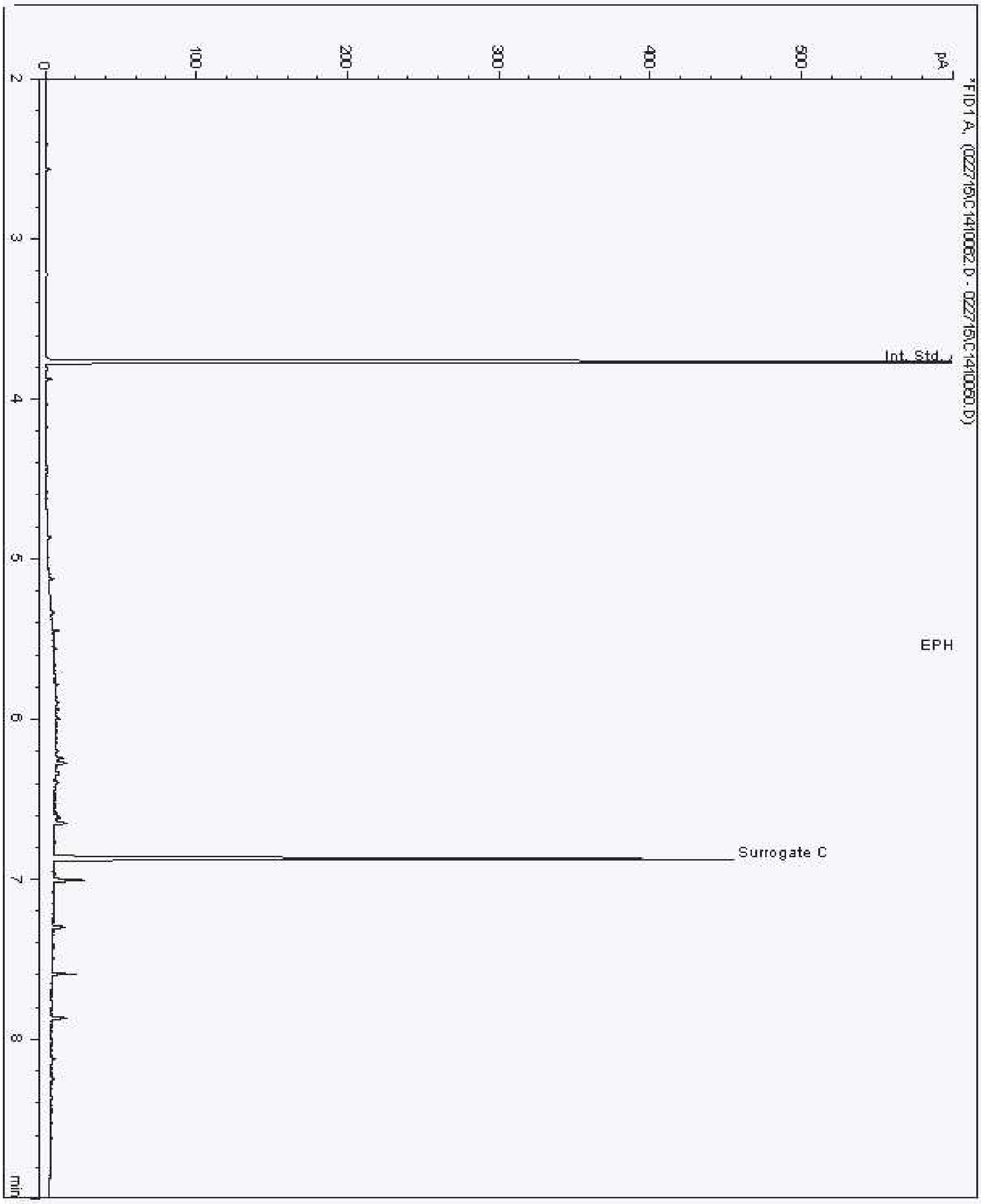
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921568	**Depth :**	0.00 - 1.00
		Sample ID :	BH02		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341625-
Date Acquired : 28/02/15 15:42:30 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



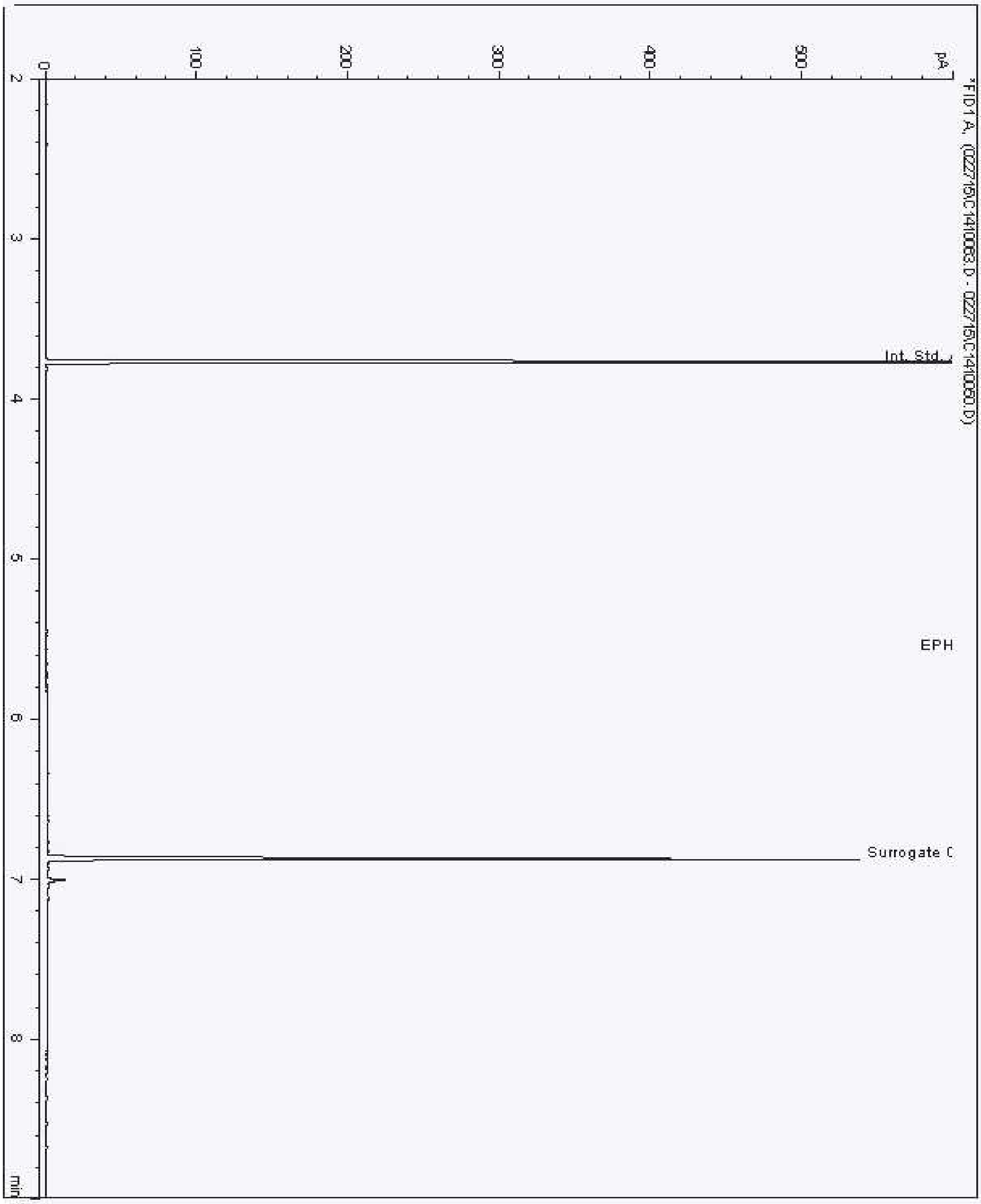
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921620	**Depth :**	2.00 - 3.00
		Sample ID :	BH06		

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341912-
Date Acquired      :  28/02/15 16:05:02 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



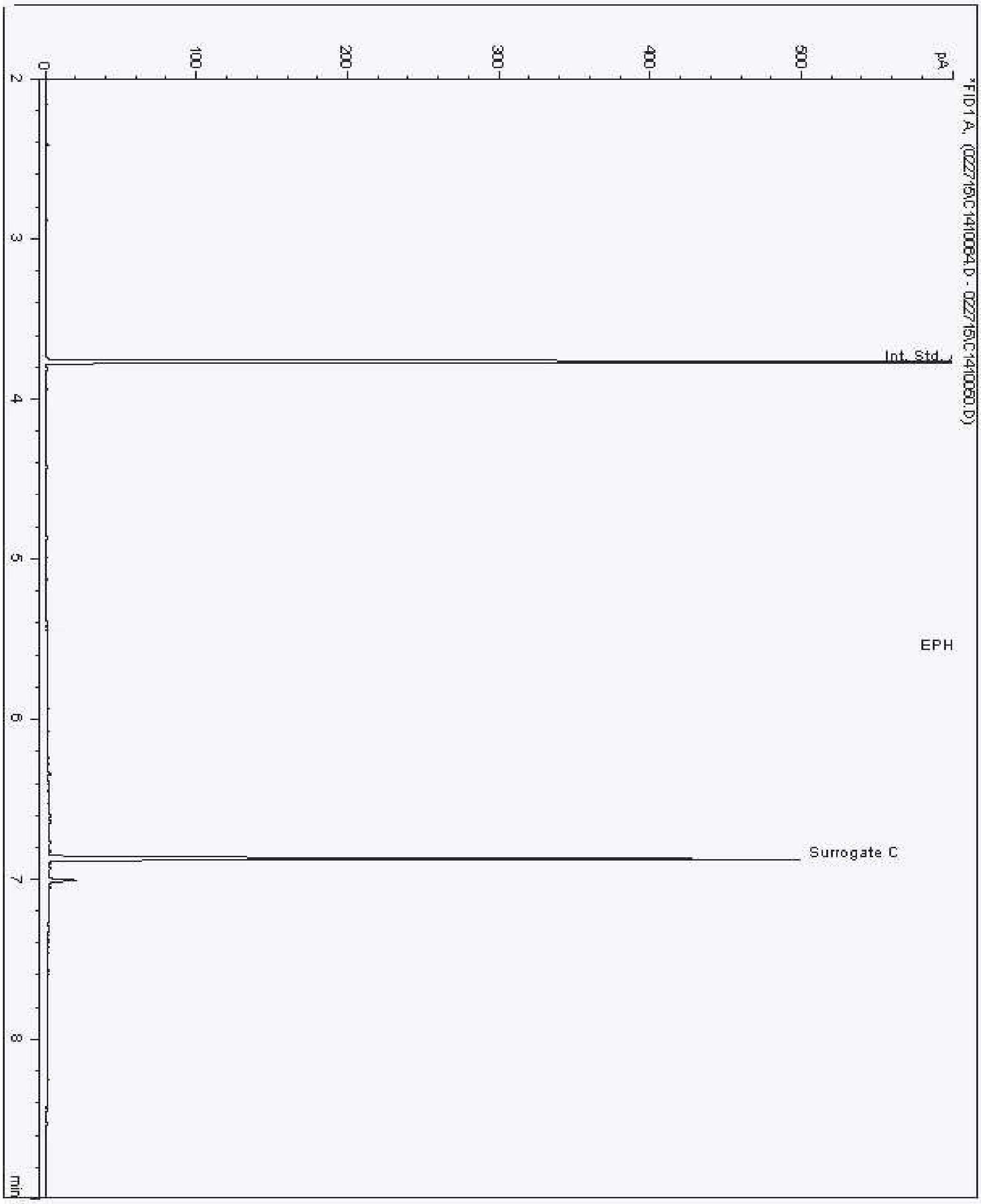
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10921652	**Depth :**	2.00 - 3.00
		Sample ID :	BH07		

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341934-
Date Acquired      :  28/02/15 16:27:29 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



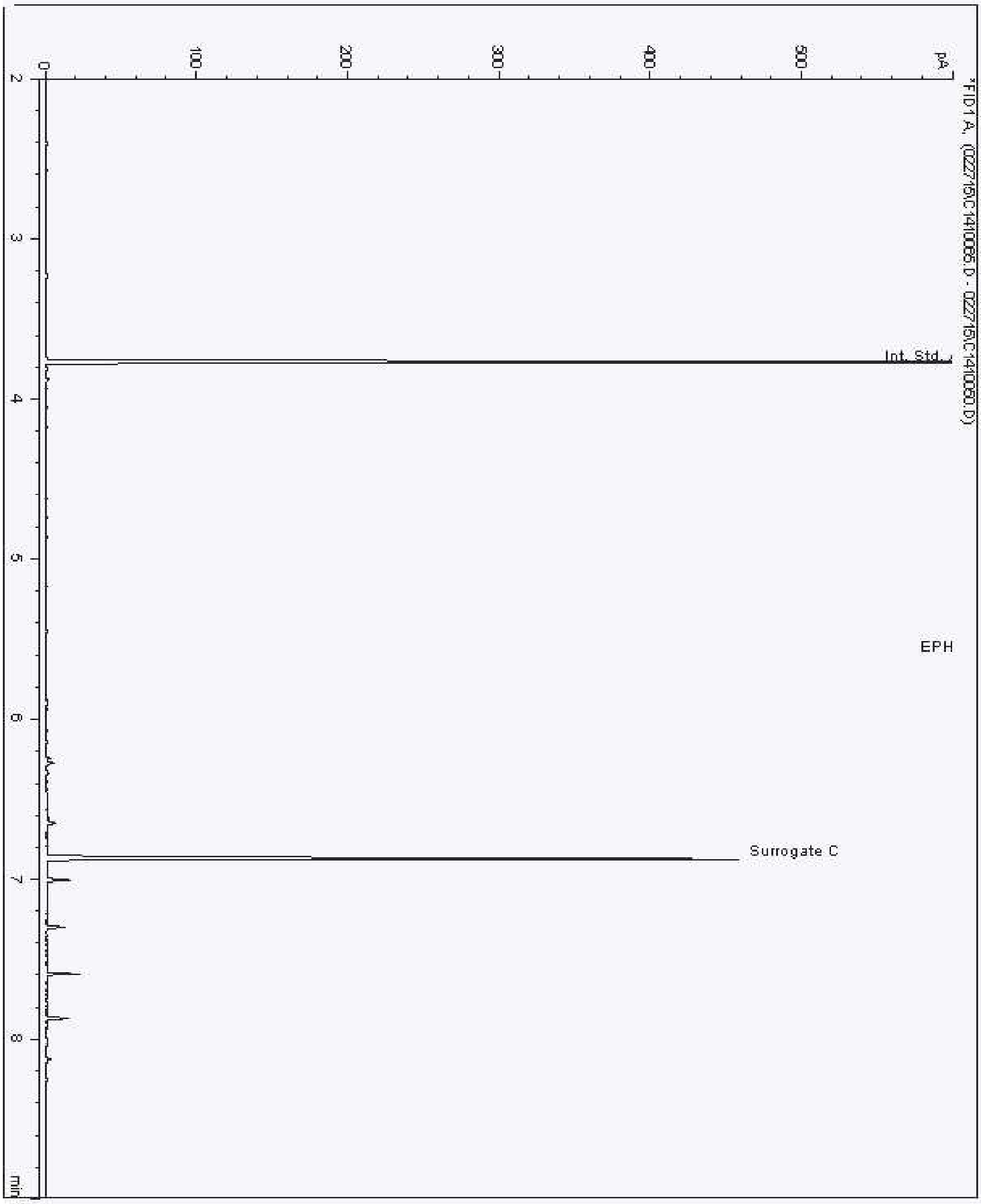
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis: EPH by FID | **Sample No :** 10921690 | **Depth :** 2.00 - 3.00
Sample ID : BH02

```
Alcontrol/Geochem Analytical Services
EPH Range Organics ( C10 - C40 )

Sample Identity    :  10341664-
Date Acquired      :  28/02/15 16:49:54 PM
Units              :  mg/kg
Sample Multiplier  :  0.000
Dilution           :
```



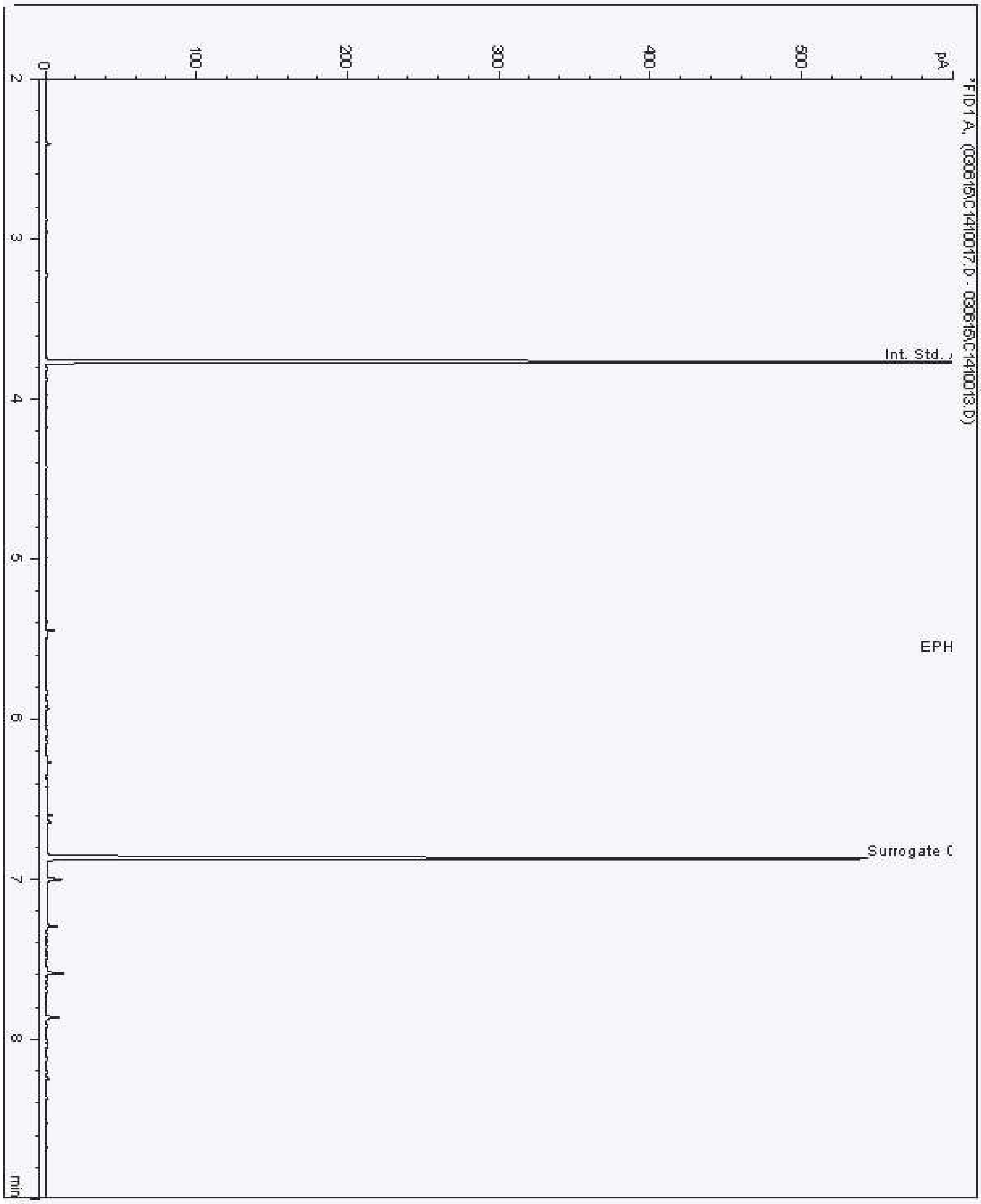
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH by FID	**Sample No :**	10947758	**Depth :**	2.00 - 3.00
		Sample ID :	BH04		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity : 10341820-
Date Acquired : 06/03/15 12:52:22 PM
Units : mg/kg
Sample Multiplier : 0.000
Dilution :



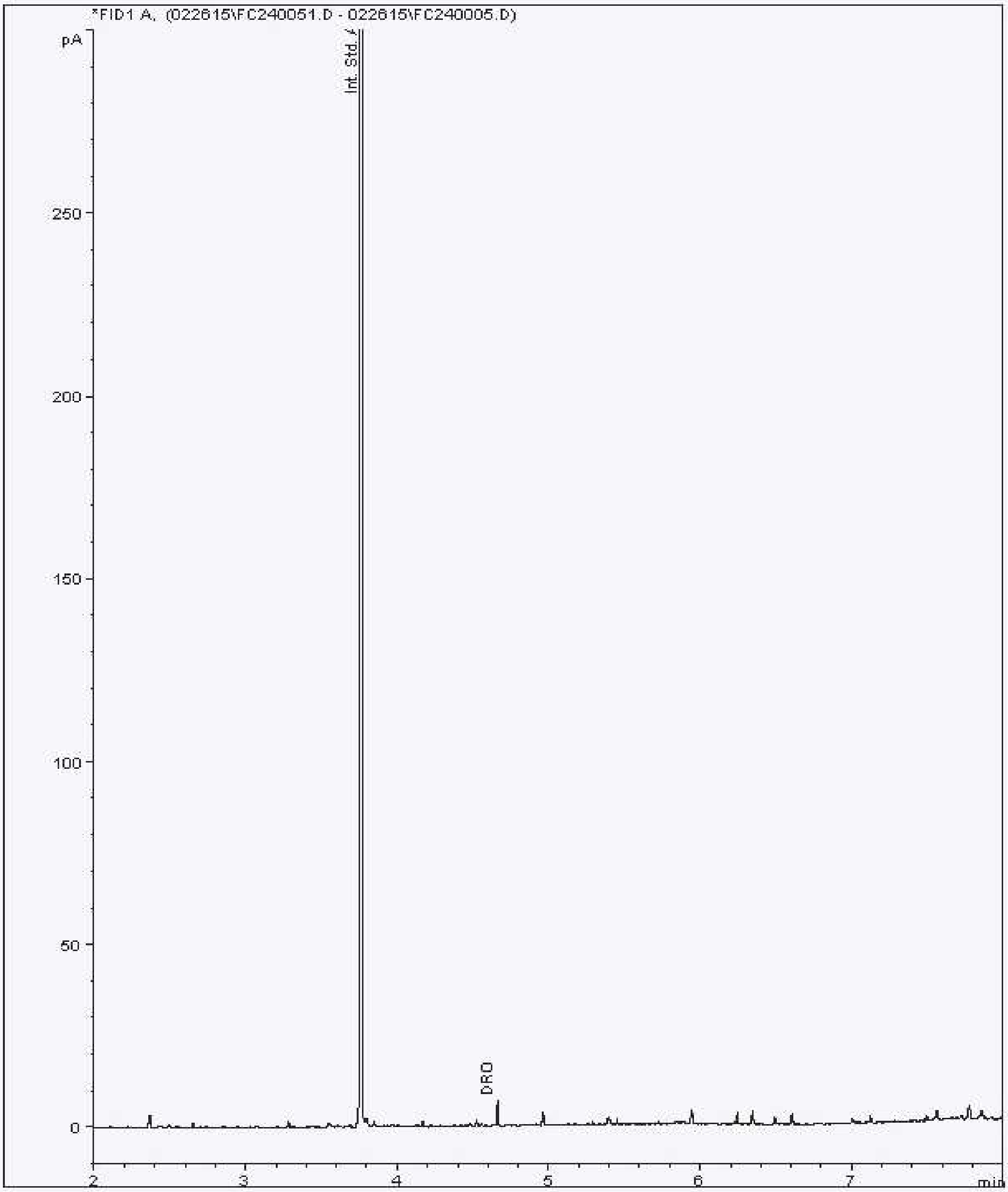
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis:	EPH (DRO) (C10-C40) Aqueous (W)	**Sample No :**	10880214	**Depth :**	14.50 - 14.90
		Sample ID :	BH01		

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity: 10341829-
Date Acquired : 27/02/2015 10:35:35 PM
Units : mg/l



CERTIFICATE OF ANALYSIS

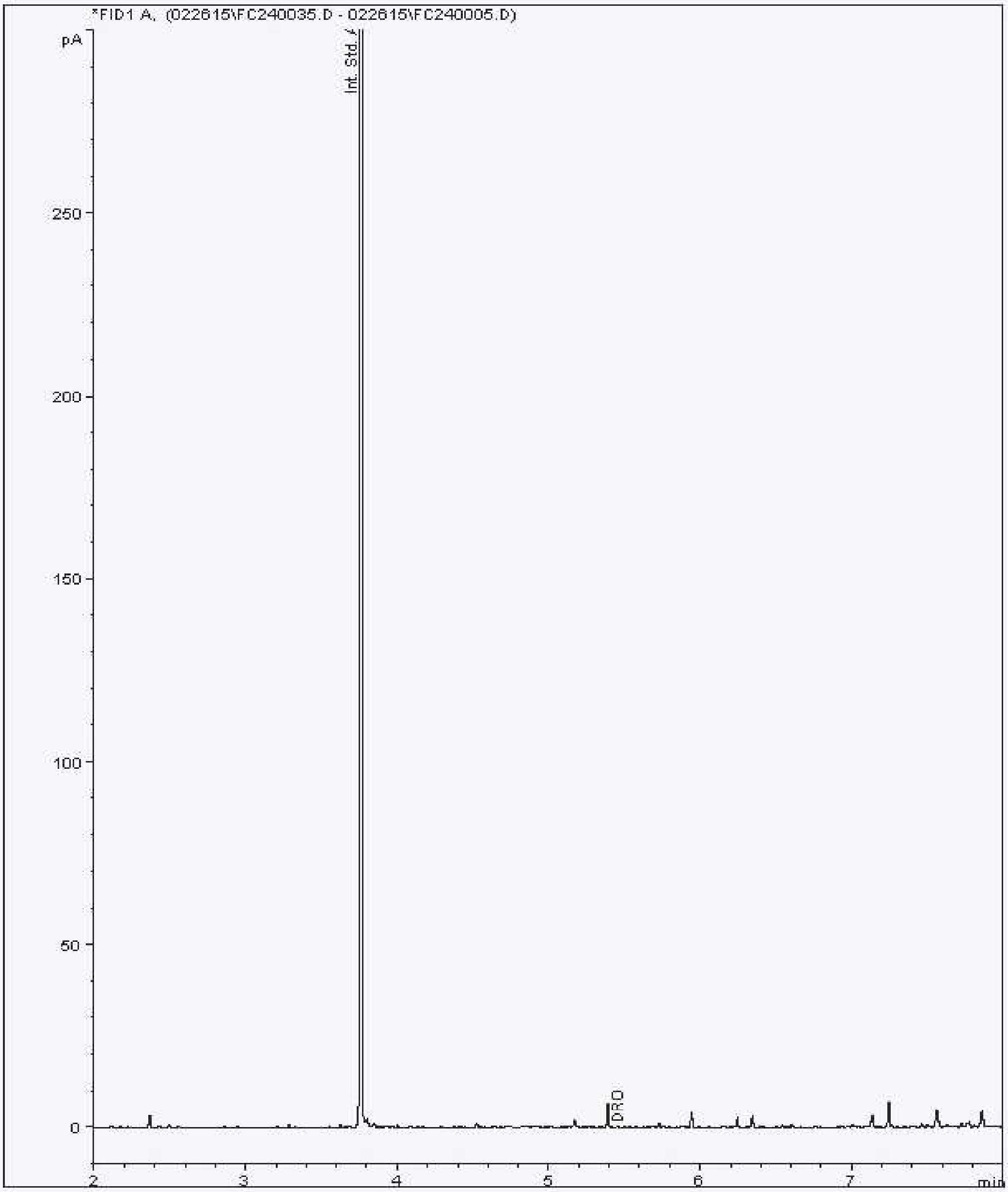
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis: EPH (DRO) (C10-C40) Aqueous (W) **Sample No :** 10880234 **Depth :** 8.00 - 8.20
Sample ID : BH02

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity: 10341849-
Date Acquired : 27/02/2015 04:45:11 PM
Units : mg/l



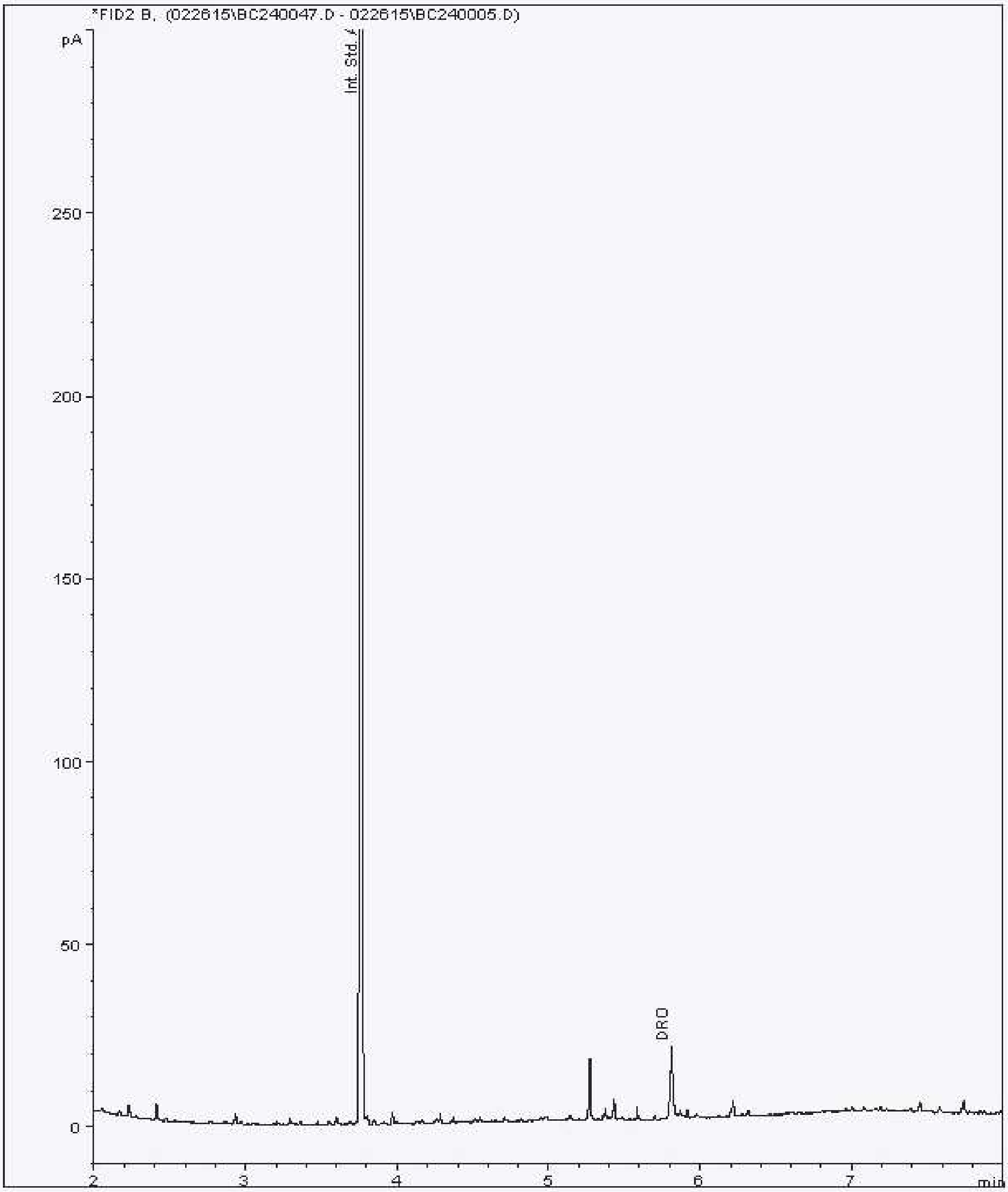
SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Chromatogram

Analysis: EPH (DRO) (C10-C40) Aqueous (W) **Sample No :** 10880247 **Sample ID :** BH03 **Depth :** 15.70 - 16.10

Alcontrol/Geochem Analytical Services
EPH Range Organics (C10 - C40)

Sample Identity: 10341871-
Date Acquired : 27/02/2015 09:07:45 PM
Units : mg/l



SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Appendix

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA Leach tests, flash point, ammonium as NH4 by the BRE method, VOC TICS, SVOC TICS, TOF-MS SCAN/SEARCH and TOF-MS TICS.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for both soil jars, tubs and volatile jars. All waters and vials will be discarded 10 days after the analysis is completed (e-mailed). All material removed during an asbestos containing material screen and analysed for the presence of asbestos will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be screened in house for the presence of large asbestos containing material fragments/pieces. If no asbestos containing material is found this will be reported as 'no asbestos containing material detected'. If asbestos containing material is detected it will be removed and analysed by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If asbestos containing material is present no further analysis will be undertaken. At no point is the fibre content of the soil sample determined.

7. If no separate volatile sample is supplied by the client, the integrity of the data may be compromised if the laboratory is required to create a sub-sample from the bulk sample -similarly, if a headspace or sediment is present in the volatile sample. This will be flagged up as an invalid VOC on the test schedule or recorded on the log sheet.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP -No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals -total metals must be requested separately.

11. A table containing the date of analysis for each parameter is not routinely included with the report, but is available upon request.

12. Results relate only to the items tested

13. **Surrogate recoveries** -Most of our organic methods include surrogates, the recovery of which is monitored and reported. For EPH, MO, PAH, GRO and VOCs on soils the result is not surrogate corrected, but a percentage recovery is quoted. Acceptable limits for most organic methods are 70 -130 %.

14. **Product analyses** -Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors
employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 14).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. Our MCERTS accreditation for PAHs by GCMS applies to all product types apart from Kerosene, where naphthalene only is not
accredited.

19. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

20. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

21. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

22. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.

23. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials -whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute themajor part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

24. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C4 -C10 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

SOLID MATRICES EXTRACTION SUMMARY

ANALYSIS	D/C OR WET	EXTRACTION SOLVENT	EXTRACTION METHOD	ANALYSIS
SOLVENT EXTRACTABLE MATTER	D&C	DCM	SOXTHERM	GRAVIMETRIC
CYCLOHEXANE EXT. MATTER	D&C	CYCLOHEXANE	SOXTHERM	GRAVIMETRIC
THIN LAYER CHROMATOGRAPHY	D&C	DCM	SOXTHERM	IATROSCAN
ELEMENTAL SULPHUR	D&C	DCM	SOXTHERM	HPLC
PHENOLS BY GCMS	WET	DCM	SOXTHERM	GC-MS
HERBICIDES	D&C	HEXANE:ACETONE	SOXTHERM	GC-MS
PESTICIDES	D&C	HEXANE:ACETONE	SOXTHERM	GC-MS
EPH (DRO)	D&C	HEXANE:ACETONE	END OVER END	GC-FID
EPH (MIN OIL)	D&C	HEXANE:ACETONE	END OVER END	GC-FID
EPH (CLEANED UP)	D&C	HEXANE:ACETONE	END OVER END	GC-FID
EPH CWG BY GC	D&C	HEXANE:ACETONE	END OVER END	GC-FID
PCB TOT / PCB CON	D&C	HEXANE:ACETONE	END OVER END	GC-MS
POLYAROMATIC HYDROCARBONS (MS)	WET	HEXANE:ACETONE	MICROWAVE TM218.	GC-MS
C8-C40 (C6-C40) EZ FLASH	WET	HEXANE:ACETONE	SHAKER	GC-EZ
POLYAROMATIC HYDROCARBONS RAPID GC	WET	HEXANE:ACETONE	SHAKER	GC-EZ
SEMI VOLATILE ORGANIC COMPOUNDS	WET	DCM:ACETONE	SONICATE	GC-MS

LIQUID MATRICES EXTRACTION SUMMARY

ANALYSIS	EXTRACTION SOLVENT	EXTRACTION METHOD	ANALYSIS
PAH MS	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GCMS
EPH	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC FID
EPH CWG	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC FID
MINERAL OIL	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GC FID
PCB 7 CONGENERS	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GCMS
PCB TOTAL	HEXANE	STIRRED EXTRACTION (STIR-BAR)	GCMS
SVOC	DCM	LIQUID/LIQUID SHAKE	GCMS
FREE SULPHUR	DCM	SOLID PHASE EXTRACTION	HPLC
PEST OCP/OPP	DCM	LIQUID/LIQUID SHAKE	GCMS
TRIAZINE HERBS	DCM	LIQUID/LIQUID SHAKE	GCMS
PHENOLS MS	DCM	SOLID PHASE EXTRACTION	GCMS
TPH by INFRA RED (IR)	TCE	LIQUID/LIQUID SHAKE	HPLC
MINERAL OIL by IR	TCE	LIQUID/LIQUID SHAKE	HPLC
GLYCOLS	NONE	DIRECT INJECTION	GCMS

Identification of Asbestos in Bulk Materials

The results for asbestos identification for soil samples are obtained from possible Asbestos Containing Material, removed during the 'Screening of soils for Asbestos Containing Materials', which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: -
Trace -Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in MDHS 100.

The identification of asbestos containing materials falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Last Updated : 2010/09/08

SDG:	150213-41	**Location:**	HFO Project	**Order Number:**	
Job:	H_JACOBS_JH_REA-45	**Customer:**	Jacobs Engineering UK Limited	**Report Number:**	304415
Client Reference:		**Attention:**	Katherine Hunt	**Superseded Report:**	

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICS and SVOC TICS.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible. The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP -No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals -total metals must be requested separately.

11. Results relate only to the items tested.

12. LODs for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** -Most of our organic methods include surrogates, the recovery of which is monitored and reported. For EPH, MO, PAH, GRO and VOCs on soils the result is not surrogate corrected, but a percentage recovery is quoted. Acceptable limits for most organic methods are 70 -130 %.

14. **Product analyses** -Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors
employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

21. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.

22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

Sample Deviations

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
4	Holding time exceeded before sample received
5	Samples exceeded holding time before presevation was performed
§	Sampled on date not provided
•	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to sampled on date
&	Sample Holding Time exceeded - Late arrival of instructions.

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than:
- Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Appendix C Borehole Logs

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME

SITE: KISSY DOCKYARD

DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE

BOREHOLE: 01

BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699051, 0937392

GROUND ELEVATION/ AXIS: 35.361m

START DATE: 11/11 /2014

LOGGED BY: ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m – 0.80 m	Reddish brown lateritic Gravel, top soil with ocasional organic materials and rootlets. Gravel is sub rounded of Laterite	34.561m						Percussion
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	33.861m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	32.861m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.861m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.861m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	29.861m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 45%	29.361m						

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME

SITE: KISSY DOCKYARD

DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE

SHEETNo.: 2 of 3

BOREHOLE: 01

BOREHOLE LOCATION: UTM 28P EASTINGS 0699051, NORTHINGS 0937392

GROUND ELEVATION/ AXIS: 35.361m

START DATE: 11/11 /2014

LOGGED BY: ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
6.00 m – 6.50 m		28.861m						Rotary
7.50 m	6.50m- 6.95m SPT 7-14-15 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	27.861m			7,14,15 (29)			Percussion Rotary
8.50 m	7.50m- 7.95m SPT 6-12-13 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	26.861m			6,12,13 (25)			Percussion
8.90 m	8.50m- 8.95m SPT 3-5-6	26.461m			3,5,6 (11)			Percussion WATER LEVEL
9.50 m	Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	25.861m						
10.50 m	9.50m- 9.95m SPT 5-7-11 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	24.861m			5,7,11 (18)			Percussion
11.50 m	10.50m- 10.95m SPT 5-9-10 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	23.861m			5,9,10 (19)			Percussion
12.00 m	11.50m- 11.95m SPT 5-7-8 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	23.361m			5,7,8 (15)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 3

BOREHOLE: 01	BOREHOLE LOCATION: UTM 28P 0699051 (EASTINGS), 0937392 (NORTHINGS)	GROUND ELEVATION/ AXIS 35.361m	START DATE: 11/11 /2014	LOGGED BY: ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
12.50 m		22.861m						
13.50 m	12.50m- 12.95m SPT 8-9-12 Pinkish white mottled brown,medium dense, silty Sand. Sand is medium grained	21.861m			8,9,12 (21)			Percussion
14.50 m	13.50m- 13.95m SPT 11-15-20 Pinkish white mottled brown, dense, silty Sand. Sand is medium grained	20.861m			11,15,20 (35)			Percussion
15.00 m	14.50m- 14.95m SPT 9-13-18 Pinkish white mottled brown,dense, silty Sand. Sand is medium grained	20.361m			9,13,18 (31)			End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME

SITE: KISSY DOCKYARD

DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE

BOREHOLE: 02

BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699072, 0937392

GROUND ELEVATION/ AXIS: 34.125m

START DATE: 18/11 /2014

LOGGED BY: ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m – 0.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	33.625m						Rotary
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	32.625m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.625m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.625m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 95%	29.625m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 65%	28.625m						Rotary
6.00 m	Pinkish white mottled brown, firm clayey Sand. Sand is medium grained	28.125m						Percussion

3BMD ASSOCIATES CONSULTING ENGINNERS. 10A THOMPSON BAY OFF WILKINSON RD Tel 076656454, 076616137 Email assoc 3bmd@yahoo.com	BOREHOLE RECORD		PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4

BOREHOLE: 02	BOREHOLE LOCATION: UTM 28P EASTINGS 0699072, NORTHINGS 0937392	GROUND ELEVATION/ AXIS 34.125m	START DATE: 18/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	6.00m- 6.45m SPT 5-8-11 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	27.125m			5,8,11 (19)			Percussion
8.00 m	7.00m- 7.45m SPT 10-11-12 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	26.125m			10,11,12 (23)			Percussion
9.00 m	8.00m- 8.45m SPT 8-10-11 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	25.125m			8,10,11 (21)			Percussion
10.00 m	9.00m- 9.45m SPT 4-5-5 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	24.125m			4,5,5 (10)			Percussion
11.00 m	10.00m- 10.45m SPT 6-7-7 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	23.125m			6,7,7 (14)			Percussion
12.00 m	11.00m- 11.45m SPT 4-5-6 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	22.125m			4,5,6 (11)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4
BOREHOLE: 02	BOREHOLE LOCATION: UTM 28P EASTINGS 0699072, NORTHINGS 0937392	GROUND ELEVATION/ AXIS 34.125m	START DATE: 18/11 /2014
LOGGED BY: ADOB			

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
12.00 m – 13.00 m	12.00m- 12.45m SPT 3-4-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	21.125m			3,4,6 (10)			Percussion
13.00 m – 14.00 m	Reddish brown mottled yellow, weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 20%	20.125m						Rotary
14.00 m – 15.00 m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained	19.125m						Percussion
15.00 m – 16.00 m (15.60 m WATER LEVEL)	15.00m- 15.45m SPT 4-4-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	18.525m 18.125m			4,4,7 (11)			Percussion WATER LEVEL
16.00 m – 17.00 m	16.00m- 16.45m SPT 5-5-5 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	17.125m			5,5,5 (10)			Percussion
17.00 m – 18.00 m	17.00m- 17.45m SPT 2-1-2 Pinkish white mottled brown, loose Sand. Sand is medium grained	16.125m			2,1,2 (3)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	4 of 4

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
02	UTM 28P EASTINGS 0699072, NORTHINGS 0937392	34.125m	18/11 /2014	ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	18.00m- 18.45m SPT 4-6-4 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	15.125m			4,6,4 (10)			Percussion
20.00 m	19.00m- 19.45m SPT 4-5-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	14.125m			4,5,6 (11)			Percussion End of Hole

3B MD	3BMD ASSOCIATES CONSULTING ENGINNERS. 10A THOMPSON BAY OFF WILKINSON RD Tel 076656454, 076616137 Email assoc_3bmd@yahoo.com	BOREHOLE RECORD		PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 3
BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699094, 0937392	GROUND ELEVATION/ AXIS 34.620m	START DATE: 03/11 /2014 — LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.60 m	Reddish brown lateritic Gravel, top soil with ocasional organic materials and rootlets. Gravel is sub rounded of Laterite	34.020m						Percussion
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	33.120m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.120m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 75%	31.120m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 30%	30.120m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.620m						Rotary
6.00 m	Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	28.620m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME

SITE: KISSY DOCKYARD

DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE

SHEETNo.: 2 of 3

BOREHOLE: 03

BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699094, 0937392

GROUND ELEVATION/ AXIS 34.620m

START DATE: 05/11 /2014

LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	6.00m- 6.45m SPT 3-3-4 Pinkish white mottled brown,loose Sand. Sand is medium grained	27.620m			3,3,4 (7)			Percussion
8.00 m	7.00m- 7.45m SPT 2-4-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	26.620m			2,4,7 (11)			Percussion
9.00 m	8.00m- 8.45m SPT 3-3-4 Pinkish white mottled brown, loose Sand. Sand is medium grained	25.620m			3,3,4 (7)			Percussion
10.00 m	9.00m- 9.45m SPT 4-6-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	24.620m			4,6,6 (12)			Percussion
11.00 m	10.00m- 10.45m SPT 4-6-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	23.620m			4,6,7 (13)			Percussion
12.00 m	11.00m- 11.45m SPT 4-6-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	22.620m			4,6,6 (12)			Percussion

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PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	3 of3

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
03	EASTINGS NORTHINGS UTM 28P 0699094, 0937392	34.620m	05/11 /2014	ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	12.00m- 12.45m SPT 3-6-6 Pinkish white mottled brown,loose Sand. Sand is medium grained	21.620m			3,6,6 (12)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 2

BOREHOLE: 04	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699079, 0937417	GROUND ELEVATION/ AXIS 32.892m	START DATE: 14/11 /2014	LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.892m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.892m						Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 68%	29.892m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	28.892m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	27.892m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	26.892m						Rotary

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2

BOREHOLE: 04	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699079, 0937417	GROUND ELEVATION/ AXIS 32.892m	START DATE: 14/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	25.892m						Percussion
7.80 m	7.00m- 7.45m SPT 12-12-4 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	25.092m			12,12,4 (16)			Percussion WATER LEVEL
8.00 m		24.892m						
9.00 m	8.00m- 8.45m SPT 2-3-2 Pinkish white mottled brown, loose silty Sand. Sand is medium grained	23.892m			2,3,2 (5)			Percussion
10.00 m	9.00m- 9.45m SPT 2-6-7 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	22.892m			2,6,7 (13)			Percussion
	10.00m- 10.45m SPT 6-6-9 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	21.892m			6,6,9 (15)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
05	EASTINGS NORTHINGS UTM 28P 0699070, 0937359	35.361m	05/11 /2014	ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown lateritic Gravel, top soil with ocasional organic materials and rootlets. Gravel is sub rounded of Laterite	34.361m						Percussion
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 70%	33.861m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 70%	32.861m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 78%	31.861m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	31.361m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.861m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 85%	29.861m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	29.361m						Rotary

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2
BOREHOLE: 05	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699070, 0937359	GROUND ELEVATION/ AXIS 35.361m	START DATE: 05/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained	28.361m						Percussion
7.80 m	7.00m- 7.45m SPT 3-4-11 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	27.661m			3,4,11 (15)			Percussion WATER LEVEL
8.00 m		27.361m						
9.00 m	8.00m- 8.45m SPT 8-12-14 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	26.361m			8,12,14 (26)			Percussion
10.00 m	9.00m- 9.45m SPT 5-6-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	25.361m			5,6,7 (13)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 2

BOREHOLE: 06	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699164, 0937434	GROUND ELEVATION/ AXIS 32.167m	START DATE: 03/11 /2014	LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	31.667m						Rotary
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 95%	30.667m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.667m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	28.667m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	27.667m						Rotary
5.00 m	Pinkish white mottled brown, loose Sand. Sand is medium grained	27.167m						Percussion
6.00 m	5.00m- 5.45m SPT 10-13-10 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	26.167m			10,13,10 (23)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2

BOREHOLE: 06	BOREHOLE LOCATION: UTM 28P EASTINGS 0699164, NORTHINGS 0937434	GROUND ELEVATION/ AXIS 32.167m	START DATE: 17/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	6.00m- 6.45m SPT 15-11-14 Pinkish white mottled brown, medium sandy Clay. Sand is medium grained	25.167m			15,11,14 (25)			Percussion
7.90 m		24.267m						WATER LEVEL
8.00 m	7.00m- 7.45m SPT 6-13-18 Pinkish white mottled brown, dense sandy Clay. Sand is medium grained	24.167m			6,13,18 (31)			Percussion
9.00 m	8.00m- 8.45m SPT 2-2-2 Pinkish white mottled brown, very loose clayey Sand. Sand is medium grained	23.167m			2,2,2 (4)			Percussion
10.00 m	9.00m- 9.45m SPT 2-3-3 Pinkish white mottled brown, loose clayey Sand. Sand is medium grained	22.167m			2,3,3 (6)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 2
BOREHOLE: 07	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699187, 0937388	GROUND ELEVATION/ AXIS 34.057m	START DATE: 14/11 /2014 — LOGGED BY: ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m								
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.057m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.057m						Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 75%	31.057m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 63%	30.057m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.057m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	28.057m						Rotary

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2

BOREHOLE: 07	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699187, 0937388	GROUND ELEVATION/ AXIS 34.057m	START DATE: 13/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
6.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 72%	27.557m						Rotary
7.00 m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained	27.057m						Percussion
7.60 m	7.00m- 7.45m SPT 6-7-9 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	27.457m			6,7,9 (16)			Percussion WATER LEVEL
8.00 m		26.057m						
9.00 m	8.00m- 8.45m SPT 5-7-9 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	25.057m			5,7,9 (16)			Percussion
10.00 m	9.00m- 9.45m SPT 6-7-9 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	24.057m			6,7,9 (16)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
08	EASTINGS NORTHINGS UTM 28P 0699003, 0937433	32.907m	13/11 /2014	ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m – 1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.907m						Rotary
1.00 m – 2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.907m						Rotary
2.00 m – 3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.907m						Rotary
3.00 m – 4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	28.907m						Rotary
4.00 m – 5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	27.907m						Rotary
5.00 m – 6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	26.907m						Rotary

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	2 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
08	EASTINGS NORTHINGS UTM 28P 0699003, 0937433	32.907m	13/11 /2014	ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	25.907m						Rotary
8.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 70%	24.907m						Rotary
9.00 m	Pinkish white mottled brown,loose Sand. Sand is medium grained	23.907m						Percussion
10.00 m	9.00m- 9.45m SPT 2-3-2 Pinkish white mottled brown, loose Sand. Sand is medium grained	22.907m			2,3,2 (5)			Percussion
	10.00m- 10.45m SPT 5-6-8 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	21.907m			5,6,8 (14)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- ENVIRONMENTAL BOREHOLES	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 4

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
01	EASTINGS NORTHINGS UTM 28P 0699136, 0937341	35.529m	15/12 /2014	ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	34.529m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.529m						Rotary Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.529m						
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.529m						Rotary Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	30.529m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	29.529m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4
BOREHOLE: 01	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699136, 0937341	GROUND ELEVATION/ AXIS 35.529m	START DATE: 15/12 /2014
LOGGED BY: ADOB			

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	28.529m						Percussion
8.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	27.529m						Percussion
9.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	26.529m						Percussion
10.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	25.529m						Percussion
11.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	24.529m						Percussion
12.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	23.529m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4

BOREHOLE: 01	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699136, 0937341	GROUND ELEVATION/ AXIS 35.529m	START DATE: 15/12 /2014	LOGGED BY: ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	22.529m						Percussion
14.00 m	Reddish brown mottled yellow, weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 30%	21.529m						Rotary
15.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	20.529m						Percussion
15.10 m		20.429m						WATER LEVEL
16.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	19.529m						Percussion
17.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	18.529m						Percussion
18.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	17.529m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES

SITE: KISSY DOCKYARD

DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE

SHEETNo.: 4 of 4

BOREHOLE: 01

BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699136, 0937341

GROUND ELEVATION/ AXIS: 35.529m

START DATE: 15/12 /2014

LOGGED BY: ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	16.529						Percussion
20.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	15.529m						Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES | SITE: KISSY DOCKYARD | DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE | SHEETNo.: 1 of 4

BOREHOLE: 02 | BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305 | GROUND ELEVATION/ AXIS 37.175m | START DATE: 19/12 /2014 | LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	36.175m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	35.175m						Rotary Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	34.175m						
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.175m						Rotary Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.175m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 30%	31.175m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305	GROUND ELEVATION/ AXIS 37.175m	START DATE: 19/12 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	30.175m						Percussion
8.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	29.175m						Percussion
8.20 m		28.975m						WATER LEVEL
9.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	28.175m						Percussion
10.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	27.175m						Percussion
11.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	26.175m						Percussion
12.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	25.175m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305	GROUND ELEVATION/ AXIS 37.175m	START DATE: 19/12 /2014	LOGGED BY: ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	24.175m						Percussion
14.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	23.175m						Percussion
15.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	22.175m						Percussion
16.00 m	Reddish brown mottled yellow, weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	21.175m						Rotary
17.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	20.175m						Percussion
18.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	19.175m						Percussion

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PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 4 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305	GROUND ELEVATION/ AXIS 37.175m	START DATE: 19/12 /2014	LOGGED BY: ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	18.175						Percussion
20.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	17.175m						Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 4
BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014
LOGGED BY: ADOB			

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	34.313m						Rotary
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	33.813m						
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.313m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.313m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.313m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.313m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.313m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	28.813m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4

BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	27.813m						Percussion
8.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	26.813m						Percussion
9.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	25.813m						Percussion
10.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	24.813m						Percussion
11.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	23.813m						
12.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	22.813m						

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PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4

BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014	LOGGED BY: ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	21.813m						Percussion
14.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	20.813m						Percussion
15.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	19.813m						Percussion
16.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	18.813m						Percussion
16.10 m		18.713m						WATER LEVEL
17.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	17.813m						Percussion
18.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	16.813m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- ENVIRONMENTAL BOREHOLES	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	4 of 4

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
03	EASTINGS NORTHINGS UTM 28P 0698989, 0937389	34.813m	09/12 /2014	ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	15.813m						Percussion
20.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	14.813m						Percussion End of Hole

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PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 3

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
01	EASTINGS NORTHINGS UTM 28P 0699051, 0937392	35.361m	11/11 /2014	ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.80 m	Reddish brown lateritic Gravel, top soil with ocasional organic materials and rootlets. Gravel is sub rounded of Laterite	34.561m						Percussion
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	33.861m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	32.861m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.861m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.861m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	29.861m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 45%	29.361m						

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	2 of 3

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
01	UTM 28P EASTINGS 0699051, NORTHINGS 0937392	35.361m	11/11 /2014	ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
6.50 m		28.861m						Rotary
7.50 m	6.50m- 6.95m SPT 7-14-15 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	27.861m			7,14,15 (29)			Percussion Rotary
8.50 m	7.50m- 7.95m SPT 6-12-13 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	26.861m			6,12,13 (25)			Percussion
8.90 m	8.50m- 8.95m SPT 3-5-6	26.461m			3,5,6 (11)			Percussion WATER LEVEL
9.50 m	Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	25.861m						
10.50 m	9.50m- 9.95m SPT 5-7-11 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	24.861m			5,7,11 (18)			Percussion
11.50 m	10.50m- 10.95m SPT 5-9-10 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	23.861m			5,9,10 (19)			Percussion
12.00 m	11.50m- 11.95m SPT 5-7-8 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	23.361m			5,7,8 (15)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	3 of 3

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
01	EASTINGS NORTHINGS UTM 28P 0699051, 0937392	35.361m	11/11 /2014	ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
12.50 m		22.861m						
13.50 m	12.50m- 12.95m SPT 8-9-12 Pinkish white mottled brown,medium dense, silty Sand. Sand is medium grained	21.861m			8,9,12 (21)			Percussion
14.50 m	13.50m- 13.95m SPT 11-15-20 Pinkish white mottled brown, dense, silty Sand. Sand is medium grained	20.861m			11,15,20 (35)			Percussion
15.00 m	14.50m- 14.95m SPT 9-13-18 Pinkish white mottled brown,dense, silty Sand. Sand is medium grained	20.361m			9,13,18 (31)			End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699072, 0937392	GROUND ELEVATION/ AXIS 34.125m	START DATE: 18/11 /2014	LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	33.625m						Rotary
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	32.625m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.625m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.625m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 95%	29.625m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 65%	28.625m						Rotary
6.00 m	Pinkish white mottled brown, firm clayey Sand. Sand is medium grained	28.125m						Percussion

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4

BOREHOLE: 02	BOREHOLE LOCATION: UTM 28P EASTINGS 0699072, NORTHINGS 0937392	GROUND ELEVATION/ AXIS 34.125m	START DATE: 18/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	6.00m- 6.45m SPT 5-8-11 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	27.125m			5,8,11 (19)			Percussion
8.00 m	7.00m- 7.45m SPT 10-11-12 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	26.125m			10,11,12 (23)			Percussion
9.00 m	8.00m- 8.45m SPT 8-10-11 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	25.125m			8,10,11 (21)			Percussion
10.00 m	9.00m- 9.45m SPT 4-5-5 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	24.125m			4,5,5 (10)			Percussion
11.00 m	10.00m- 10.45m SPT 6-7-7 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	23.125m			6,7,7 (14)			Percussion
12.00 m	11.00m- 11.45m SPT 4-5-6 Pinkish white mottled brown, medium dense clayey Sand. Sand is medium grained	22.125m			4,5,6 (11)			Percussion

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4
BOREHOLE: 02	BOREHOLE LOCATION: UTM 28P EASTINGS 0699072, NORTHINGS 0937392	GROUND ELEVATION/ AXIS 34.125m	START DATE: 18/11 /2014	LOGGED BY: ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
12.00 m – 13.00 m	12.00m- 12.45m SPT 3-4-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	21.125m			3,4,6 (10)			Percussion
13.00 m – 14.00 m	Reddish brown mottled yellow, weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 20%	20.125m						Rotary
14.00 m – 15.00 m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained	19.125m						Percussion
15.00 m – 15.60 m	15.00m- 15.45m SPT 4-4-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	18.525m			4,4,7 (11)			Percussion WATER LEVEL
15.60 m – 16.00 m		18.125m						
16.00 m – 17.00 m	16.00m- 16.45m SPT 5-5-5 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	17.125m			5,5,5 (10)			Percussion
17.00 m – 18.00 m	17.00m- 17.45m SPT 2-1-2 Pinkish white mottled brown, loose Sand. Sand is medium grained	16.125m			2,1,2 (3)			Percussion

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 4 of 4

BOREHOLE: 02	BOREHOLE LOCATION: UTM 28P EASTINGS 0699072, NORTHINGS 0937392	GROUND ELEVATION/ AXIS 34.125m	START DATE: 18/11 /2014	LOGGED BY: ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	18.00m- 18.45m SPT 4-6-4 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	15.125m			4,6,4 (10)			Percussion
20.00 m	19.00m- 19.45m SPT 4-5-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	14.125m			4,5,6 (11)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 3

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
03	EASTINGS NORTHINGS UTM 28P 0699094, 0937392	34.620m	03/11 /2014	ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m – 0.60 m	Reddish brown lateritic Gravel, top soil with ocasional organic materials and rootlets. Gravel is sub rounded of Laterite	34.020m						Percussion
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	33.120m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.120m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 75%	31.120m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 30%	30.120m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.620m						Rotary
6.00 m	Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	28.620m						Percussion

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 3
BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699094, 0937392	GROUND ELEVATION/ AXIS 34.620m	START DATE: 05/11 /2014
LOGGED BY: ADOB			

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
6.00 m – 7.00 m	6.00m- 6.45m SPT 3-3-4 Pinkish white mottled brown,loose Sand. Sand is medium grained	27.620m			3,3,4 (7)			Percussion
7.00 m – 8.00 m	7.00m- 7.45m SPT 2-4-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	26.620m			2,4,7 (11)			Percussion
8.00 m – 9.00 m	8.00m- 8.45m SPT 3-3-4 Pinkish white mottled brown, loose Sand. Sand is medium grained	25.620m			3,3,4 (7)			Percussion
9.00 m – 10.00 m	9.00m- 9.45m SPT 4-6-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	24.620m			4,6,6 (12)			Percussion
10.00 m – 11.00 m	10.00m- 10.45m SPT 4-6-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	23.620m			4,6,7 (13)			Percussion
11.00 m – 12.00 m	11.00m- 11.45m SPT 4-6-6 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	22.620m			4,6,6 (12)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	3 of3

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
03	EASTINGS NORTHINGS UTM 28P 0699094, 0937392	34.620m	05/11 /2014	ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	12.00m- 12.45m SPT 3-6-6 Pinkish white mottled brown,loose Sand. Sand is medium grained	21.620m			3,6,6 (12)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
04	EASTINGS NORTHINGS UTM 28P 0699079, 0937417	32.892m	14/11 /2014	ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.892m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.892m						Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 68%	29.892m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	28.892m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	27.892m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	26.892m						Rotary

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	2 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
04	EASTINGS NORTHINGS UTM 28P 0699079, 0937417	32.892m	14/11 /2014	ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	25.892m						Percussion
7.80 m	7.00m- 7.45m SPT 12-12-4 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	25.092m			12,12,4 (16)			Percussion WATER LEVEL
8.00 m		24.892m						
9.00 m	8.00m- 8.45m SPT 2-3-2 Pinkish white mottled brown, loose silty Sand. Sand is medium grained	23.892m			2,3,2 (5)			Percussion
10.00 m	9.00m- 9.45m SPT 2-6-7 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	22.892m			2,6,7 (13)			Percussion
	10.00m- 10.45m SPT 6-6-9 Pinkish white mottled brown, medium dense silty Sand. Sand is medium grained	21.892m			6,6,9 (15)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
05	EASTINGS NORTHINGS UTM 28P 0699070, 0937359	35.361m	05/11 /2014	ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m								
1.00 m	Reddish brown lateritic Gravel, top soil with ocasional organic materials and rootlets. Gravel is sub rounded of Laterite	34.361m						Percussion
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 70%	33.861m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 70%	32.861m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 78%	31.861m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	31.361m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.861m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 85%	29.861m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	29.361m						Rotary

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2
BOREHOLE: 05	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699070, 0937359	GROUND ELEVATION/ AXIS 35.361m	START DATE: 05/11 /2014 — LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained	28.361m						Percussion
7.80 m / 8.00 m	7.00m- 7.45m SPT 3-4-11 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	27.661m / 27.361m			3,4,11 (15)			Percussion; WATER LEVEL
9.00 m	8.00m- 8.45m SPT 8-12-14 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	26.361m			8,12,14 (26)			Percussion
10.00 m	9.00m- 9.45m SPT 5-6-7 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	25.361m			5,6,7 (13)			Percussion; End of Hole

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PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
06	EASTINGS NORTHINGS UTM 28P 0699164, 0937434	32.167m	03/11 /2014	ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	31.667m						Rotary
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 95%	30.667m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.667m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	28.667m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	27.667m						Rotary
5.00 m	Pinkish white mottled brown, loose Sand. Sand is medium grained	27.167m						Percussion
6.00 m	5.00m- 5.45m SPT 10-13-10 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	26.167m			10,13,10 (23)			Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME

SITE: KISSY DOCKYARD

DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE

BOREHOLE: 06

BOREHOLE LOCATION: UTM 28P EASTINGS 0699164, NORTHINGS 0937434

GROUND ELEVATION/ AXIS: 32.167m

START DATE: 17/11 /2014

LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	6.00m- 6.45m SPT 15-11-14 Pinkish white mottled brown, medium sandy Clay. Sand is medium grained	25.167m			15,11,14 (25)			Percussion
7.90 m	7.00m- 7.45m SPT 6-13-18 Pinkish white mottled brown, dense sandy Clay. Sand is medium grained	24.267m			6,13,18 (31)			Percussion WATER LEVEL
8.00 m		24.167m						
9.00 m	8.00m- 8.45m SPT 2-2-2 Pinkish white mottled brown, very loose clayey Sand. Sand is medium grained	23.167m			2,2,2 (4)			Percussion
10.00 m	9.00m- 9.45m SPT 2-3-3 Pinkish white mottled brown, loose clayey Sand. Sand is medium grained	22.167m			2,3,3 (6)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	1 of 2

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
07	EASTINGS NORTHINGS UTM 28P 0699187, 0937388	34.057m	14/11 /2014	ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.057m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.057m						Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 75%	31.057m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 63%	30.057m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.057m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	28.057m						Rotary

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PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2

BOREHOLE: 07	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699187, 0937388	GROUND ELEVATION/ AXIS 34.057m	START DATE: 13/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
6.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 72%	27.557m						Rotary
7.00 m	Pinkish white mottled brown, medium dense Sand. Sand is medium grained	27.057m						Percussion
7.60 m	7.00m- 7.45m SPT 6-7-9 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	27.457m			6,7,9 (16)			Percussion WATER LEVEL
8.00 m		26.057m						
9.00 m	8.00m- 8.45m SPT 5-7-9 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	25.057m			5,7,9 (16)			Percussion
10.00 m	9.00m- 9.45m SPT 6-7-9 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	24.057m			6,7,9 (16)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 2
BOREHOLE: 08	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699003, 0937433	GROUND ELEVATION/ AXIS 32.907m	START DATE: 13/11 /2014	LOGGED BY: ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.00 m – 1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.907m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.907m						Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.907m						Rotary
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	28.907m						Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	27.907m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	26.907m						Rotary

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- FRETOWN POWER STATION 128MW DIESELSCHEME	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 2

BOREHOLE: 08	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699003, 0937433	GROUND ELEVATION/ AXIS 32.907m	START DATE: 13/11 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 90%	25.907m						Rotary
8.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 70%	24.907m						Rotary
9.00 m	Pinkish white mottled brown,loose Sand. Sand is medium grained	23.907m						Percussion
10.00 m	9.00m- 9.45m SPT 2-3-2 Pinkish white mottled brown, loose Sand. Sand is medium grained	22.907m			2,3,2 (5)			Percussion
	10.00m- 10.45m SPT 5-6-8 Pinkish white mottled brown, medium dense Sand. Sand is medium grained	21.907m			5,6,8 (14)			Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 4
BOREHOLE: 01	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699136, 0937341	GROUND ELEVATION/ AXIS 35.529m	START DATE: 15/12 /2014
LOGGED BY: ADOB			

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	34.529m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.529m						Rotary Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.529m						
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.529m						Rotary Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 80%	30.529m						Rotary Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	29.529m						Percussion

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PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4

BOREHOLE: 01	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699136, 0937341	GROUND ELEVATION/ AXIS 35.529m	START DATE: 15/12 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	28.529m						Percussion
8.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	27.529m						Percussion
9.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	26.529m						Percussion
10.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	25.529m						Percussion
11.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	24.529m						Percussion
12.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	23.529m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4

BOREHOLE: 01	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699136, 0937341	GROUND ELEVATION/ AXIS 35.529m	START DATE: 15/12 /2014	LOGGED BY: ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	22.529m						Percussion
14.00 m	Reddish brown mottled yellow, weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 30%	21.529m						Rotary
15.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	20.529m						Percussion
15.10 m		20.429m						WATER LEVEL
16.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	19.529m						Percussion
17.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	18.529m						Percussion
18.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	17.529m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- ENVIRONMENTAL BOREHOLES	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	4 of 4

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
01	EASTINGS NORTHINGS UTM 28P 0699136, 0937341	35.529m	15/12 /2014	ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	16.529						Percussion
20.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	15.529m						Percussion End of Hole

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305	GROUND ELEVATION/ AXIS 37.175m	START DATE: 19/12 /2014	LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	36.175m						Rotary
2.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	35.175m						Rotary Rotary
3.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	34.175m						
4.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.175m						Rotary Rotary
5.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.175m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 30%	31.175m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305	GROUND ELEVATION/ AXIS 37.175m	START DATE: 19/12 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	30.175m						Percussion
8.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	29.175m						Percussion
8.20 m		28.975m						WATER LEVEL
9.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	28.175m						Percussion
10.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	27.175m						Percussion
11.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	26.175m						Percussion
12.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	25.175m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT:	SITE:	DRILL TYPE:	SHEETNo.:
CEC AFRICA- ENVIRONMENTAL BOREHOLES	KISSY DOCKYARD	DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	3 of 4

BOREHOLE:	BOREHOLE LOCATION:	GROUND ELEVATION/ AXIS	START DATE:	LOGGED BY:
02	EASTINGS NORTHINGS UTM 28P 0699121, 0937305	37.175m	19/12 /2014	ADOB

Depth	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
12.00 m – 13.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	24.175m						Percussion
13.00 m – 14.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	23.175m						Percussion
14.00 m – 15.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	22.175m						Percussion
15.00 m – 16.00 m	Reddish brown mottled yellow, weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 60%	21.175m						Rotary
16.00 m – 17.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	20.175m						Percussion
17.00 m – 18.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	19.175m						Percussion

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PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 4 of 4

BOREHOLE: 02	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0699121, 0937305	GROUND ELEVATION/ AXIS 37.175m	START DATE: 19/12 /2014	LOGGED BY: ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	18.175						Percussion
20.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	17.175m						Percussion End of Hole

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PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 1 of 4

BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014	LOGGED BY: ADOB

0.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
0.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	34.313m						Rotary
1.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	33.813m						
1.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	33.313m						Rotary
2.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	32.313m						Rotary
3.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	31.313m						Rotary
4.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	30.313m						Rotary
5.50 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 100%	29.313m						Rotary
6.00 m	Reddish brown mottled yellow, moderately weak to weak, fine-coarse grained, Massive, Cemented, Concretionary, honey combed filled with soil material hard pan Laterite Core recovery 50%	28.813m						Percussion

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PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 2 of 4
BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014	LOGGED BY: ADOB

6.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
7.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	27.813m						Percussion
8.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	26.813m						Percussion
9.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	25.813m						Percussion
10.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	24.813m						Percussion
11.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	23.813m						
12.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	22.813m						

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 3 of 4
BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014 — LOGGED BY: ADOB

12.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
13.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	21.813m						Percussion
14.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	20.813m						Percussion
15.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	19.813m						Percussion
16.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	18.813m						Percussion
16.10 m		18.713m						WATER LEVEL
17.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	17.813m						Percussion
18.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	16.813m						Percussion

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BOREHOLE RECORD

PURCHASE ORDER

PROJECT: CEC AFRICA- ENVIRONMENTAL BOREHOLES	SITE: KISSY DOCKYARD	DRILL TYPE: DANDO 3000 ROTARY & PERCUSSION DRILLING PQ SIZE	SHEETNo.: 4 of 4

BOREHOLE: 03	BOREHOLE LOCATION: EASTINGS NORTHINGS UTM 28P 0698989, 0937389	GROUND ELEVATION/ AXIS 34.813m	START DATE: 09/12 /2014	LOGGED BY: ADOB

18.00 m	DESCRIPTION OF LAYER (STRATA)	LEVEL (m)	LEGEND	SAMPLING POINT	N-VALUE	Pocket penetrometer	Torvane Tests	COMMENTS
19.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	15.813m						Percussion
20.00 m	Reddish brown mottled brown, medium dense clayey Sand. Sand is medium grained	14.813m						Percussion End of Hole

Appendix H: ESHIA Scoping Report

CEC Africa (SL) Western Area Power Generation Project

CEC AFRICA (SIERRA LEONE)

Environmental, Social, and Health Impact Assessment:

Scoping Report

Prepared by:

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INTEGEMS
Integrated Geo-information and Environmental Management Services

Prepared Under a USTDA Grant

U.S. TRADE AND DEVELOPMENT AGENCY

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CECASL Western Area Power Generation Project (WAPGP) –
Environmental, Social and Health Impact Assessment: Scoping Report

Project no:

Document title: Environmental, Social and Health Impact Assessment: Scoping Report

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Date: 15 September 2020

Author: David Phillippi, Atiyeh Thurston, José Menéndez

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Acronyms

ACC	*Air Cooled Condenser*
ACFM	*Actual Cubic Feet per Minute*
BOOT	*Build Own Operate and Transfer*
BOP	*Balance of Plant*
CCGT	*Combined Cycle Gas Turbine*
CCW	*Closed Cooling Water*
CECA	*CECA SL Generation Limited*
CECASL	*Copperbelt Energy Corporation Africa Sierra Leone*
CFC	*Chlorofluorocarbons*
CRCC	*China Republic Construction Company*
CTG	*Combustion Turbine Generator*
EDSA	*Electricity Distribution and Supply Authority*
EIA	*Environmental Impact Assessment*
EMS	Environmental Management Systems
EPA-SL	*Environment Protection Agency of Sierra Leone*
EPC	Engineering Procurement Construction
ES	*Environmental Statement*
ESHIA	*Environmental, Social and Health Impact assessment*
ESMP	Environmental and Social Management Plan
FCC	*Freetown City Council*
GDMA	*Grid Development and Management Agreement*
GHG	*Greenhouse Gases*
GLO	*Generator Lube Oil*
GoSL	*Government of Sierra Leone*
GSUT	*Generator Step Up Transformer*
GVWC	*Guma Valley Water Company*
HCFC	*hydrochlorofluorocarbons*
HFC	*Hhydrofluorocarbons*
HFO	*Heavy Fuel Oil*
HRSG	*Heat Recovery Steam Generator*
IFC	*International Finance Corporation*
LNG	*Liquefied Natural Gas*
LPG	*Liquefied Petroleum Gas, Liquefied Petroleum Gas*
M & E	Monitoring and Evaluation
MDA	*Ministries, Departments and Agencies*
MIGA	*Multilateral Investment Guarantee Agency*
MLCPE	*Ministry of Lands, Country Planning and the Environment*
MoHS	*Ministry of Health and Sanitation*
MSU	*Mechanical Service Unit*
MWHTM	*Ministry of Works, Housing and Technical Maintenance*
NGO	Non-Governmental Organization
NP	*National Petroleum*
OCF	*Operation Clean Freetown*
ODS	*Ozone-depleting Substances*
PAP	*Project Affected People*
PCM	*Power Control Module*

PERI	*Princeton Energy Resources International*
PHU	*Peripheral Health Units*
PPA	*Power Purchase Agreement*
PS	Performance Standard
SEP	Stakeholder Engagement Plan
SLRA	*Sierra Leone Roads Authority*
SLRA WR	*Sierra Leone Roads Authority Western Region*
SLRE	*Sierra Leone River Estuary*
SST	*Station Service Transformer*
STG	*Steam Turbine Generator*
TOR	Terms of Reference
UAT	*Unit Auxiliary Transformer*
USTDA	*United States Trade and Development Agency*
WAPGP	*Western Area Power Generation Project*
WBG	*World Bank Group*
WHO	*World Health Organization*

Executive Summary

The Copperbelt Energy Corporation Africa Sierra Leone Generation Limited (CECASL) is a joint venture established in 2014 to develop an electricity-generating, Heavy Fuel Oil (HFO) fired power generation plant on a Build Own Operate and Transfer (BOOT) basis on a parcel of land located 4 km east from the center of Freetown. An Environmental, Social and Health Impact assessment (ESHIA) was undertaken for the project in 2015. However, the project has been restructured from an HFO-fired power generation plant to a Liquefied Petroleum Gas (LPG)/combined cycle plant and reconstituted as the Western Area Power Generation Project (hereinafter, the project).

CECASL has retained Princeton Energy Resources International (PERI) to perform the Environmental, Social and Health Impact Assessment (ESHIA) of the project under a United States Trade and Development Agency (USTDA) Grant.

This scoping report completes the first formal stage of the ESHIA process and disclosure of the report will allow the EPA-SL and other stakeholders to inform the development of the ESHIA by providing advice and commentary in response to the information within the scoping report and through ongoing consultation to ensure that the ESHIA process and final project design will reflect stakeholder concerns and take advantage of stakeholder knowledge.

Following formal commencement of the EPA-SL ESHIA process with receipt of the EPA-SL screening opinion and site ground-truthing exercise by the EPA-SL, permission was granted to proceed to the scoping phase. The scoping process has consisted of the following activities:

- Desk based review of environmental and social information identified to date;
- Site visits to undertake stakeholder and public consultation activities, and identify further information to fill data gaps;
- Screening of potential environmental and social project issues;
- Scoping level assessment of likely key environmental and social project issues, potential mitigation design and associated requirements for baseline data collection;
- Production of a draft Environmental and Social Management Plan (ESMP);
- Key stakeholder consultations and engagement; and,
- The provision of draft terms of reference (TOR's) for the main ESHIA stage, for review by the EPA-SL. The TORs ultimately agreed with the EPA-SL, along with the information contained within this report, will form the framework for the main ESHIA activities.

The results of the scoping process indicate that the following potentially significant issues will require further consideration and/or detailed assessment in the main ESHIA phase.

Potential Issue / Impact	Construction	Operation
Social	Construction employment opportunities and knock on economic benefits in the local community. Potential strain on local health and other municipal infrastructure, and increased risk of HIV/AIDS transmission if there is significant worker influx. Air quality and noise emissions, including transport. Increased occupational and community health and safety risk due to construction transport. Monitoring of resettlement of farmers on the site by the GoSL against IFC PS 5. Tourism is not expected to be impacted by the project	Operational impacts include skilled operational and maintenance employment and indirect economic benefits to suppliers and local business due to increased electrical provision. Key adverse impacts for operation phase are air emissions and noise impacts which will be carefully assessed.
Atmospheric Emissions	Atmospheric emissions and dust from oil handling and plant movement (controlled by such activities as retaining vegetation and wetting of surfaces). Staff vehicular and construction plant emissions will also arise.	The thermal production of power is associated with a range of combustion related emissions including: Nitrogen oxides (NO, NO_2 and N_2O) associated with health effects, acid rain and ground level ozone Sulphur dioxide (SO_2) associated with health effects and acid rain Carbon oxides (CO and CO_2) – CO is associated with health effects while CO_2 is associated with climate change Unburnt hydrocarbons associated with health effects and ground level ozone. Particulate Matter (PM_{10}) associated with health effects For these type of projects 'end-of-pipe' mitigation technologies (e.g. filters, scrubbers etc.) are not generally feasible on a cost/benefit basis, therefore mitigation tends to focus on optimizing of stack height. However, end of pipe solutions will still be reviewed as part of mitigation optioneering as appropriate and may still be feasible.

Potential Issue / Impact	Construction	Operation
Water Supply	Construction sites need relatively limited supplies of water for cement manufacture, damping down for dust control and messing purposes.	Since Combustion Turbine Generators in this projects scope has a high-water demand, a desalination plant will be needed. The impacts from the desalination effluent will need to be taken into consideration Water will be taken from a borehole and potentially from the local municipal supply for other parts of the plant, which has the potential to impact on other boreholes in the area and users of the municipal supply.
Effluents	Storm water run-off from construction sites may include high sediment loads, oil, fuels and litter. These can be controlled using appropriate interceptors and other standard mitigation design. Sewage will be controlled either through use of portable toilets or a septic tank. Washout water from any concrete mixing on site will also need to be carefully controlled. Hazardous effluents such as used oils will either be incinerated during construction using temporary facilities or stored and incinerated once the main incinerator is operational.	Effluent from thermal power plants may contain various contaminants (e.g. particulates, oils, fuels, ash etc.). There will also be sewage and domestic effluents. Controls will include the use of appropriate runoff interceptors and oil/water separators, effluent treatment plant and sampling from an observation pond prior to discharge to ensure compliance with IFC EHS Guidelines.
Solid Wastes	Construction phase wastes will come from general construction and maintenance of construction plant. This will include non-hazardous (inert topsoil, construction rubble, wood, surplus materials, plastics, packaging etc.) and hazardous waste (contaminated soils, oils, solvents, contaminated containers, used filters, batteries, etc.). General refuse (effectively domestic waste - non- hazardous materials including food residues, paper, bottles, cans, packaging etc.) will also be generated. All wastes should be recycled where practicable. Inert wastes may be disposed of at existing dump sites. Hazardous wastes may have to be incinerated or exported for disposal if no suitably licensed and controlled disposal facilities are developed.	Other hazardous waste includes used filters, lubricants, contaminated containers, rags, oil and filters from machinery/vehicles, oil from O/W separator. The small volume of inert (mainly domestic) wastes produced during operation may be disposed of at existing dump sites. It's likely that hazardous wastes will have to be incinerated if no suitably licensed and controlled disposal facilities are developed. A very small volume of items which cannot be incinerated (e.g. batteries) will need to be stored and exported for disposal. Any disposal of hazardous waste will be in line with the provisions of paragraph 12 of PS 3.

Potential Issue / Impact	Construction	Operation
Hazardous Materials	Hazardous materials may include oils, fuels, cleaning materials, and lubricants. These will need to be stored appropriately (e.g. bunded enclosures etc.) to prevent or control spills.	Hazardous materials will include on-site stores of diesel, other oils, lubricants, solvent-based cleaning materials and potentially water treatment reagents. These will need to be stored appropriately to prevent or control spills and will require appropriate oil spill response and clean up planning including staff training.
Noise and vibration	Construction noise and vibrations can disturb neighbors (particularly residential areas especially if any construction activities are carried out at night. Controls can include limiting construction hours, silencing equipment on plant, use of acoustic fencing, etc.	Thermal power plants are typically operational on a 24hr basis and can emit noise from material handling, vents, stacks, generators and vehicle movements. Controls can include appropriate siting of infrastructure, acoustic insulation, limiting of delivery times, bunding, etc.
Traffic	Construction involves the transport of both materials and personnel which can have congestion and safety implications on access roads. Traffic management plans will be developed and will also assess community safety aspects.	Operational traffic includes staff vehicle movements and delivery of materials or replacement parts.
Soil and Groundwater Contamination	There may potentially be some contamination already on- site due to current/historical use and adjacent presence of the disused refinery. This contamination could be mobilized during construction. Any such contamination would need to be removed from site or treated as appropriate. If human health risks are identified, a remediation plan may need to be produced to prevent risk to future users of the site. Hazardous materials and wastes should be appropriately stored (e.g. on areas of fully bunded hard standing, as necessary). The potential for contamination in the existing borehole water supply will also be investigated and assessed.	Hazardous materials stored on site during operation (including LPG and diesel tanks, oils, lubricants and other hazardous materials) will always have the potential to cause contamination in the event of a spill or other type of accident. Hazardous materials and wastes should be appropriately stored (e.g. on areas of fully bunded hard standing, as necessary). Appropriate accident and spill response plans will be required.

Potential Issue / Impact	Construction	Operation
Climate Change	Climate Change shouldn't affect the construction phase of the project.	Climate Change has been identified as a potential impact to the operation as temperature and sea level could affect the project over time. The findings of how climate change could affect the project will be talked about in the Climate Resiliency Report
Marine Ecology	There shouldn't be any significant impact to marine ecology in the construction phase of the project.	The installation of a desalination plant could affect the marine ecology in the area. The impacts will be looked at in the ESHIA.

The following issues are considered unlikely to be of significance to the project either because there is no direct or indirect impact on sensitive features resulting from the proposed project activities, or where the potential for impacts is addressed through standard mitigation measures already including in the project design:

- Landscape and visual impact;
- Archaeology and cultural heritage;
- Hydrology/flood risk; and,
- Terrestrial ecology.

While it is not currently planned to consider these issues in detail during the main ESHIA phase, should further information be identified that indicates potentially significant issues may occur, the scope of the ESHIA will be amended accordingly.

Stakeholder and community consultation undertaken to date indicates broad support for the project and the anticipated positive impacts of increased power generation, job creation and secondary economic benefits, and community benefits. Identified stakeholder and community concerns have been recorded and addressed within this report and will continue to form one of the key factors influencing project design throughout the ESHIA process and beyond.

Important Note about Your Report

The sole purpose of this report and the associated services performed by Princeton Energy Resources International, LLC (PERI) is to describe the initial scoping phase activities undertaken by the ESHIA team in accordance with the scope of services set out in the contract between PERI and the Client, CECA SL Generation Limited("CECA"). That scope of services, as described in this report, was developed with the Client.

In preparing this report, PERI has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, PERI has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

PERI derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re- evaluation of the data, findings, observations and conclusions expressed in this report. PERI has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures (as defined in the contract) and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by PERI for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, PERI's Client, and is subject to, and issued in accordance with, the provisions of the contract between PERI and the Client. PERI accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

The CECA SL Generation Limited (CECASL) is a Special Purpose Vehicle established in 2014 to develop an electricity-generating, Heavy Fuel Oil (HFO) fired power generation plant on a Build Own Operate and Transfer (BOOT) basis on a parcel of land located 4 km east from the center of Freetown. An Environmental, Social and Health Impact assessment (ESHIA) was undertaken for the project in 2015. However, the project has been restructured from an HFO-fired power generation plant to a Liquefied Petroleum Gas (LPG)/combined cycle plant and reconstituted as the Western Area Power Generation Project (hereinafter, the project).

CECASL has retained Princeton Energy Resources International (PERI) to perform the Environmental, Social and Health Impact Assessment (ESHIA) of the project under a United States Trade and Development Agency (USTDA) Grant.

This scoping report completes the first formal stage of the ESHIA process and disclosure of the report will allow the EPA-SL and other stakeholders to inform the development of the ESHIA by providing advice and commentary in response to the information within the scoping report and through ongoing consultation to ensure that the ESHIA process and final project design will reflect stakeholder concerns and take advantage of stakeholder knowledge.

1.1. Content of the report

The report provides the following information:

- A description of the proposed project and the project setting which may be impacted;
- A summary of the national and international legal and regulatory framework, standards and guidelines applicable to the project;
- Details of the findings of the desktop review and initial consultations with interested and affected parties regarding the likely significant impacts and issues that are proposed for consideration during the subsequent phases of the ESHIA process;
- A draft, preliminary Environmental and Social Management Plan (ESMP) document to provide an initial summary of possible mitigation measures and associated actions which the proponent and/or Engineering Procurement Construction (EPC) contractor will adhere to; and,
- The draft terms of reference for conducting the subsequent phases of the ESHIA process that will be submitted to the EPA- SL for approval.

1.2. Project Sponsors

The Project is sponsored by a consortium of two firms, each with a 50% shareholding: Milele Energy and TCQ Power Ltd.

Milele Energy is an independent power-generation company head quartered in Nairobi with offices in the US and South Africa. Milele's vision is to provide clean, cost-effective electricity to Sub-Saharan Africa through investments in new sources of reliable energy. Milele — meaning “forever” in Swahili — invests in developing, owning, and operating solar, wind, geothermal, hydroelectric as well as conventional power-generation facilities. The company is an initiative of Everstrong Capital, a U.S.-based asset manager.

TCQ Power (TCQ) was established in January 2012 to acquire, build, develop and operate power projects in Africa. It was set up by the Nasser family, who have experience in construction through their firm Target

Engineering Construction Co., which is based in the United Arab Emirates. In December 2008 Target Engineering was sold to Arabtec Holding PJSC.

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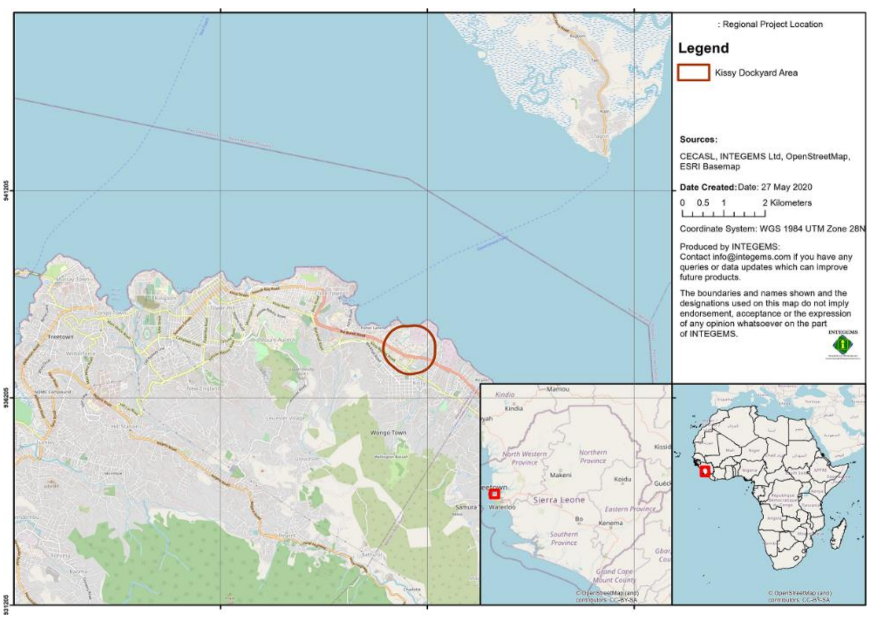
Freetown Sierra Leone

1.3. CECASL Western Area Power Generation Project Overview

The project is located on a site in the Kissy Dock area, approximately 4 km east of the center of Freetown, Sierra Leone. In the first phase of the project a 85-MW CCGT power block will be fueled by LPG delivered to the PetroJetty . LPG will be transferred to the site via a new interconnecting pipeline and will be stored in horizontal tanks that are mounded in earthen berms for enhanced fire protection. To meet emissions requirements, the project will draw seawater from a beach well near Cline Bay and discharge brine east of the Jetty. Power will be evacuated at 33-kV to the Blackhall Road and Ropoti substations via existing overhead transmission lines that pass over the Site.

The location of the site is shown in Figure 1.1.

Figure 1.1 Regional Location of Site



The power will be exported to the national transmission and distribution network which is owned and operated by the Electricity Distribution and Supply Authority (EDSA). It is intended that building the plant capacity in stages will allow for the concurrent development of evacuation capacity to the grid. EDSA will be the purchasers of the power produced by the plant on the basis of a Power Purchase Agreement (PPA)

Key elements of the proposed plant design are summarized in Section 3.3 and a detailed Project Description document (Exhibit A EPC Spec) is included in Appendix A.

1.4. Need for the Development

In September 2017 The Government of Sierra Leone Minister of Energy released an Electricity Sector Reform Roadmap (2017-2030). This roadmap cites the evacuation capacity to Freetown was assessed at 42 MW, with distribution losses assessed at 35% in 2016.[1] In 2015 the estimated demand for electricity was 256MW with a national generation capacity of 78.5MW leaving a large deficit.

The Electricity Sector Reform Roadmap provided key actions to be taken in short-term (2017-mid 2020), mid-term (2020-2025), and long-term (after 2025). A draft roadmap for reform for each term is shown in Appendix A. The CECASL Western Area Power Generation Plant represents a priority development that is urgently needed to support Sierra Leone's continued economic development.

1.5. The Study Area

The scale of the project is such that, whilst some elements (e.g. air emissions, materials supply) may have national or international influence, the key positive and negative project impacts will affect the environment and communities local to the site. In addition to mainly secondary information presented in this report, collected at the national/provincial level, baseline data will therefore be collected from sources at the local and district level.

The main study area for the ESHIA will focus on the site itself and the area within a buffer zone of 2 km radius from the site boundary. Where appropriate for specific technical disciplines (e.g. for the air quality assessment), wider areas will be considered.

1.6. ESHIA Approach and Methodology

1.6.1. Objectives for the Environmental Statement

An ESHIA is a systematic, scientific and participatory process to assess potential environmental, social, and health impacts of a development, including consideration of project alternatives, cumulative impacts with other planned developments, the use of natural resources, and potential implications of climate change. The process involves public consultation and disclosure of findings at every phase.

The key output of the ESHIA process is the ESHIA Study Report (sometimes referred to as an Environmental Statement or ES). The ES is an independent document which sets out the predicted significant environmental and social impacts of the proposed development and proposes mitigation and associated action plans to avoid, reduce, remedy or compensate for identified potentially significant impacts. The ESHIA is supplemented by the Environmental & Social Management Plan (ESMP). The ESMP summarizes the mitigation action plan and shows how these will be implemented, managed, monitored and reported.

The ESHIA Study Report enables the EPA-SL, local community and other key stakeholders to determine whether or not the proposals (including recommended mitigation) are acceptable. The report also informs the permitting process as the recommended mitigation measures and other actions included in the ESMP form conditions the EIA License issued by the EPA-SL.

Based on an initial desk-based review, discussions with stakeholders and a walkover of the site, it is considered that the key environmental / social issues associated with the development will be air quality,

[1] https://rise.esmap.org/data/files/library/sierra-leone/Energy%20Access/EA%2014.1B.pdf (last accessed 1 September 2020)

noise and vibration, and socio-economic effects. Other issues that will also be considered include water, soils and contamination, traffic and transport and visual impact.

1.6.2. Environmental Protection Agency of Sierra Leone Regulatory Requirements for ESHIA

The EPA-SL is responsible for the approval and permitting of new developments in Sierra Leone. The EPA was established in 2008 through the Environmental Protection Agency Act (2008) ('the EPA Act') with the goal of creating and enforcing a strict regulatory framework for environmental regulation in Sierra Leone. It therefore has the mandate to coordinate, monitor and evaluate the implementation of national environmental policies, programs and projects, including issuing Environmental Impact Assessment (EIA) licenses. Environmental protection as stipulated within legislation and regulations includes activities aimed at preserving a healthy and clean environment, improving the environment, ensuring ecological balance, preventing and overcoming adverse impacts of man and nature on the environment, and, promoting a rational, economic exploitation and utilization of natural resources.

Subsection 1 of section 24 of the EPA Act (2008) submits that an EIA is demanded for certain types of project activities for which, any person who wishes to undertake or cause to be undertaken any of the projects set out in the first schedule shall apply to the EPA-SL for a license. Projects requiring an EIA are those as recognized in the first schedule (Section 24) of the EPA Act (2008) and factors determining the necessity of an EIA are given in Section 25.

Section 25 indicates that projects requiring an EIA include those which involve "industrial activities" such as power plants; however, determination of necessity of an EIA also relates to factors such as:

- The environmental impact on the community;
- The location of the project;
- Whether the project transforms the locality;
- Whether the project has or is likely to have substantial impact on the ecosystem of the locality;
- Whether the project results in the diminution of aesthetic, recreational, scientific, historical, cultural or other environmental quality of the locality;
- Whether the project will endanger any species of flora or fauna or the habitat of flora or fauna;
- The scale of the project;
- The extent of the degradation on the quality of the environment;
- Whether the project will result in an increase in demand for natural resources in the locality; and
- The cumulative impact of the project together with other activities or projects, on the environment.

A flow diagram of the ESHIA process administered by the EPA-SL is shown in Figure 1.2.

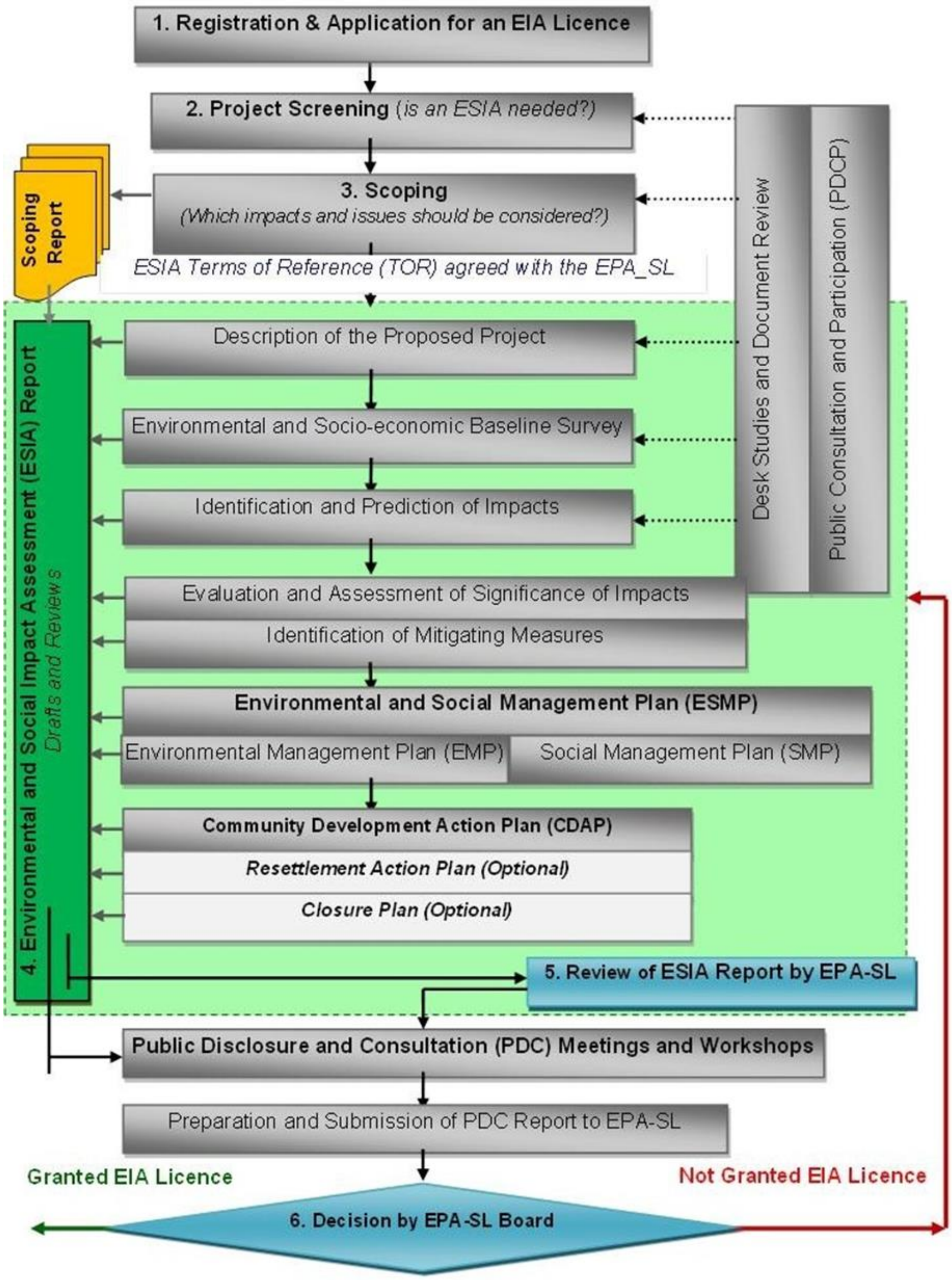
The ESHIA process in Sierra Leone begins with a screening phase (to identify requirement for ESHIA), followed by the scoping phase which identifies potential significant impacts (or scopes out insignificant impacts) and defines the Terms of Reference (TOR's) for the main ESHIA phase.

The main ESHIA phase includes baseline studies to collect site specific information where required, followed by impact assessment and proposal of appropriate mitigation measures and management and monitoring action plans, which are then stipulated in the ESMP.

The current status of the process is that CECA submitted the EPA-SL Screening Form in May 2020. The response received from EPA-SL on 1 July 2020 indicating that the project is classified as 'Category A' and that an ESHIA is required for the development.

This Scoping Report represents the next step in the ESHIA process. Once this report, including the Terms of Reference (TORs) presented in Section 8, is reviewed and approved by the EPA-SL, the main ESHIA phase will commence.

Figure 1.2 The ESHIA Process in Sierra Leone (courtesy of EPA-SL)



1.6.3. Areas for Consideration in EIA

Section 26 of the EPA Act (2008)[2] indicates the areas to be considered in undertaking the Environmental Impact Assessment (EIA). It is stated that an EIA shall contain a true statement and description of:

- The location of the project and its surroundings;
- The principle, concept and purpose of the project;
- The direct or indirect effects that the project is likely to have on the environment;
- The social, economic and cultural effect that the project is likely to have on people and society;
- The communities, interested parties and Government ministries consulted;
- Any actions or measures which may avoid, prevent, change, mitigate or remedy the likely effect on people and society;
- Any alternatives to the proposed project;
- Natural resources in the locality to be used in the project;
- The plans for decommissioning of the project; and
- Such other information as may be necessary for a proper review of the potential environmental impact of the project.

The technical areas considered as required for further study in the main ESHIA phase and associated structure of the Environmental Statement are detailed in the TOR for ESHIA, presented Section 8.

1.6.4. Assessing Significance

The methodology developed and adopted for this assessment provides a tool for assessing and evaluating the significance of effects and is based on the following criteria:

- The type of effect (i.e. whether it is positive/acceptable, negative/unacceptable, neutral or uncertain).
- Duration and/or frequency of occurrence (short term/frequent, long term/long return period, intermittent).
- The policy importance or sensitivity of the resource/receptor under consideration in a geographical context and/or size of affected population (whether it is international, national, regional or local, as defined in Table 1.1).
- The magnitude of the effect in relation to the resource that has been evaluated, quantified if possible, or rated qualitatively as high, medium or low, as defined in Table 1.2.

Other considerations for sensitivity evaluation of a resource/receptor include:

- Its vulnerability to material damage or loss by the impact;
- The resistance of the receptor/resource to change;
- The resilience of the resource/receptor or its capacity to return to baseline condition upon cessation of Project activities;
- The value/importance of a receptor to other receptors/processes;
- Its importance to cultural value systems;
- The subjective perception of individuals/communities regarding the importance of change; and,

[2] http://www.sierra-leone.org/Laws/2008-11.pdf (Accessed 18 August 2020)

- For environmental receptors, their status, whether by statutory or attributed conservation status, land use zoning or environmental quality standard.

Both professional judgement and the results of modelling analysis are used to assess the findings in relation to each of these criteria to give an assessment of significance for each effect. Effects are considered to be major, minor or negligible and can be negative or positive. Where positive impacts are identified mitigation is not required.

Table 1.1 Geographical Context and Policy Importance

Geographical Context	Topic definition
International	Important at global, African or trans-boundary levels
National	Important in the context of Sierra Leone
Regional	Important in the context of Freetown
District	Important in the context of the Eastern Freetown / Kissy Docks Area.
Local	Important within the site and up to 1 km from the site

Table 1.2 Magnitude Criteria

Magnitude of effect	Negative effects	Positive effects
High	Widespread community concern. Failure to meet legal compliance requirements. Fatality or serious health disability. Severe, prolonged, frequent, or possibly irreversible damage to an important ecosystem or resource.	Widespread community benefit. High contribution to safety or prevention of fatalities. High level of technology transfer. Prevents or significantly reduces the risk and probability of serious damage to an important ecosystem or resource.
Medium	Local community opposition and levels of complaint. Regulatory concerns. Lost time injury or short term health effects. Medium term damage to an ecosystem or resource.	Contributes to local development and economy. Positive community support. Provides confidence to regulators. Prevents medium term damage to an ecosystem or resource.
Low	Minor community opposition or complaints. Able to comply with legal requirements. Local/minor health effects requiring short-term treatment. Short-term, minor damage to an ecosystem or resource.	Low level of community support, but no objections. Positive economic benefits are present, but limited and not widely distributed locally.

As a guide Table 1.3 presents a significance evaluation tool which calculates the significance of the effect by a combination of importance/ sensitivity and magnitude.

Table 1.3 Evaluation of Significance of Effect

Sensitivity of Impact	Magnitude of Impact		
	Low	Medium	High
International	Minor / Major	Major	Major
National	Minor / Major	Major	Major
Regional	Minor / Major	Minor / Major	Major
District	Negligible / Minor	Minor / Major	Minor / Major
Local	Negligible	Minor	Minor / Major

1.7. Timescale of the ESHIA Process

The current ESHIA is scheduled to have a draft to key investors by the end of August and a final draft done by the beginning of October of 2020.

1.8. Introduction to the ESHIA Team

1.8.1. Princeton Energy Resources International, LLC (PERI)

Princeton Energy Resources International, LLC (PERI), established in 1980, is an energy and environmental consulting firm providing engineering, technical, economic, policy, and regulatory services to various government agencies, bilateral and multilateral financial institutions, and private sector clients worldwide. In addition to traditional project services such as feasibility studies, planning, policy design, environmental review and assessments, engineering design, construction management/ inspection services, PERI provides technical assistance to governments, their agencies, and private sector organizations to strengthen institutional capabilities through organizational development, sector reform, technology transfer, and training. Headquartered in Rockville, Maryland, just outside of Washington, DC, PERI is within easy reach of U.S. Federal Government Agencies and national, bilateral and multilateral financial institutions such as the Export-Import Bank of United States, Overseas Private Investment Corporation (OPIC), the World Bank, International Finance Corporation (IFC), and the Inter-American Development Bank.

1.8.2. INTEGEMS

INTEGEMS is a Sierra Leone based multidisciplinary consultancy that is registered in both the United Kingdom and Sierra Leone. INTEGEMS integrate innovative GIS technologies with environmental management expertise to provide and enable public and private sector organizations to effectively and efficiently respond to natural resources management challenges and opportunities.

INTEGEMS has experience across Sierra Leone and has developed a thorough understanding of national, regional and local legislative requirements and the environmental and socio-economic challenges faced by various programs, projects and organizations in Sierra Leone. In collaboration with strategic partners, INTEGEMS has successfully designed and carried out several environmental and socio-economic baseline surveys and assessments in diverse communities in various districts of Sierra Leone.

INTEGEMS provides demonstrable experience and expertise in:

- Environmental Management Systems (EMS) and tools, including ESHIA and Monitoring;
- Environmental and Geospatial Data and Information Management Systems;
- Environmental Policy Formulation, Implementation, Monitoring and Evaluation;
- Geo-information Management, including GIS (desktop, server, Web-based and mobile), Remote Sensing, Mapping, Spatial Analysis and Modelling; and
- Research, Monitoring and Evaluation (M & E), including socio-economic baseline data collection and analysis.

1.9. Structure of this Report

The structure of this report is as follows and includes those aspects defined in section 1.6.3 for inclusion in the ESHIA:

- This introduction;
- Applicable Legislation and Standards;
- Environmental Context;
- The CECA Project including alternatives considered;
- Consultation, Engagement and Disclosure;
- The potential direct and indirect social, economic, environmental and cultural effects of the project
- Proposed Scope of the ESHIA;
- Environmental and Social Management Plan (ESMP); and,
- Terms of Reference of Main ESHIA.

At this stage it is too early to consider two aspects as defined in section 1.6.3 notably:

- Natural resources in the locality to be used in the project; and
- The plans for decommissioning of the project

Both aspects will however for part of the subsequent ESHIA.

2. Applicable Legislation and Standards

2.1. Introduction

Relevant identified legislation, regulations, policies, guidelines and standards from Sierra Leone and International treaties, standards and guidance will be considered in the development of the ESHIA.

2.2. Sierra Leonean Legislation

The applicable legislation and standards from Sierra Leonean legislation are provided in Table 2.1. Newly applicable legislation is denoted in bold.

Table 2.1 Relevant Sierra Leonean Legislation

Legislation/Policy	Summary	Project Relevance
National Environmental Policy **1994**	The National Environmental Policy (1994) seeks to achieve sustainable development in Sierra Leone through the implementation of sound environmental management systems which will encourage productivity and harmony between man and his environment. Thus, the key objective of the policy is to secure for all Sierra Leoneans a quality environment that can adequately provide for their health and well-being. The policy indicates inter-sectoral synergies in major areas for policy formulation. It takes into consideration major sector goals and policies for enhancing sustainability in environmental management systems.	Given that the Project is generally sensitive and covers key environmental components, this Policy will thus, promote efforts which will prevent/eliminate damage to the environment and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation.
National Energy Policy **2010**	The objective of the National Energy Policy (2010) is to ensure the provision of modern energy services for increased productivity, wealth creation and improved quality of life for all Sierra Leoneans. The energy supply sub-sectors covered by this policy are electricity, petroleum and renewable energy, with a focus on increasing modern energy supplies for Sierra Leone. The policy is geared towards increasing supplies, through a comprehensive reform of the power sector, including liberalization of the sub-sector, attracting private investments and involvement, and putting in place more effective mechanisms for monitoring and control. For the petroleum sub-sector, the upstream focuses on oil exploration, while the downstream addresses measures to reduce costs, without compromising the security of supply.	The Project aims at complementing Government's efforts in the energy sector development in by increasing access to increased electricity supply in Western Area. Thus, the project is required to be developed in line with the policy commitments in Chapter 3 of the National Energy Policy of Sierra Leone.
National Land Policy **2015**	The National Land Policy promotes the objectives of equal opportunity and sustainable social and economic development. The principles guiding the Land Policy include: (1) protecting the common national or communal property held in trust for the people; (2) preserving existing rights of private ownership and (3) recognizing the private sector as the engine of growth	CECA SL Generation has acquired a lease over the land on which the WAPG Project will be developed. The acquisition of the lease was undertaken in accordance with the National Lands

Legislation/Policy	Summary	Project Relevance
	and development, subject to national land-use guidelines and rights of landowners and their descendants.	Policy's provisions for Access to Land for Responsible Investment (Section 6.4).
Environment Protection Agency Act **2008** **(No. 11 of 2008)** **as amended in 2010**	This Act establishes the Environment Protection Agency-Sierra Leone (EPA-SL), defines its functions and powers, provides for its organization and administration and provides rules for various matters regarding the environment in Sierra Leone. The Agency is established as a corporate body managed by the Board of Directors and an Executive Chairperson to provide for the effective protection of the environment and other related matters. It mandates the EPA among others to: • Advise the Minister of Environment on the formulation of policies on all aspects of the environment; • Issue environmental permits and pollution abatement notices for controlling the volume, types, constituents and effects of waste discharges, emissions, deposits or other sources of pollutants of substances which are hazardous and dangerous to the quality of the environment; • Prescribe standards and guidelines relating to ambient air, water and soil quality, air pollution, water, land and other forms of environmental pollution including the discharge of waste and the control of toxic substances; • Ensure compliance with any environmental impact assessment procedures laid down in the planning and execution of development projects; and • Impose and collect environmental protection levies. • Part IV of the Act exclusively deals with the activities requiring Environmental and Social Impact Assessment and describes the permitting processes leading to the acquisition of an environmental license.	Given that the Project's activities would impact various Environmental and Social components within and around the Project area, CECA-SL is required to acquire an EIA License as stipulated in Part IV, Sections 23 and 24 of the EPA-SL Act of 2008 (as amended in 2010).

Legislation/Policy	Summary	Project Relevance
National Electricity Act **2011**	This National Electricity Act, 2011 is established as an Act to incorporate the Electricity Generation and Transmission Company (EGTC) and to establish the Electricity Distribution and Supply Authority (EDSA) to provide for other related matters. EGTC is responsible for the generation and transmission of electricity and the sale of electricity to the Authority subject to a power purchase agreement approved by the commission. EDSA is responsible for the supply, distribution and retail sale of electricity for the entire country exception areas in which the Commission has issued a distribution License to another appropriately qualified person.	The Project will be operating a power plant that will generate electricity with EDSA as the single off-taker through a 20-year Power Purchase Agreement (PPA). Therefore, CECA SL Generation Ltd is required to comply with the provision of Section 52 (which dictates the conduct of Independent Power Producers), Sections 55-61 (which dictates the conduct of IPPs with regards land acquisition and use) and Section 62 of the National Electricity Act of 2011 which stipulates that that environmental, social, health and safety legislation should be complied with in constructing and operating an electricity generation and supply project.
National Water Resources Management Agency Act **2017**	The Act provides for the equitable, beneficial, efficient, and sustainable use and management of the country's water resources; to establish a National Water Resources Management Agency; to provide a Water Basin Management Board and Water Catchment Area Management Committees for the management of the water resources and other related matters. The Act makes provisions for how the Project is required to abstract water from the water resource points. Specifically, Part II, Section 2 prohibits the unlicensed use of raw water, while Part VII, Sections 28 and 29 outlines the procedure for a water use permit acquisition.	The Project will mechanically abstract water from boreholes or the sea for cooling of power plant engines and other ancillary operations. Therefore, CECA SL Generation Ltd is required to acquire a Water Use Permit as stipulated in Sections 28 and 29 of the National Water Resource Management Agency (NWRMA) Act of 2017, which repeals the Water (Control and Supply) Act, (Act No. 16 of 1963).
Factories Act **1974**	This Act deals with health and safety measures as they concern the factory worker. It protects the worker through demands for all aspects of cleanliness, reports of all injuries, accidents, diseases and death. It makes provision for inspection of facilities, prescribes the powers of an inspector and sets penalties for defaulting parties.	Although the interpretation of “Factory” presented in Section 3 of the Act does not specifically include power plant construction and operation, the provisions of the Factories Act are important in the management

Legislation/Policy	Summary	Project Relevance
		of occupational health and safety at the WAPG Project.
Petroleum Regulatory Agency Act **2014**	This Act establishes the Petroleum Regulatory Agency, to Register, License and Regulate the efficient Importation, Storage, Transportation, and Distribution of Petroleum, to ensure its regular availability to consumers at reasonable prices and to provide for other related matters. The Petroleum Regulatory Agency is therefore responsible for issuing license and regulates the importation, refining, storage, transportation and distribution of petroleum products in a bid to ensure their regular supply to consumers at reasonable standard prices, and for the efficient administration and enforcement of the enactments relating to downstream petroleum activities. The PRA also regulates monitors and overseas petroleum and petroleum products in the downstream industry in Sierra Leone, for growth, efficiency and stakeholder satisfaction, efficiently connecting global energy supplies, as a catalyst for economic transformation and growth in Sierra Leone.	The Project will be importing Liquefied Petroleum Gas (LGP) or Liquefied Natural Gas as the fuel in the power plant. Section 12(1) of the PRA Act of 2014 mandates the Agency to license and regulate the importation, refining, storage, transportation and distribution of petroleum and petroleum products in Sierra Leone. This implicitly implies that the Project would require a License from the Agency for the importation and storage of LPG/LNG for its operation.
Sierra Leone Local Content Policy, 2016 and the Sierra Leone Local Content Agency Act **2016**	The National Local Content Policy (2016) creates an opportunity for local/indigenous businesses and individuals to maximize benefits from the increasing private investments in the country. This policy was issued to boost the economy by leveraging the power of the local industries and Sierra Leone citizens through their participation in the economy. For example, it indicates that: In all enterprises operating in any sector of the economy; at least 20 % of the managerial and 50% of intermediate positions shall be held by Sierra Leonean citizens. The respective ratio will be increased over time and after 5 years of the establishment will stand at 60% for managerial positions and 80% for intermediate positions. A foreign company that partners with Sierra Leonean firms will be granted preferential treatment when competing against companies with no percentage of equity share ownership by Sierra Leonean firms or citizens.	The Project will be creating employment and training opportunities for people at each of its phases. To ensure maximum benefits to the local businesses and population, it is Policy of the Government of Sierra Leone to ensure that priority is given to Sierra Leonean citizens and businesses. This policy is promulgated on the in Part VIII, Sections 54 and 55 of the Sierra Leone Local Content Agency Act of 2016.

Legislation/Policy	Summary	Project Relevance
	That 20% of the equity shares of every registered foreign entity in Sierra Leone should belong to Sierra Leoneans. The Project should have a preference for local competence in the provision of goods and services.	
National Protected Area Authority and Conservation Trust Fund Act **2012**	This Act provides for the establishment of the National Protected Area Authority (NPAA) and Conservation Trust Fund. The purpose of the Act is to promote biodiversity conservation, wildlife management, research and to provide for the sale of ecosystems services in national protected areas. Part III of the Act states the role of the NPAA, which is to exercise oversight and authority over National Parks and Protected Areas designated for conservation purposes and to promote sustainable land-use practices and sustainable environmental management. Furthermore, section III (f) states that another function of the NPAA is to collaborate with other stakeholders in developing a national REDD+ Strategy and to promote REDD+ projects in Sierra Leone as a sustainable source of financing for protected area management. Section III (xi) promotes co-management of natural resources for the NPAA within and outside national protected areas with local forest edge communities.	The Jetty is located within the Sierra Leone River Estuary (SLRE), which is the main marine habitat within the Project Area. The SLRE is located on the Atlantic Ocean and is formed by the Bankasoka and Rokel Rivers. The estuary is the only site in Sierra Leone designated as Wetlands of International Importance (Ramsar Site)[3] and is one of four Marine Protected Areas in Sierra Leone. Therefore, considerations from NPPA would be required for the WAPG Project.
National Biodiversity Strategic Action Plan **2017**	The Sierra Leone Biodiversity Strategic Action Plan comprises a series of measures and mechanisms intended to conserve and promote the sustainable use of the different components of the country's biodiversity. The actions proposed to cover several key thematic areas under terrestrial biodiversity, inland water ecosystems, forest biodiversity, marine and coastal biodiversity and agricultural biodiversity. This Action Plan is intended to provide a framework for setting priority policies and actions for the conservation and sustainable use of biological diversity in Sierra Leone; facilitate information sharing and coordinated action among the various stakeholders at the national level and foster scientific and technical cooperation with other countries and international organization.	The Project site is not located at any major area of concern for National Protected Area Network. However, there is potential that, the Project will be posing threats such as habitat loss and fragmentation of natural habitats of certain dominant terrestrial species such as lizards, green mantis, ants, earthworms, birds etc., due to the project's operations as stipulated in the NBSAP.
Local Government Act, **2004 (as Amended in 2017)**	This Act deals with the establishment and operation of local councils around the country to enable meaningful decentralization and devolution of Government functions. It stipulates that a local council shall be the highest political authority in the locality and shall have	The local authorities within and around the Project area will act as a direct representation of the central government in the locality and they will be the primary

[3] The Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar, 1971) is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Legislation/Policy	Summary	Project Relevance
	legislative and executive powers to be exercised in accordance with this Act or any other enactment. It shall be responsible, generally for promoting the development of the locality and the welfare of the people in the locality with the resources at its disposal and with such resources and capacity as it can mobilize from the central government and its agencies, national and international organizations, and the private sector. The local council should initiate and maintain programs for the development of basic infrastructure and provide works and services in the locality. A local council shall cause to be prepared a development plan which shall guide the development of the locality. Many projects are bound to operate within areas controlled by one local council or another. There is also a relationship between the local council and the Chiefdom within which a project operates. Therefore, every project is required to involve local councils in their development work. The schedules to the Local Government Act outline the activities of various MDAs that have been devolved to local councils.	point of contact in terms of community engagement, community development and the welfare of the people in the community as stipulated in Part V, Section 20 (1 & 2) of the Local Government Act, 2004 (as Amended in 2017).

The work of several Ministries, Departments and Agencies (MDAs) also impacts on the work of the EPA to varying degrees. These include the Ministry of Finance (fiscal and tax matters), the Ministry of Lands, Country Planning and the Environment (MLCPE), the Ministry of Local Government and Community Development (communal lands) and the Ministry of Works, Housing and Technical Maintenance (MWHTM). These ministries will be engaged with as part of the ESHIA consultation and disclosure process to ensure any relevant requirements or concerns regarding the project are considered as appropriate.

Administratively, Sierra Leone is divided into various administrative areas/units: Country, Province, District, Chiefdom, Section and Village.

2.3. International Treaties, Conventions, and Protocols

The applicable legislation and standards from international treaties, standards and regulations is provided in Table 2.2 below.

Table 2.2 Relevant International Treaties, Conventions, and Protocols

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
Vienna Convention on Protecting the Ozone Layer	The Vienna Convention for the Protection of the Ozone Layer was adopted in 1985 and entered into force on 22 Sep 1988. In 2009, the Vienna Convention became the first Convention of any kind to achieve universal ratification. The Vienna Convention is often called a framework convention because it served as a framework for efforts to protect the globe's ozone layer.	21 August 2001	29 August 2001

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	The objectives of the Convention were for Parties to promote cooperation through systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer. The Convention did not require countries to take concrete actions to control ozone-depleting substances. Instead, following the provisions of the Convention, the countries of the world agreed on the Montreal Protocol on Substances that Deplete the Ozone Layer under the Convention to advance that goal. The Parties to the Vienna Convention meet once every three years, back to back with the Parties to the Montreal Protocol, to make decisions designed to administer the Convention.		
United Nations Framework Convention on Climate Change (UNFCCC)	The UNFCCC entered into force on 21 March 1994. Today, it has near-universal membership. The 197 countries that have ratified the Convention are called Parties to the Convention. Preventing "dangerous" human interference with the climate system is the ultimate aim of the UNFCCC. The Convention recognized that there were a problem and bound member state to act in the interests of human safety even in the face of scientific uncertainty. The ultimate objective of the Convention is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system." It states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed sustainably."	11 February 1993	22 June 1995
Kyoto Protocol to the United Nations Framework Convention on Climate Change	The Kyoto Protocol was adopted on 11 December 1997. Owing to a complex ratification process, it entered into force on 16 February 2005. Currently, there are 192 Parties to the Kyoto Protocol. The Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries to limit and reduce greenhouse gases (GHG) emissions following agreed individual targets. The Convention itself only asks those countries to adopt policies and measures on mitigation and to report periodically. The Protocol is based on the principles and provisions of the Convention and follows its annex-based structure. It only	Acceded	10 November 2006

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	binds developed countries and places a heavier burden on them under the principle of “common but differentiated responsibility and respective capabilities”, because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere. In its Annex B, the Kyoto Protocol sets binding emission reduction targets for 36 industrialized countries and the European Union. Overall, these targets add up to an average 5 per cent emission reduction compared to 1990 levels over the five years 2008–2012 (the first commitment period). The Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries to limit and reduce greenhouse gases (GHG) emissions following agreed individual targets. The Convention itself only asks those countries to adopt policies and measures on mitigation and to report periodically. The Protocol is based on the principles and provisions of the Convention and follows its annex-based structure. It only binds developed countries and places a heavier burden on them under the principle of “common but differentiated responsibility and respective capabilities”, because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere. In its Annex B, the Kyoto Protocol sets binding emission reduction targets for 36 industrialized countries and the European Union. Overall, these targets add up to an average 5 per cent emission reduction compared to 1990 levels over the five years 2008–2012 (the first commitment period). The Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries to limit and reduce greenhouse gases emissions following agreed individual targets. The Convention itself only asks those countries to adopt policies and measures on mitigation and to report periodically. The Protocol is based on the principles and provisions of the Convention and follows its annex-based structure. It only binds developed countries and places a heavier burden on them under the principle of “common but differentiated responsibility and respective capabilities”, because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere. In its Annex B, the Kyoto Protocol sets binding emission reduction targets for 36 industrialized countries and the European Union. Overall, these targets add up to an average 5 per cent emission reduction compared to 1990		

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	levels over the five years 2008–2012 (the first commitment period).		
The Paris Agreement	The Paris Agreement builds upon the UNFCC and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort. The Paris Agreement central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity-building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework. Further information on key aspects of the Agreement can be found here.	26 September 2016	1 November 2016
Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment	The Montreal Protocol, 1987, is a global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances (ODS). The stratospheric ozone layer filters out harmful ultraviolet radiation, which is associated with an increased prevalence of skin cancer and cataracts, reduced agricultural productivity, and disruption of marine ecosystems. The Montreal Protocol has proven to be innovative and successful and is the first treaty to achieve universal ratification by all countries in the world. Leveraging worldwide participation, the Montreal Protocol has sent clear signals to the global market and placed the ozone layer, which was in peril, on a path to repair. The Montreal Protocol’s Scientific Assessment Panel estimates that with the implementation of the Montreal Protocol a near-complete recovery of the ozone layer can be expected by the middle of the 21st century. On October 15, 2016, Parties to the Montreal Protocol adopted the Kigali Amendment to phase down production and consumption of hydrofluorocarbons (HFCs) worldwide.	Acceded	29 August 2011

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	HFCs are widely used alternatives to ozone-depleting substances such as hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs), already controlled under the Protocol. This amendment creates market certainty and opens international markets to new technology that is better for the environment, without compromising performance. It calls on all countries to gradually phase down their production and consumption of HFCs in the coming decades using the flexible, innovative, and effective approaches the Montreal Protocol has used for three decades. Global stakeholders endorsed the adoption of the Kigali amendment, including most of the major U.S. companies working in related sectors.		
United Nations Convention on Biodiversity (UNCBD)	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. The objectives of the Convention, to be pursued following its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. Each Contracting Party shall, in accordance with its particular conditions and capabilities: a) Develop national strategies, plans or programs for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programs which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned; and b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies.	12 December 1994	12 March 1995
African Convention on the Conservation of Nature and Natural Resources	The African Convention on the Conservation of Nature and Natural Resources was adopted in 1968 in Algiers. Considered the most forward-looking regional agreement of the time, it significantly influenced the development of environmental law in Africa. The Convention supersedes the Convention Relative to the Preservation of Fauna and Flora in their Natural State of 1933 and has been superseded by the African Convention	15 November 1968	Acceded

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	on Conservation of Nature and Natural Resources (revised) signed in Maputo in 2003. The objective of the Convention is to encourage conservation, utilization and development of soil, water, flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural and aesthetic point of view.		
Convention on Migratory Species (The Bonn Convention)	The Convention on Migratory Species (CMS) is an intergovernmental treaty, concluded under the aegis of the United Nations Environmental Program (UNEP), concerned with the conservation of wildlife and habitats on a global scale and in particular terrestrial, aquatic and avian migratory species throughout their range. Marine debris is a significant concern for species and populations of animals that spend all or part of their life-cycles in or near the marine environment. The key threats are through entanglement and ingestion, as well as from the pollutants transferred into the food chain through microplastics	23 June 1979	1 June 1983
International Convention for the Prevention of Pollution from Ships (MARPOL)	The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at IMO. The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument entered into force on 2 October 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on 19 May 2005. MARPOL has been updated by amendments through the years. The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes.	2 November 1973	2 October 1983
Ramsar Convention on the Conservation of Wetlands	The Convention on Wetlands is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental	15 January 2000	13 December 1999

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". Under the "three pillars" of the Convention, the Contracting Parties commit to work towards the wise use of all their wetlands; designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management; cooperate internationally on transboundary wetlands, shared wetland systems and shared species. The Secretariat, which carries out the day-to-day coordination of the Convention's activities is based at the headquarters of the International Union for the Conservation of Nature (IUCN) in Gland, Switzerland.		
United Nations Convention on the Law of the Sea (UNCLOS)	The United Nations Convention on the Law of the Sea lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources. It enshrines the notion that all problems of ocean space are closely interrelated and need to be addressed as a whole. The Convention was opened for signature on 10 December 1982 in Montego Bay, Jamaica. This marked the culmination of more than 14 years of work involving participation by more than 150 countries representing all regions of the world, all legal and political systems and the spectrum of socio/economic development. At the time of its adoption, the Convention embodied in one instrument traditional rules for the uses of the oceans and at the same time introduced new legal concepts and regimes and addressed new concerns. The Convention also provided the framework for further development of specific areas of the law of the sea.	20 January 1914	25 May 25 1980
International Convention for the Safety of Life at Sea (SOLAS), 1974	The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The first version was adopted in 1914, in response to the Titanic disaster, the second in 1929, the third in 1948, and the fourth in 1960. The 1974 version includes the tacit acceptance procedure - which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties.	20 January 1914	25 May 1980

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	As a result, the 1974 Convention has been updated and amended on numerous occasions. The Convention in force today is sometimes referred to as SOLAS, 1974, as amended.		
Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972	The 1972 Convention was designed to update and replace the Collision Regulations of 1960 which were adopted at the same time as the 1960 SOLAS Convention. One of the most important innovations in the 1972 COLREGs was the recognition given to traffic separation schemes - Rule 10 gives guidance in determining safe speed, the risk of collision and the conduct of vessels operating in or near traffic separation schemes. The first such traffic separation scheme was established in the Dover Strait in 1967. It was operated voluntarily at first but in 1971 the IMO Assembly adopted a resolution stating that that observance of all traffic separation schemes be made mandatory - and the COLREGs make this obligation clear.	20 October 1972	15 November 1977
International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC)	The OPRC was adopted in 1990 after the 1989 conference of leading industrial nations in Paris called upon IMO to develop further measures to prevent pollution from ships. Parties to OPRC are required to establish measures for dealing with pollution incidents, either nationally or in co-operation with other countries. Ships are required to carry a shipboard oil pollution emergency plan. Operators of offshore units under the jurisdiction of Parties are also required to have oil pollution emergency plans or similar arrangements which must be coordinated with national systems for responding promptly and effectively to oil pollution incidents. Ships are required to report incidents of pollution to coastal authorities and the convention details the actions that are then to be taken. The Convention calls for the establishment of stockpiles of oil spill combating equipment, the holding of oil spill combating exercises and the development of detailed plans for dealing with pollution incidents. Parties to the convention are required to assist others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided. The Convention provides for IMO to play an important coordinating role.	30 October 1990	1995

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
International Convention on Civil Liability for Oil Pollution Damage	International Convention on Civil Liability for Oil Pollution Damage, 1969 (and renewed in 1992) applies exclusively to pollution damage caused on the territory including the territorial sea of a Contracting State and to preventive measures taken to prevent or minimize such damage[4]. The Civil Liability Convention was adopted to ensure that adequate compensation is available to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships. The Convention places the liability for such damage on the owner of the ship from which the polluting oil escaped or was discharged. Subject to a number of specific exceptions, this liability is strict; it is the duty of the owner to prove in each case that any of the exceptions should operate. However, except where the owner has been guilty of an actual fault, they may limit liability in respect of any one incident.	1973	13 August 1993
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	The text of the Rotterdam Convention was adopted on 10 September 1998 by a Conference of Plenipotentiaries in Rotterdam, the Netherlands. The Convention entered into force on 24 February 2004 with the objectives to: • promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals to protect human health and the environment from potential harm; • contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties. • The Convention creates legally binding obligations for the implementation of the Prior Informed Consent (PIC) procedure. It built on the voluntary PIC procedure, initiated by UNEP and FAO in 1989 and ceased on 24 February 2006. • The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by Parties and which have been notified by Parties for inclusion in the PIC procedure.	Acceded	1 November 2016

[4] International Convention on Civil Liability for Oil Pollution Damage (accessed via: http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-on-Civil-Liability-for-Oil-Pollution-Damage-(CLC).aspx, 24 august 2020)

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	The Convention promotes the exchange of information on a very broad range of chemicals through: • the requirement for a Party to inform other Parties of each national ban or severe restriction of a chemical; • the possibility for Party which is a developing country or a country in transition to inform other Parties that it is experiencing problems caused by a severely hazardous pesticide formulation under conditions of use in its territory; • the requirement for a Party that plans to export a chemical that is banned or severely restricted for use within its territory, to inform the importing Party that such export will take place, before the first shipment and annually thereafter; • the requirement for an exporting Party, when exporting chemicals that are to be used for occupational purposes, to ensure that an up-to-date safety data sheet is sent to the importer; and • labelling requirements for exports of chemicals included in the PIC procedure, as well as for other chemicals that are banned or severely restricted in the exporting country.		
Stockholm Convention on Persistent Organic Pollutants	The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have harmful impacts on human health or the environment. Exposure to Persistent Organic Pollutants (POPs) can lead to serious health effects including certain cancers, birth defects, dysfunctional immune and reproductive systems, greater susceptibility to disease and damages to the central and peripheral nervous systems. Given their long-range transport, no one government acting alone can protect its citizens or its environment from POPs. In response to this global problem, the Stockholm Convention, which was adopted in 2001 and entered into force in 2004, requires its parties to take measures to eliminate or reduce the release of POPs into the environment. As set out in Article 1, the objective of the Stockholm Convention is to protect human health and the	26 September 2003	1 November 2016

Treaty/ Convention/ Protocol	Summary	Year Signed	Year Ratified
	environment from persistent organic pollutants with a requirement of each party to[5]: Prohibit and/or eliminate the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex A to the Convention (Article 3). Restrict the production and use, as well as the import and export, of the intentionally, produced POPs that are listed in Annex B to the Convention (Article 3). Reduce or eliminate releases from unintentionally produced POPs that are listed in Annex C to the Convention (Article 5). The Convention promotes the use of best available techniques and best environmental practices for preventing releases of POPs into the environment. Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner (Article 6). The Convention requires that such stockpiles and wastes be identified and managed to reduce or eliminate POPs releases from these sources. The Convention also requires that wastes containing POPs are transported across international boundaries taking into account relevant international rules, standards and guidelines.		
African Convention on the Conservation of Nature and Natural Resources	The African Convention on the Conservation of Nature and Natural Resources was adopted in 1968 in Algiers. Considered the most forward-looking regional agreement of the time, it significantly influenced the development of environmental law in Africa. The Convention supersedes the Convention Relative to the Preservation of Fauna and Flora in their Natural State of 1933 and has been superseded by the African Convention on Conservation of Nature and Natural Resources (revised) signed in Maputo in 2003. The objective of the Convention is to encourage conservation, utilization and development of soil, water, flora and fauna for the present and future welfare of mankind, from an economic, nutritional, scientific, educational, cultural and aesthetic point of view.	Acceded	15 November 1968

The ESHIA will also consider the policies, guidelines, and standards of the World Bank Group's International Finance Corporation (IFC). The requirements of the World Bank Multilateral Investment Guarantee Agency (MIGA) essentially reflect those of the IFC Performance Standards for private sector projects.

[5] UNEP – Stockholm Convention (accessed via: http://www.pops.int/TheConvention/Overview/tabid/3351/Default.aspx, 30 March 2020)

2.4. International Standards

The ESHIA also considers the policies, guidelines and standards of the WBG's IFC. The requirements of the World Bank Multilateral Investment Guarantee Agency essentially reflect those of the IFC Standards for private sector projects.

2.4.1. IFC Performance Standards (IFC PS) (2012)

Table 2.3 International Standards Considered for the ESHIA

IFC PS	Summary
Performance Standard 1: Social and Environmental Assessment and Management Systems	Performance Standard 1 underscores the importance of managing environmental and social performance throughout the life of a project. An effective Environmental and Social Management System (ESMS) is a dynamic and continuous process initiated and supported by management and involves engagement between the client, its workers, local communities directly affected by the project (the Affected Communities) and, where appropriate, other stakeholders. Drawing on the elements of the established business management process of "plan, do, check, and act," the ESMS entails a methodological approach to managing environmental and social risks and impacts in a structured way on an ongoing basis.
Performance Standard 2: Labor and Working Conditions	Performance Standard 2 recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by the protection of the fundamental rights of workers. For any business, the workforce is a valuable asset, and a sound worker-management relationship is a key ingredient in the sustainability of a company. Failure to establish and foster a sound worker-management relationship can undermine worker commitment and retention and can jeopardize a project. Conversely, through a constructive worker-management relationship, and by treating the workers fairly and providing them with safe and healthy working conditions, clients may create tangible benefits, such as enhancement of the efficiency and productivity of their operations.
Performance Standard 3: Resource Efficiency and Pollution Prevention	Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. There is also a growing global consensus that the current and projected atmospheric concentration of greenhouse gases (GHG) threatens the public health and welfare of current and future generations. At the same time, more efficient and effective resource use and pollution prevention and GHG emission avoidance and mitigation technologies and practices have become more accessible and achievable in virtually all parts of the world. These are often implemented through continuous improvement methodologies similar to those used to enhance quality.
Performance Standard 4: Community Health, Safety and Security	Performance Standard 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. Also, communities that are already subjected to impacts from climate change may experience acceleration and/or intensification of impacts due to project activities. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, this Performance Standard addresses

IFC PS	Summary
	the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.
Performance Standard 5: Land Acquisition and Involuntary Resettlement	Performance Standard 5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) as a result of project-related land acquisition and/or restrictions on land use. Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement. This occurs in cases of (i) lawful expropriation or temporary or permanent restrictions on land use and (ii) negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail.
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.
Performance Standard 8: Cultural Heritage	Performance Standard 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities. Also, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity.

2.4.2. IFC/WB Environmental Health and Safety (EHS) General Guidelines (2007)

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). These General EHS Guidelines, shown in Table 2.4, are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in specific industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary.

Table 2.4 Relevant WB/IFC EHS Guidelines

WB/IFC EHS General Guidelines	Summary
Environmental	This guideline applies to facilities or projects that; • generate emissions to air at any stage of the project life-cycle (Air Emissions and Ambient Air Quality);

WB/IFC EHS General Guidelines	Summary
	• consume energy in process heating and cooling; process and auxiliary systems, such as motors, pumps and fans, compressed air systems and heating, ventilation and air conditioning systems (HVAC) and lighting systems (Energy Conservation); • discharge of process wastewater, wastewater from utility operations or stormwater to the environment (Wastewater and Ambient Water Quality); • promote the continuous reduction in water consumption and achieve savings in the water use (Water Conservation); • store, or handle any quantity of hazardous materials (Hazmats), defined as materials that represent a risk to human health, property, or the environment due to their physical or chemical characteristics (Hazardous Materials Management); • that generate, store, or handle any quantity of waste across a range of industry sectors (Waste Management). • addresses impacts of noise beyond the property boundary of the facilities (Noise) • management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances (Contaminated Land). This sector complements the industry-specific environmental guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for emissions management that may be applied to a range of industry sectors.
Occupational Health and Safety	Employers and supervisors are obliged to implement all reasonable precautions to protect the health and safety of workers. This Guideline provides guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety. Although the focus is placed on the operational phase of projects, much of the guidance also applies to construction and decommissioning activities. Companies should hire contractors that have the technical capability to manage the occupational health and safety issues of their employees, extending the application of the hazard management activities through formal procurement agreements. The Occupational Health and Safety issues focus on the following: • General Facility Design and Operation • Communication and Training • Physical Hazards • Chemical Hazards • Biological Hazards • Radiological Hazards • Personal Protective Equipment (PPE)

WB/IFC EHS General Guidelines	Summary
	• Special Hazard Environments • Monitoring
Community Health and Safety	This section complements the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities taking place outside of the traditional project boundaries, but related to the project operations, as may be applicable on a project basis. These issues may arise at any stage of a project life cycle and can have an impact beyond the life of the project. These issues include: • Water Quality and Availability • Structural Safety of Project Infrastructure • Life and Fire Safety (L&FS) • Traffic Safety • Transport of Hazardous Materials • Disease Prevention • Emergency Preparedness and Response
Construction and Decommissioning	This section provides additional, specific guidance on prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life-cycle, or due to expansion or modification of existing project facilities. Cross-referencing is made to various other sections of the General EHS Guidelines.

3. The Western Area Power Generation Project (WAPGP)

3.1. Project Development

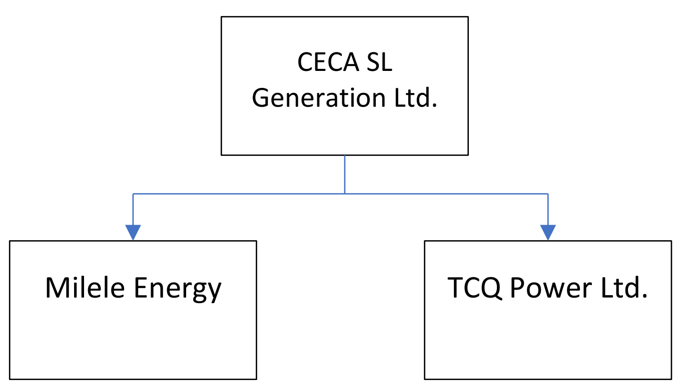
3.1.1. Project Ownership History

Blue Flare Power SL (BVI) Ltd. (Blue Flare) was founded to pursue opportunities for private sector investment in Freetown's electricity distribution network and power generation facilities. In July 2011 Blue Flare signed two foundational agreements with the Government of Sierra Leone (GoSL): the Grid Development and Management Agreement (GDMA) and the Power Purchase Agreement (PPA).

In 2012 TCQ Power Ltd. (TCQ) entered into agreements with the founders of Blue Flare and a Joint Development Agreement with CEC Africa Investments Ltd (CECA) was subsequently signed in April 2013. CECA has incorporated a Sierra Leonean entity named CECA SL Generation Ltd. and has re-branded the project under this name.

In 2016 the commonwealth Development Corporation acquired the shares from CECA and replaced them as the majority sponsor. In 2018 after the withdrawal of the World Bank from the project and the restructuring of the same to a Gas Powered CCGT plant, Milele Energy acquired the shares from CDC. Below in Figure 3.1 shows the current shareholding for the transaction.

Figure 3.1 Project Ownership



3.1.2. Project Development History

In late 2010 GoSL requested and reviewed three proposals to provide 120 MW of generating capacity for the town of Freetown. The founders of Blue Flare were amongst those invited to submit proposals for review. The technical proposal was prepared and supported by a San Francisco-based firm, Suntrough.

During initial negotiations it was suggested that rehabilitation of the 33 kV grid was added to the scope, as a prerequisite to the generation project, due to the poor state of the distribution grid which would limit the ability of generated electricity to be delivered to customers, and therefore NPA's ability to collect payments. This proposal was set out in a power purchase agreement (PPA), grid development and management agreement (GDMA) and a Project Framework Agreement. These agreements were given GoSL Cabinet approval in July 2011.

During technical development of the scheme, it was agreed that a staged approach to development of the generation capacity would be built up along with the increased evacuation capacity to the grid. It was later then agreed to split the GDMA from the generation PPA. The PPA for the generation component was signed in March 2014. This ESHIA is for the generation project, though the generation project now includes a 5000 m transmission upgrade element.

Since 2018 the project has been restructured from a HFO-fired power generation plant to a Liquefied Petroleum Gas (LPG)/combined cycle plant

CECA's experienced project team, including Milele and TCQ personnel, has been active in pursuing the various project workstreams necessary to reach financial close and commence construction. This ESHIA process is one of the key elements required prior to financial close.

3.2. Project Alternatives

A number of sites were considered by the GoSL with regard to the potential for new power generation installations as part of a power sector masterplan produced for the GoSL by the Japan International Cooperation Agency (JICA) in 2003.

The project site was selected by the GoSL for the first development and forms the basis for the generation PPA. This was done given the project site's proximity to the fuel terminal in SL. Additionally there was no other government land available in the area.

A technology assessment was undertaken in 2013 to consider feasible and most appropriate generation technology options for the project. After the 2013 assessment an HFO reciprocating combustion engine design was picked. After the withdrawal of the WB, the sponsors looked for a gas fired plant in order to reduce emissions. The GoSL lead an energy initiative for the country to use and import more LPG and LNG. Aeroderivative combustion turbines offer several advantages over reciprocating engines when burning gas, including higher capacity per unit, reduced operations and maintenance costs, competitive economics, and reduced emission characteristics.

In addition, there were two environmental aspects that originally resulted in alternative design proposal for water supply and for waste disposal.

First, the original design included reciprocating engines in simple cycle operation, which require negligible amounts of water to fill internal closed loop cooling circuits. These cooling needs were met with groundwater drawn from boreholes on the Project site. The aeroderivative engines will require a similar amount of water to fill closed loop cooling circuits, which are used to cool the Project's equipment.

The aeroderivative engines will operate in combined cycle mode, where electricity is generated from both the combustion turbine generator and a steam turbine generator, increasing the Project's efficiency. Steam is generated from the exhaust gas in a boiler system, passed through the steam turbine to produce power, and condensed back to water using an air-cooled condenser. Occasionally, the boiler system will use a blowdown system to reject a small amount of water at the bottom of the boiler drums, which typically contain impurities that are damaging to equipment. This water is pressurized and flashes to steam, resulting in a loss from the system. So, a small amount of water is consumed in this process.

The aeroderivative engines are equipment with a wet injection combustor system, which sprays an almost equal mixture of demineralized water and LPG into the engines in order to significantly reduce NOX emissions from stacks. The water demand for the wet injection system is met by drawing seawater to the site and processing it in a water treatment plant. This process includes separating desalinated water from the seawater intake stream, resulting in a waste stream that has a higher concentration of brine. So, the new technology uses substantially more water for the sprint emissions system and will require a desalination plant. The desalination process and associated waste stream could have impacts on the local marine ecology and therefor will need to be studied in the ESHIA.

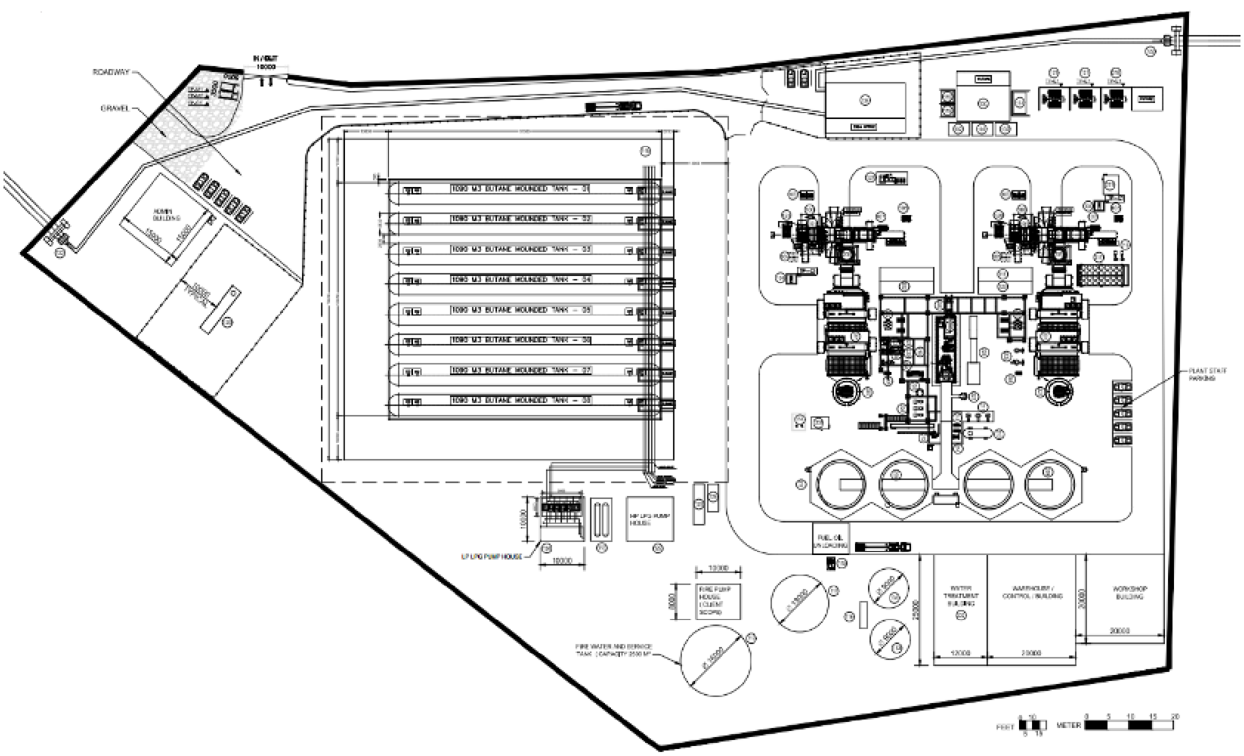
3.3. Key Elements of Project

The Western Area Power Generation Project will consist of two (2) combined cycle gas turbine (CCGT) power blocks with a 128-megawatt (MW) nominal output. The first 85-MW CCGT power block will be fueled by LPG delivered by barge from the New Kissy Jetty. LPG will be transferred to the site via a new interconnecting pipeline and will be stored in horizontal tanks that are mounded in earthen berms for enhanced fire protection. To meet emissions requirements, the project will draw seawater from a beach well near Cline Bay and discharge brine east of the Jetty through an underwater outfall structure. Power will be evacuated at 33-kV to the Blackhall Road and Ropoti substations via existing overhead transmission lines that pass over the Site.

This section summarizes key elements of the development. A detailed project description document is included in Appendix A.

3.3.1. Site Layout

Figure 3.2 Site Layout



3.3.2. Main Features of the Plant

The Project will be configured as a 2x1 combined cycle power plant (CCGT), consisting of two (2) Combustion Turbine Generator (CTGs) exhausting into two (2) Heat Recovery Steam Generator (HRSGs). The HRSG will be a two-pressure design (HP and LP) without duct firing. Steam from the HRSG will be admitted to one (1) condensing Steam Turbine Generator (STG). The steam cycle will be dry cooled using an air-cooled condenser.

The project will include a standby generator for black start capability and emergency shutdown.

The CTG exhaust gases will be used to generate steam in the HRSG.

LPG is the primary fuel for the Project, which will be delivered by ship to the New Kissy Jetty, located to the north of the plant. The Project includes a new pipeline that will connect the jetty LPG unloading line with the on-site storage system. LPG will be pumped to site and stored in horizontal bullet tanks, which are mounded beneath earth for improved fire protection.

Diesel fuel oil will be a backup fuel for the facility, should LPG not be available due to a delivery delay or LPG system outage. Diesel fuel oil will be brought to site by truck and unloaded into an on-site storage tank sized for one day of baseload fuel consumption.

Associated equipment will include emission control systems necessary to meet the proposed emission limits. The combustion turbines will require water injection to meet NOX emission limits. NOx emissions may be additionally controlled by a selective catalytic reduction (SCR) system in the HRSG. An oxidation (CO) catalyst may be installed in the HRSG to control CO emissions.

To meet needs for water injection, cooling cycle make-up, and service/fire protection water requirements, the Project will use both well water and a desalination system. Raw water will be primarily sourced from on-site wells and supplemented by the desalination system to provide additional capacity. The desalination system will intake seawater near the New Kissy Jetty and will discharge treated wastewater to the northeast of the site. Both the seawater intake and discharge pipelines will follow a common right-of-way with the LPG pipeline.

Potable water for drinking, safety showers, and sanitary uses will be served from the Project's water treatment system.

The electrical transmission interconnection will link the Project into the Sierra Leone National Grid through a 33kV Indoor Metal Glad Switchboard located at the CC Plant and a 33kV transmission line between the CC Plant's Switchyard and two nearby substations: Ropiti to the southeast and Black Hall Road to the west.

Additional 33/11kV distribution substation upgrades will be included in the Project, as determined by the Grid Impact Assessment.

The layout and equipment of the plant is shown in Figure 3.2 and Table 3.1:

Table 3.1 Project Equipment List

Equipment List	
Description (Simple Cycle)	**Description (Combined Cycle)**
GE LM2500 Combustion Turbine	Heat Recovery Steam Generator (HRSG)
Generator Circuit Breaker (GCB)	HRSG / Steam Turbine Generator (STG) Power Control Module (PCM)

Equipment List	
Description (Simple Cycle)	**Description (Combined Cycle)**
Fuel Gas Filter Skid	ST Generator
Waste Drains Tank	High Pressure/Low Pressure Steam Turbine
Water Wash Cart	Feed Water Pumps
CO2 Skid	Recirculation Pump
Generator Lube Oil (GLO) Skid	HRSG Stack
Auxiliary Skid	Bypass Stack
Turbine Lube Oil/Hydraulic & Generator Lube Oil Fin Fan Cooler	Air Cooled Condenser (ACC)
Air Filter	Condensate Tank
Balance of Plant (BOP) PCM	Condensate Pumps
Raw and Fire Water Tank	Blowdown Tank with Transfer Pump
LPG Buffer Tanks	ADV
Drain Pit with Transfer Pump	ADV Pumps
Diesel Forwarding Pumps	Drain Pot Pumps
Pretreatment Tank	Closed Cooling Water (CCW) Pump Skid
Diesel Fuel Storage Tank	CCW Fin Fan Coolers
Mounded LPG Storage Tank	Generator Step Up Transformer (GSUT) 33/11.5kV
Unit Auxiliary Transformer (UAT) 11.5kV/400V	Sampling Skid
Incinerator / Flare	Dosing Skid
Generator Step Up Transformer (GSUT) 33/11.5kV	Compressed Air Skid
Riser Tower	Start-Up Ejector
Combined GT PCM	Service Ejector
Control Module (LPG Vaporizer)	GSC
LPG Heat Exchanger	CCW Tank
Low Pressure LPG pumps	HP / LP Bypass Station
Black Start Diesel Generator	Flash Tank
Water Injection Boost Skid	STG Laydown Area
High Pressure LPG Pumps	-

Equipment List	
Description (Simple Cycle)	**Description (Combined Cycle)**
11kV & 33kV Switchgear Building	Main Pipe Rack
Demineralized Water Tank	Blowdown Tank Fin Fan Cooler
Filtered Water Tank	Water Treatment Plant
Station Service Transformer (SST) 33kV/400V	
33-KV Switchgear Building (EDSA)	

3.3.3. Associated Infrastructure (Transmission Upgrade and Fuel Supply Pipeline)

In order to evacuate the generated power from the project, approximately 6 km of rehabilitation works are anticipated to the local transmission network, from Blackhall Road substation to the plant site and on to Wellington Substation The extent of the rehabilitation will be determined by the Grid Impact Assessment

3.4. Design Changes to Reflect ESHIA

The following key changes to the design due to environmental and social considerations below.

• Noise – Noise has been determined to be a large impact to the surrounding community. The site layout has been designed to mitigate these impacts as much as possible. The large earth berm containing the LPG tanks will help mitigate sound transmission to sensitive residential areas close by. These impacts will be looked at more closely in the ESHIA as well as the mitigation options.

- Water use – The change from the HFO reciprocated air-cooled engines to the LPG fired aeroderivative turbines require significantly more water to meet emissions standards. From the well testing reports it has been determined that a desalination plant will be required to supply enough water for the turbines needs. The desalination plant will also reduce any potential impacts on local users of the groundwater resource by ensuring that the existing borehole is not used to provide the full water requirement for the plant.
- Impacts on the RAMSAR site:
    - It was identified that the site is located close to the Sierra Leone river estuary RAMSAR site and the water intake and discharge, could have the potential to cause significant impacts on marine ecology. With the inclusion of a desalination plant to meet the needs of the turbines, impacts of the RAMSAR site will need to me taken into consideration. This includes a stormwater drainage system that will be in line with relevant IFC EHS guidelines to avoid the potential to impact the RAMSAR site.
- Effluent discharge – The design includes an oil water separator and effluent treatment system to ensure that any discharges from the site will be in line with relevant IFC EHS guidelines to avoid the potential to impact on the RAMSAR site. It was also identified that it is likely to be possible to discharge the small amount of effluent as it will be treated.

4. Environmental Context for the Project

4.1. Introduction and Site Context

The project is located on a site in the Kissy Dock area, approximately 4 km east of the center of Freetown, Sierra Leone, on existing industrial land immediately south of the National Petroleum fuel depot. The site is approximately 200m west of Wellington Creek and 500m south of the Sierra Leone River Estuary (SLRE). The site layout is shown in Figure 3.2.

The site is owned by the Government of Sierra Leone (GoSL) and is currently occupied by government and commercial premises. is divided into two main areas. The western part of the site is occupied by the Sierra Leone Roads Authority (SLRA) Western Region Administration Office ("the SLRA WR area").

4.1.1. Site Layout

The key features of the site and surrounding area are shown on Figure 4.1 and referenced by letter (e.g. 'M') in the legend. The following discussion refers to the relevant legend key letter where appropriate. There are no current occupants on the site. CECA SL Generation Ltd. Signed a land lease with GoSL on January 17, 2017 and has occupied the site since then.

The areas described below are descriptions of how the land was used before signing the lease. These organizations do not currently occupy the site.

The Sierra Leone Roads Authority-Western Region (SLRA-WR) Area: The SLRA-WR area was primarily used to store equipment and machinery.

The main structures in the SLRA WR area include an administration building located along the northern boundary, close to the entrance (offices, toilets and a reception area – 'D' on Figure 2.3) and a large Dutch barn ('B') in the southwest part of the site that is used to store items including drains, culverts, sign posts and old machinery.

Ancillary features of the administration building include:

- The office potable water tank (between the building and the boundary);
- A borehole ('M') to the east of the building (believed to be 3 to 4m deep);
- A temporary structure used as a carpentry/upholstery workshop ('R'); and,
- A shed housing the generator for the administration building ('P').

China Republic Construction Company (CRCC) Compound: The southeast quarter of the SLRA-WR site contains the CRCC compound. It is fenced off from the WR site by chain fencing topped by razor wire. Access is gained through the northern fence of the CRCC compound.

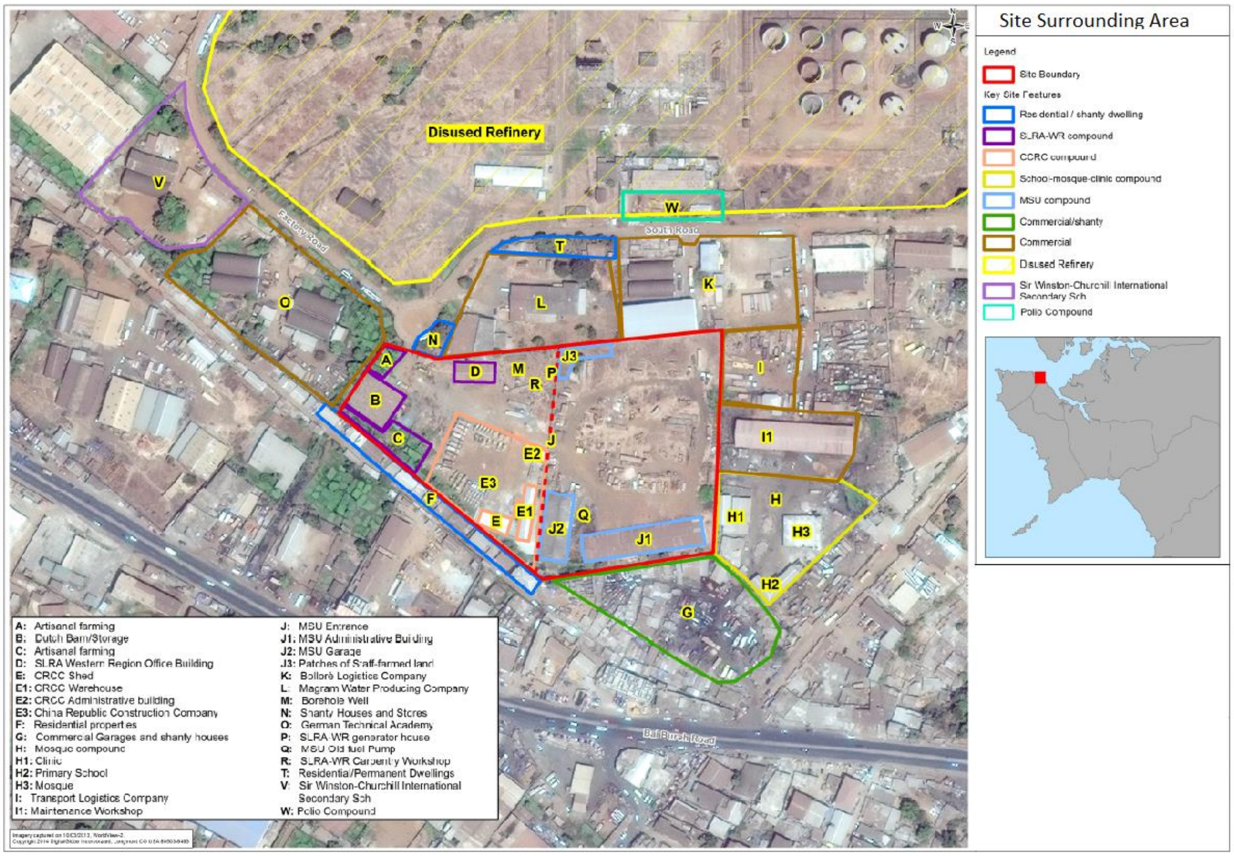
The structures ('E' and E1-3 on Figure 4.1) in the compound consist of an administrative building to the east of the gate, a warehouse and a shed.

Between the CRCC structures and the southern perimeter wall is a strip of land that has not been cultivated and is currently overgrown, although there are banana and mango trees present. In the eastern corner of the perimeter wall, adjunct to the MSU boundary, there is a sealed-up access gate and a security post.

The Mechanical Service Unit (MSU) Compound: The MSU compound occupies the western and largest portion of the site. Access is via a metal gate along the dividing wall with the SLRA-WR.

The MSU compound holds two buildings; a store ('J') to the west and a large maintenance garage and with administrative buildings at each end (J1) which runs along most of the southern boundary of the MSU compound. Adjacent to the eastern wall of the warehouse is a fuel pump and associated area of hardstanding (Q). A small generator house is located at the back of the store building, in the southwest corner of the MSU compound.

Figure 4.1 Site Surrounding Area



4.1.2. Surrounding Land Use

As stated above, the areas surrounding the project site are zoned industrial. Residential uses in the area are either mostly shanty buildings constructed by the individuals dwelling or are generally occupied by renters. Other facilities, such as the Islamic Compound and the Polio Compound described below, have also been informally established in the area. Most of what is known from the surrounding area was gathered from the original study so some of the land use could have changed. INTEGEMS will update this part of the ESHIA.

The following section presents the key observations.

- To the south of the site, adjacent to the SLRA-WR area, is Old Railway Road. Permanent residential dwellings ('F') have been constructed along the alignment of an old railway. The dwellings are a mixture of multi-story (up to five stories) and single-story buildings.
- To the south of the MSU compound is a mixture of shanty houses and vehicle repair garages ('G').

- Adjacent to the southern end of the MSU compound's eastern wall is an Islamic compound ('H'). The compound contains a nursery and primary school, a mosque, hospital and an Islamic center.
- To the east of the MSU compound (north of the Islamic compound), there is a logistics company and lumber yard ('I').
- To the north of the MSU compound is the Bolloré Logistical Company ('K'). Currently, the over ground drainage from the MSU compound flows through the Bolloré site into the opened drainage ditch on South Road.
- To the north of the SLRA-WR compound is the Magram Water Production and Packing Factory ('L').
- Immediately to the north of the Magram site, along South Road, there is an area of Shanty houses ('N') that stretches up to the site entrance.
- On the northern side of South Road is a 'Polio Compound,' beyond which is the decommissioned oil refinery.
- To the immediate west of the SLRA-WR site is the German Technical Academy, beyond which is the Winston Churchill Secondary School. Both of these educational facilitates have access from Factory Road.

As stated above, the areas surrounding the project site are zoned industrial. Residential uses in the area are either mostly shanty buildings constructed by the individuals dwelling or are generally occupied by renters. Other facilities, such as the Islamic Compound and the Polio Compound described below, have also been informally established in the area. During the 25 February 2014 inception mission, a walkover was undertaken by the ESHIA team and the EPA-SL along the nearest roads surrounding the site.

4.1.3. Disused Refinery and Liquid Petroleum Gas (LPG)/Addax Jetty

Liquid Petroleum Gas (LPG)for the project is planned to be imported via the Addax jetty, which was constructed in 2015, north of the site via an approximately 1300 meter pipeline. The pipeline will be constructed on an elevated base or pipe rack within the existing right of way (RoW) and within the secured areas of the National Petroleum (NP) compound disused refinery.

4.2. Air Quality

Prior to the original HFO study, no significant data was available to determine the baseline air quality levels in Freetown. The air testing for the original study indicated that air quality at certain locations is considered poor and for a large portion of the urban population are exposed to high levels of toxic air pollutants. [6]

The significant sources of air pollution which influence air quality in the vicinity of the project site are likely to be domestic or commercial-scale power generators, burning of household or commercial wastes, residential wood and charcoal ovens, road traffic emissions, industrial emissions and re-suspended dust/particulate matter from poorly surfaced or unsurfaced roads. Due to unreliable power sources, domestic and commercial power generators, commonly running on diesel are prevalent in most parts of Freetown, including around the site. This will lead to increased emissions of substances associated with combustion in addition to those emitted by road traffic, for example, nitrogen dioxide, sulfur dioxide, particulates and carbon monoxide. The amount of poorly surfaced roads is likely to lead to significant dust

[6] Taylor & Nakai (2012) Monitoring the levels of toxic air pollutants in the ambient air of Freetown, Sierra Leone. African Journal of Environmental Science & Technology, 6 (7) 283-292

generation during the dry season. During the rainy season, the potential for significant dust generation is less likely.

The unsurfaced access roads leading to the project site attract relatively high proportions of heavy vehicles, fuel tankers and commercial trailers accessing neighboring facilities including warehouses and factories. The amount of poorly surfaced roads is likely to lead to significant dust generation during the dry season. During the rainy season, flooded roads have the potential for significantly less dust generation.

During the original HFO study it was concluded from the baseline monitoring that the levels of particulate matter (PM) are higher than the WHO Guidelines. The primary mitigation factor was exhaust stack height.

Further baseline monitoring will be necessary to confirm the current baseline conditions around the proposed site and determine the air quality from those substances which could be emitted to air from the proposed power station.

4.3. Noise

A quantitative review of the site and surrounding area will be completed via a noise monitoring program and site walk.

During the initial assessment in 2015, an ambient noise baseline was established using noise surveys conducted during February and September site visits. During the initial site visit, noise from local roads, generators and other industrial sources were noted. Potential noise sensitive receptors were also identified and they included:

- Residential property along the southern boundary,
- A school-hospital-mosque complex at the southeast corner, and
- Commercial properties along remaining boundaries.

The noise emissions from the Project operating will be predicted, and the potential impacts at the noise sensitive receptors will be quantified. The noise assessment will consider Sierra Leonean legislation, and relevant guidelines.

The separation distances between these some of the receptors and the Project are considered to be relatively small and achieving acceptable noise levels at these receptors is likely to influence the design and specification of the Project. It is noted that the EPA-SL also highlighted that noise impacts on local residential receptors should be carefully considered in the design of the plant.

4.4. Socio-economics

4.4.1. Introduction

Data described within this section was derived predominantly from surveys provided by INTEGEMS as well as the Sierra Leone 2015 Population and Housing Census Report. Information concerning the immediate project area is limited and therefore information concerning the Western Area (specifically Wester Urban) or Sierra Leone as a whole has been used. For the purpose of the socio-economic baseline, it has been assumed that no significant changes will take place within the project area between the time of data collection and the submission of the ESHIA report.

Due to the Coronavirus Disease 2019 (COVID-19), additional protocols have been implemented for data collection. These guidelines have been based on the recommendation of the Government of Sierra Leone (GoSL) and the World Health Organization (WHO).

New studies are being performed by INTEGEMS and this ESHIA will be updated accordingly. Alternative sources of information will be sought, and current baseline data will need to be verified during the implementation of the ESMP (Volume II).

4.4.2. Socio-economic Structure of Sierra Leone

Sierra Leone, officially the Republic of Sierra Leone, is a constitutional republic with a directly elected president and a unicameral legislature. It consists of five provinces split into 16 districts. The Western province is divided into two districts, Western Rural and Western Urban. Freetown and the project site are located within the Western Area Urban District. This is the most affluent area of the country and is the governmental, cultural and financial center. Despite this characterization, a 2008 Atkins report classified it as a "poor area" (but not very poor), with medium population density, and having some coverage of essential services and a sense of security. The Kissy peninsula is highly built-up compared to other parts of the country.

4.4.3. Project Area of Influence

The area of socio-economic influence for the project is considered to be 5km around the site based on a review of the population and economic assets likely to be influenced by the project. This area of influence was selected because it covers all of the adjacent communities where the project is expected to create direct economic or social impact. This includes the Fisher Lane district to the north, beyond which is the Sierra Leone River Estuary. To the southeast is Wellington, and to the west and northwest are Allen Town, Maeba Town, Kortright, Foulah Town, Mount Aureol, Tower Hill, Magazine, Jinger Hall, Cline Town Upgun Area and Kissy Dockyard. To the south and southwest are vegetated areas with a lower population density.

4.4.4. Population Demographics

Statistics Sierra Leone (the GoSL Department for statistics) (SSL) indicated that the last national census was undertaken in 2015. Population projections for the project are based on 2015 Sierra Leone population and housing census data. Predictions indicate that in 2015, Freetown's population consisted of 1,088,957, but could grow by nearly 37% between 2015 and 2030 to 1,488,217. The Sierra Leone 2015 Population and Housing Census indicates that 49.2% of the population is male, and 50.8% female. The population nationally has a high proportion of young people (41.5% age below 15, and only 5.1% above 60). Within the (more urban) Western Region, this is less marked, with 34.6% under 15, but only 4.2% over 60. In 2007, average household size was 6.0 in urban areas, and amongst poor households in urban areas, was 11.8. Amongst families in which polygamy is practiced there are typically 2 to 3 wives.

4.4.5. Race, Ethnicity and Language

Ethnic groups found within the Western Area include all of the ethnic groups in Sierra Leone. The Creoles are the indigenes of Freetown, and this ethnic group makes up the highest proportion of the population. The main ethnicity of the Kissy area is not known, but is assumed to be the same as for Freetown as a whole (Creole). A UNEP Report on Sierra Leone (2010) describes the major religions in the Western Area as Islam (60%) and Christianity (30%) practiced by groups that have migrated into Freetown. The official language of Sierra Leone is English, although Krio is spoken by 90% of the country's population, and by 10.5% as a mother tongue. Mende and Temne are also spoken widely in the north and south of the country rather than in Freetown.

4.4.6. Gender Relations

The war in Sierra Leone was associated with high levels of extreme sexual and gender violence towards women and children. Levels of Gender Based Violence (GBV) are difficult to ascertain but the UNICEF Gender analysis of the situation of women and children in Sierra Leone (2011) report estimates them to be very high.

The Rainbo Centres provide services to victims of rape and sexual assault. In 2019 they provided support to 3,897 clients, compared with 754 fewer in the previous year, indicating an increase in service access. In the same year, only 216 cases out of approximately 4000 filed were successfully prosecuted in court. The years of civil war have normalized violent behavior, although this acceptance is beginning to change.

Although equally likely to attend primary school, girls are less likely to complete their education. Reasons cited include sexual exploitation by teachers and the low number of female teachers and other role models, as well as demands from families or themselves to marry and start a family. Another difficulty faced by women is the customary inability for women outside the Western Area to own property or land. A livelihood closely tied to land access and food security can therefore be severely compromised in the event of marital breakdown.

Women are under-represented in almost all non-agricultural employment fields. Gender parity in senior positions is particularly low, and despite a recommendation of the Truth and Reconciliation Commission that political parties ensure at least 30% of their candidates for public elections were women, this has not been achieved. Reasons for this may include barriers to women entering politics (for example low literacy), bullying behavior in a male-dominated environment, difficulties in financing election campaigns, and in commanding respect.

4.4.7. Vulnerable Groups

Vulnerable people in Sierra Leone include children, women, elderly people, those who are sick, disabled and those who are part of any ostracized or disempowered minority (for example homosexuals). The construction and operation of the project could affect vulnerable people differently to others. While employment opportunities will be made equal between racial and religious groups, sick and heavily disabled persons may be unable to work.

Some of the pressures which the project may exert on local services and infrastructure as a result of worker influx may have a proportionally larger impact on vulnerable groups. For example, medical services that could be further stretched by increasing population may have more significant consequences for those who are sick, elderly, disabled, and children.

4.4.8. Infrastructure

Access to safe drinking water is essential to help prevent water-borne diseases such as cholera, typhoid and schistosomiasis, and to avoid adverse health effects associated with other contaminants. The need for safe drinking water is closely associated with that for adequate sanitation, refuse disposal systems and healthcare education.

In the previous report it was noted that the Western Area generally has a high level of access to safe drinking water compared with provincial regions. There is however strain on facilities as a result of migration that took place during and after the decade of civil unrest that ended in 2002. The movement of people into the catchment areas of watercourses used as water supplies is also associated with the contamination of surface- and groundwater sources. Because of the high population density, contamination can spread very quickly, with cholera being a particular problem during the rainy season.

The piped water supplies that do exist can be intermittent, particularly during the dry season. The remaining population rely on streams and rivers within the Western Area. The Guma Valley Water Company (GVWC) supplies piped water to parts of Freetown but access is limited.

As is the case in many parts of West Africa, there is no adequate means of refuse disposal in Freetown. The dumping of refuse on undesignated sites is commonplace and associated with breeding grounds for disease-causing organisms, vermin, bad odors and other health and safety issues. Burning of refuse is also practiced but can also create problems through the production of noxious fumes, the potential for fires becoming out of control, and explosions associated with the burning of highly combustible materials.

Much of Freetown's road network has been neglected and is in a poor state of repair. With heavy congestion and severe weather conditions (intense heat and humidity in the dry season and heavy rainfall in the wet season), the roads have suffered badly, such that potholes and broken surfaces are the norm. During initial site visits, it was noted that there were several ongoing road construction projects in Freetown. The access roads between the site entrance and Bai Bureh Road are tarmac routes that are generally in poor repair.

4.4.9. Health

The recent outbreak of Coronavirus Disease 2019 - (COVID-19) has impacted Freetown affecting both people and health services. Data on COVID-19 for the site area will be sought from WHO and the Sierra Leone government.

Primary healthcare is the patient's first point of contact with health care professionals, usually within the local community. In Sierra Leone this is delivered at Peripheral Health Units (PHUs) which comprise community health centers, community health posts and maternal and child health posts. The ratio of people to PHUs in the Western Area is 32,500:1 compared with the national average of 9000:1. The Atkins report found that the Western area receives the worst level of service provision nationally from the Ministry of Health and Sanitation (MoHS). However, private and NGO-run PHUs (including missionary facilities such as those adjacent to the site) are more widespread in the area than elsewhere. This is likely to ease the pressure on state-operated facilities. Secondary healthcare refers to the services provided by medical specialists, as well as acute care in emergency situations. Availability of such services is, by contrast, higher in Freetown than nationally, with 1,500:1 hospital beds, and 9800:1 doctor. 80% of the country's doctors practice in the capital.

4.4.10. Education

The Sierra Leone 2015 Population and Housing Census Report on Education and Literacy indicated that literacy within the Western Area was nearly double the national average, at 74.5%. For comparison, within the Northern region, the literacy rate was 42.2%. Nationally, 70% of heads of households reported no education in 2007, while this figure was only 25% in the Urban Western Area. Of the 75% in the Urban Western Area that do have some education, approximately 4% have some/completed primary education, 43% have some/completed secondary education, and 28% have post-secondary education. Literacy is generally higher in males than in females across all age groups, and literacy rates are higher in older age groups than younger age groups. This is likely a result of increasing school provision in recent years, and the lack of educational facilities during the civil war pre 2002. According to the census, 83% of households with children ages 6 to 15 confirmed that the children were attending school.

4.4.11. Agriculture and Land Tenure

Within the Western Region, the 2015 Census shows private renting at 59.3% is the most common ownership type. The majority (88%) of households surveyed in the project vicinity are not engaged in farming, and generally when farming is practiced in the area, it is located away from the residence (82% of farming households).

4.4.12. Archaeological and Cultural Heritage Resources

The Atkins 2008 Review of Environmental and Social Factors reports that the majority ethnic group in Freetown, Creoles, do not practice activities which involve sacred sites or other protected features. It is possible that sites of cultural importance used by other tribes may lie within the study area, but the potential for this is considered to be minimal given the highly industrialized nature of the area. Any such cultural sites will be identified as part of baseline studies. Archaeological and cultural heritage resources are discussed further in Section 4.13.

The recent civil war means that archaeological and historical sites are unlikely to be present. In the event that any archaeological site is discovered during construction operations, works would cease until further assessment could be carried out.

4.4.13. Visual Quality of the Area

The impact of the project on the visual landscape is likely to minimal, since the surrounding landscape context is of a similar nature, namely industry and highly built-up. The upgrade of nearby roads and clearing of debris on the project site is likely to represent an improvement to the appearance of the area. Visual impacts are discussed further in Section 4.11.

4.5. Geology, Soils and Contamination

The coastal regions of much of Sierra Leone adjacent countries are generally low-lying and flat. The Western Area of Sierra Leone is the only mountainous coastal region in West Africa comprising a range of thickly forested mountains rising from sea level to close to 1,000m and dominating the peninsula at the northern end where Freetown is situated. The regional geology here is known as the Freetown Complex, a major intrusion characterized by prominent layering of repeated sequences of troctolitic, gabbroic and anorthositic rocks, together with transitional rock types.

Apart from the areas of hard standing or cultivation, the surface of the site is primarily sand/gravel with patchy weed-type vegetation. There are areas of hard laterite pan outcropping across the ground surface within the MSU compound, which indicates that shallow hard rock is likely to be encountered across the site.

Local soils in the area are known to be well drained with dusky reddish gravelly sandy clay loam to clay loam with sand content increasing with depth with some laterite and quartz gravel materials.

The key contamination sources on site and receptors are summarized as follows:

- The fuel supply island and fuel tanks in the MSU compound.
- Multiple point sources from the large number of vehicles not stored on hardstanding.
- Key receptors for potential contamination are shallow groundwater and adjacent land receiving runoff from the site. Ultimately, the end receiving environment for groundwater and runoff is likely to be the Sierra Leone estuary which could result in cumulative impacts.

While it appears that prevailing topography will result in overland drainage to the north, the likely fractured, hard rock geology means that groundwater flow patterns may be complex and may not necessarily be towards the north. Therefore, the potential for contamination due to migration of historical spills from the disused refinery to the north will require consideration.

A geotechnical and contamination site investigation is to be undertaken by contractors on behalf of CECA. Results of this investigation will be considered as part of a soils and groundwater chapter of the ESHIA, which will include an assessment of contamination risk to human health and the environment, if appropriate.

4.6. Groundwater and Water Supply

The borehole in the SLRA WR area confirms the presence of shallow groundwater. SLRA staff indicated that the borehole abstracts all year and that it is 3-4 m deep. A test pumping exercise and condition assessment should be undertaken as part of the site investigation works to determine suitability of the borehole for use by the project, associated implications for siting of plant infrastructure, and potential for existing groundwater contamination.

There are Guma Valley Water Company (GVWC) pipes that appear to run beyond the site boundary to a communal water facility located on the south side of Factory Road, approximately 100m from the site entrance. The plant design will need to ensure that GVWC water supply to the communal water supply point is not interrupted or if so, that an alternative supply is made available.

With the significant water demand of the proposed aeroderivative combustion turbines, sea water will be needed to fulfill the water demand. A thermal desalination plant will need to be installed onsite as a result.

4.7. Transport

During initial site visits, the transport network in Freetown was observed to be poorly maintained and heavily congested, particularly during morning and evening rush hour, with anecdotal information indicating that this is exacerbated by increasing population in the capital. It has been identified that there are several ongoing road construction projects in that are likely to rapidly change the nature of the transport baseline in Freetown.

Further information on the transport baseline (including likely road construction projects and the potential for long standing queues of heavy vehicles in the area around the site) will be collected during the baseline phase of the ESHIA. The potential implications of construction transport on the local road network, and conversely the implications of the standing queues for construction transport will be considered within the transport chapter of the ESHIA.

4.8. Climate, Rainfall and Climate Change

Freetown, as with Sierra Leone and other West African countries has a tropical climate with two distinct seasons; the dry season which occurs between November-April and the wet season which occurs between May-October with a peak of up to 800 mm rain during August.

The temperature generally ranges between 22 and 32°C. As the project site is located approximately 500 m from the sea, it is likely to experience higher wind speeds than inshore locations.

The risk of flooding occurring can be planned for by a consideration of predicted climate changes in the drainage system design. A recommendation will therefore be included within the ESMP that an appropriate increase in drainage capacity is incorporated into the design, to account for potential increased rainfall relative to the historical and current norm.

Appropriate steps will also be described within the ESMP regarding annual reporting of greenhouse gas emissions in line with the requirements of the IFC Performance Standard 2.

4.9. Hydrology, Drainage and Flooding

The key sensitive hydrological feature is the Sierra Leone River Estuary. This is located some 400m to the north of the project site. The second most significant surface water feature in proximity to the project site is the Wellington Creek. This stream is located some 200m to the east of the project site and this stream discharges to the SLRE. There is also a small stream located to the south of the project site that runs along the southern side of Old Railway Road and then turns north through the grounds of the Winston Churchill Secondary School and a disused refinery area before ultimately discharging to the Sierra Leone River Estuary.

There is currently no formal storm water drainage system on the site, apart from some small perimeter drains around the hardstand of the SLRA-WR administration building. Drainage across much of the site is, therefore, anticipated to be as surface runoff. Much of the site appears to drain towards the north in line with the prevailing topographic gradient and the western portion of the site by the site entrance slopes to the northwest. There are holes in the northern perimeter walls of the site to allow the runoff to pass through. Similar holes are present in the northern perimeter walls of the adjacent commercial premises to the north.

Sewage effluent management on the site is currently through use of septic tanks with no municipal sewer connection identified.

4.10. Ecological Resources

This section presents a summary of the main findings from a desk-based ecological review of the site and surrounding area.

The proposed power plant site and immediate surroundings comprise industrial and degraded areas with little vegetation remaining. The local area is highly built-up and lies within the densely populated suburbs of eastern-Freetown.

A previous site visit shows the areas being cultivated are along the northern and western boundaries, but consultations with the farmers indicate that other areas of the site are farmed during the year. Given the highly industrialized and degraded nature of the proposed site, and its associated lack of vegetated habitats, the site is considered to be of negligible terrestrial ecological value and the potential for protected or otherwise notable species to be present on site would appear to be very limited.

4.11. Landscape and Visual

Given the size and scale of the development in the context of heavily industrialized and urbanized Kissy Docks area, it is not anticipated that there will be significant effects associated with Landscape and Visual amenity. In consultations with the EPA-SL, it was also confirmed that landscape and visual impacts are not considered to be a significant development constraint in Sierra Leone. Nevertheless, the following discussion of the current baseline is provided as a basis to scope out this assessment from the main ESHIA stage.

The site is located within the Kissy Dock area of Eastern Freetown. The area surrounding the site is mainly industrial / commercial to the north, north east and west, whilst the area to the south and southeast is a mix of densely urbanized areas, social infrastructure (schools, mosques/churches, hospitals etc.) and commercial/industrial premises.

4.12. Waste Management

Waste management planning in Sierra Leone falls under the remit of the Ministry of Health and Sanitation. An Integrated National Waste Management Strategy document was released by the ministry in 2012.The strategy includes a comprehensive framework for the management of healthcare, municipal and industrial waste along with recommendations for educational programs to raise awareness of domestic waste management and associated good practices.

Recent industrialization and associated urbanization has led to a significant population increase in Freetown, particularly within slum areas. This overwhelmed the limited waste handling capacity of the previously existing Freetown Waste Management Authority. Poor solid, liquid and healthcare waste management, combined with poor community and personal sanitation/hygiene practices is indicated as closely related to high infant mortality due to spread of malaria, diarrhea and cholera.

From 2012 until 2017, the Masada Waste Management Company ('Masada') was the sole body responsible for all waste handling in Freetown. In 2017 the Freetown City Council (FCC) regained responsibility for solid waste management, with a new initiative called Operation Clean Freetown (OCF), which was created as part of an alliance with international organizations. OCF's predominant aim is to reduce the risk of epidemics through improved solid waste management FCC has control over the waste management and Operation Clean Freetown.

The main types of waste that will be produced by the project include:

- General construction waste;
- Waste metal (welding rods, rebar, piping etc.) during the construction phase;
- Paints and solvents;
- Wood;
- Plastics;
- Paper;
- Electric cabling;
- Glass;
- Empty storage containers;
- Domestic and food waste;
- Waste oils, lubricants and sludges; and,
- Water treatment sludges.

As a rough guide almost 15% of construction materials is wasted and the higher volume of waste is produced during the construction phase although for a shorter period of time than the operational phase. Some construction wastes can be recycled into the community as there are usually markets for waste oils and lubricants that can be used for timber treatment or as industrial fuel. During the ESHIA there will be an evaluation of the existing structures for asbestos. Hazardous materials will require careful removal, storage, treatment and disposal.

A waste management plan will need to be prepared for construction, operation and decommissioning phases. This requirement has been included within the ESMP.

4.13. Archaeology and Cultural Heritage

The site is located within the heavily urbanized Kissy Docks area of Freetown. Those areas of the site which do not contain buildings are either hard rock outcrops or likely to be shallow sand/gravel (potentially made ground) in the main areas in which vehicles are stored. Waste land within the site has been farmed at different times for the last three years.

No information regarding the archaeological or cultural heritage significance of the site has been identified. Consultations with representatives of identified users of the site – SLRA, MSU, CRCC and farmers – has not identified any practices of cultural heritage significance within the site. Given the developed nature and current use of the site, it is considered unlikely that the site has archaeological value of note.

An assessment of potential impacts on archaeological and cultural heritage will therefore not be included within the scope of the main ESHIA. Further enquires will, however, be made during the baseline phase of the ESHIA and should relevant information be identified, this will be considered in the assessment as appropriate.

4.14. Cumulative Impacts

When a project is being developed, it is possible that other projects may also be under development within the local area which may impact upon the same receptors. The ESHIA will therefore attempt to identify any such projects and include the potential impacts of these within relevant assessments.

At present, limited information is available on the developments around the proposed site. Should it be confirmed that any projects are proceeding, or any other relevant developments be identified during subsequent stages of the ESHIA, these will be considered in the main ESHIA as appropriate.

4.15. Trans-boundary Impacts

This project is not located close to the national borders and s not of a scale that is likely to result in trans-boundary impacts.

5. Consultation, Engagement and Disclosure

5.1. CECA Approach to Consultation, Engagement and Disclosure

Consultation is an important component of the ESHIA process, allowing interested and project affected parties and organizations to become involved in the planning and development process of the project. It ensures that their concerns, ideas and expectations of the project are considered and acted upon. The consultation exercise will assist in identifying key issues of relevance to ensure that these are assessed at a level of detail appropriate to the scale of the project.

5.2. Stakeholder Consultation to Date

CECA has consulted informally and formally with a number of organizations and key stakeholders during the scoping phase of the project as follows:

- Government (National, Regional and Local) Ministries, Departments and Agencies;
- Community Leaders (e.g. Religious, Educational);
- Local and International NGOs;
- International Financial Institutions.
- Vulnerable Groups (e.g., women, youth and elderly);
- Business Organizations; and
- Communities & Community-Based Organizations (CBO).

CECA originally consulted stakeholders for the HFO project. Since restructuring the project CECASL has consulted with stakeholders again to listen to their input on the new project. A full list of meetings and the key talking points and concerns will be included in the ESHIA. An updated list of stakeholders is listed below in Table 5.1

Table 5.1 List of Stakeholders

GoSL Ministries, Departments and Agencies	NGOs
Ministry of Environment	Native Consortium and Research Centre (NCRC)
Ministry of Health and Sanitation	Conservation Society Sierra Leone (CSSL)
Ministry of Energy	Friends of the Earth Sierra Leone (FESL)
Ministry of Fisheries and Marine Resources	Environmental Foundation for Africa - Sierra Leone (EFA-SL)
Ministry of Lands, Housing and Country Planning	**Project Neighbors**
Electricity Distribution and Supply Authority (EDSA)	National Petroleum (SL) Limited
Electricity Generation and Transmission Authority (EGTC)	Total (SL) Limited
Ministry of Water Resources	Petro Jetty
Guma Valley Water Company (GVWC)	AfriGas (SL) Limited
National Water Resources Management Agency	Magram Water Company
Sierra Leone Ports Authority (SLPA)	Kissy Industries
Sierra Leone Meteorological Agency	Sierra Fishing Company
Sierra Leone Maritime Administration	All Petroleum Product Limited

National Fire Force (NFF)	Sierra Leone Water Company (SALWACO)
National Protected Area Authority (NPAA)	Government Independent Memorial Secondary School
West Africa Regional Fisheries Programme	Sir Winston-Churchill International Secondary School
Sierra Leone Standards Bureau	German Technical Academy
Climate Change Secretariat	Islamic Mission School and Clinic Facility adjacent Project
Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone	Residences adjacent Project Site
Parliament and Local Council	Occupant of former Bollore Compound - adjacent Project Site
Freetown City Council (FCC)	Community Based Organisations (if any)
Councillor - Ward 415	
Parliamentarian - Constituency 119	

Table 5.2 presents a summary of the key observations/outcomes from the project consultation meetings held with various consultees and stakeholders so far in the process.

Table 5.2 Stakeholder Focus Group Discussions

FOCUS GROUP DISCUSSION			
Category	**Date and Venue**	**Purpose of Engagement**	**Key Observations/Outcomes**
Key community stakeholders **Participants:** Councillors Area chiefs Religious leaders Youth leaders Disabled Community Women's leaders Political party representatives	**17/08/2020** Kissy Dockyard Community (Councillor Bintu's house)	To notify them about the Project and the ESHIA update. To acquire in-depth information on community issues that should be considered by the project and the ESHIA process. To provide guidance on how to conduct the ESHIA especially with regards to cultural and other sensitive issues.	There were thirteen participants (9 male and 4 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project and pledge to provide support where needed. They believe that the operations of the project will contribute to boost local business in terms of electricity supply • They expressed dissatisfaction over the compensation package that wasn't paid for the remaining year(s) for the Project Affected People (PAPs). • They expressed concern about noise and air pollution that will be generated from the operations of the company especially those in close proximity to the project site. • They requested CECA should consider locals within the community for

FOCUS GROUP DISCUSSION			
Category	**Date and Venue**	**Purpose of Engagement**	**Key Observations/Outcomes**
			employment, particularly for unskilled labour. • They stated that the movement of CECA vehicles will likely contribute to further degradation of the roads in the area and therefore requested that CECA provide support to rehabilitate the roads in the community. **Activities suggested for the CDAP:** • Support to health (Construction of a health centre) • Support to road rehabilitation • Support to education and skill training
Youth Group **Participants:** Youth men and women	**17/08/2020** In front of CECA compound	To notify them about the Project and the ESHIA update. To get their own perspective as youths about the project and to understand their major concerns in the community.	There were sixteen participants in total (14 male and 2 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project and expressed their commitment to provide support where needed. • They are concern about impacts of noise and air pollution that will be generated form the operations of the company especially for those living closer to the project site. • They are expected to benefit from the project in the area of employment opportunities and particularly requested CECA to prioritise the youths. • They are also keen to know when the project implementation will commence. • They requested CECA to support in rehabilitating the roads within the community. **Activities suggested for the CDAP:** • Support to health (Construction of a health centre) • Support to road rehabilitation

FOCUS GROUP DISCUSSION			
Category	**Date and Venue**	**Purpose of Engagement**	**Key Observations/Outcomes**
			• Support to education and skill training
Mix Group **Participants:** Community authorities Young and old people Disable community	**18/08/2020** South road (Kissy Dock Yard)	To notify them about the Project and the ESHIA update. To acquire in-depth information on community issues that should be considered by the project and the ESHIA process. To have a further understanding of the socio-economic settings and issues within the community.	There were twenty-three participants (7 male and 16 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project since 2015. • Impacts of noise and air pollution that will be generated from the operation of the company was a general concern. • Community members complained that they haven't been given job opportunities by other existing companies and requested CECA should consider locals within the community for employment particularly for unskilled labour. • Some of the community members also suggested that CECA should directly engage the local community members to give them an opportunity expressed their genuine concerns/constrain. • Community members are keen to know when the project implementation will commence. • Movement of CECA vehicles will possibly add to further degradation of the roads in the community and therefore requested the support of CECA in the rehabilitation of the roads. **Activities suggested for the CDAP:** • Support to road rehabilitation. • Support to education (Construct primary school). • Micro-finance support to business people.

Table 5.3 Key Informant Interviews/ Meetings

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
Abdala Abdelgani Medical Centre	**15/08/2020** Clinic facility	Mariatu Moseray **In-charge**	The purpose is to notify health centre authorities about the project and to obtain information on the health status of the community and also understand the potential health impacts of the project from a health expert perspective. **Comments and concerns:** • There is no public health centre in the community and the only one present is a mission owned which constrained with insufficient water supply and lack of building infrastructures. • The common sicknesses prevalent in the community are Malaria, Typhoid and high blood pressure. Malaria and Typhoid are mainly caused by mosquito bite and consumption of contaminated water or food. While high blood pressure is mostly associated with aging. • The major health related concern for the project would be air and noise pollution which can cause respiratory diseases and hearing deformities with prolong exposure to pollutant sources.
Government Independence Secondary School	**15/08/2020** School Compound	Alhassan Mamoud **Principal**	Government Independent Secondary School is approximately 250m from the project site. It is therefore important to engage the school authorities to inform them about the project; understand the general status of the educational facilities within the community and to obtain concerns they might have relating to the project. **Comments and concerns:** • Most schools in the project area are government and government assisted schools. • Some of the challenges in the schools are lack of electricity, unequipped libraries, water shortage and computer labs etc. • Electrical fault, noise and air pollution are major concerns about the project that will potentially affect schools. • Expected benefits are access to electricity, support to education and road rehabilitation.
Sierra Leone Parliament	**16/08/2020** Residence	Hon. Wurroh T. Jalloh **Member of Parliament**	The Project site falls within Constituency 119 in Kissy community which is the most populated area in the entire Western Area Urban.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
		(Constituency 119)	The consultation was held with the MP for constituency 119 to brief him about the project and inform him about the ESHIA process and obtain any concerns may regarding the project. The MP is also member of the parliamentary oversight committee on environment on was important to seek guidance on key issues/factors to consider particularly with regards to legislative provisions relevant to the project. **Comments and concerns:** • Petty trading is the major livelihood activity within the community. • Education challenges are inadequate classrooms and learning materials. • There is no market and public health centre. • Guma Valley Water Company is the main provider of water within the community but there are still faced some challenges. • There are wastes collectors (FCC) within the community but there are general challenges on waste management. • There is access to electricity within the community but there are issues with voltage fluctuation. • Noise and air pollution are major concerns about the project that will potentially affect residents within the community. • Access to electricity, job creation, improve local business are expected benefits from the project. • Key social issues to be considered in the CDAP are support to education, health care and construction of market. • The MP emphasised that CECA should consider and prioritise locals within the community for job opportunities.
Freetown City council	**16/08/2020** Resident	Bintu D. Konjor **Councillor** (Ward 415)	The Project site falls within Ward 415 in Kissy community which is the most populated area in the entire Western Area Urban. The local council is the highest political authority in the locality and have legislative and executive powers to exercise in accordance with the local government Act of 2004 or any other enactment. The council is also responsible to promote development within the community and the welfare of the

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			people with the resources at its disposal and with such resources and capacity as it can mobilise from the central government and its agencies, national and international organisations, and the private sector. The councillor is responsible to: a) Maintain close contact with his ward or chiefdom, consult the electorate on issues to be discussed in the local council and collate their views, opinions and proposals for that purpose, and present them to the local council; b) Report to the electorate the decisions of the Council and the actions he has taken to solve problems or deal with issues raised by the electorate; and c) Promote communal and other development activities in the locality. **Comments and concerns:** • Petty trading is the major livelihood activity within the community. • Education challenges are inadequate classrooms and learning materials. • There is no market and public health centre. • Guma Valley Water Company is the main provider of water within the community, but supply is limited and there is need for water tanks in some parts of the community to help supply areas without reach. • There are wastes collectors (MASADA and FCC) within the community but there are general challenges on waste management. • There is access to electricity within the community but there are issues with voltage fluctuation. • CARITAS and GOAL are the few NGOs operating the community but mostly provide their support to disaster response. • Noise and air pollution are major concerns about the project that will potentially affect residents within the community. • Access to electricity, job creation, improve local business are expected benefits from the project.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• Key social issues to be considered in the CDAP are support to education, health care and construction of market. • The MP emphasised that CECA should consider and prioritise locals within the community fir job opportunities.
Sierra Leone Police	**19/08/2020** Shell police post	Neneh Koroma **Officer in Charge** (Shell Police post) Kallay Kargbo **Admin Officer**	Shell police post was consulted because they are within the project area of influence approximately within 100m from the project site. Issues of community safety and security is one of the key responsibilities of the police. Therefore, the police were consulted to understand security status and concerns within the community. **Comments and concerns:** • Assault, larceny, pickpockets are the common crimes prevalent within the community. • The men are mostly the culprit of these crimes. • Generally, crime rate has reduced due to pro-activeness of police. However, crimes are mostly reported during festive seasons. • There is no vehicle or any form of mobility to ease the work of police personnel. • The Shell police post are not aware about CECA and the project but pledged their support where needed. • Access to electricity, provision of clean water, job creation, improve local business are expected benefits from the project. • They anticipate that the project will lead to influx of workers and this will add to their responsibilities especially in the area of security.
Sir Winston Churchill Secondary School	**19/08/2020** School Compound	Abdul Frederick Sesay **Principal and Proprietor**	Sir Winston Churchill Secondary School is approximately less than 100m from the Project Site and the only private secondary school within the delineated 500m study area. It is therefore important to engage the school authorities to inform them about the project; understand the general status of the educational facilities within the community and to obtain concerns they might have relating to the project. **Comments and concerns:** • Most schools in the project area are government and government assisted schools.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• Some of the challenges in the schools are lack of electricity, unequipped libraries, water shortage and computer labs etc. • Electrical fault, noise and air pollution are major concerns about the project that will potentially affect schools. • Expected benefits are access to electricity, support to education and road rehabilitation.

5.3. Household Surveys

INTEGEMS will be conducting household surveys. The survey will be based on interviews of one or more individuals (ideally the head of household and spouse) within the household who are able to answer questions about their household. The household surveys and prior consultation meetings will allow CECA to provide project information to and obtain information, views and concerns from the wider community.

Previous community consultations had shown clear support for the project and expectations that the projects will provide tangible benefits in the form of job opportunities, electricity supply, and economic and community development. It is also expected that potential adverse impacts will be predicted and prevented or mitigated. Further discussions with the farmers at the SLRA site will be particularly important so that every effort is made to ensure that livelihoods are not adversely affected by the project.

The consultation program will continue and a Stakeholder Engagement Plan (SEP) is in development so that all concerns are identified and managed, will be fully reflected in the ESHIA and subsequent management plans and factored into the design development for the project.

A grievance mechanism has been established to allow stakeholders, and in particular the local community, to have the ability to lodge complaints or voice their concerns, and for any such complaints to be dealt with, recorded and monitored by CECA.

Further consultation reports will be prepared as the project develops and ongoing consultation continues. Further public consultation workshops will be held towards the end of the ESHIA process in line with the requirements of the EPA-SL ESHIA process.

6. Proposed Scope of the ESHIA

This section presents an initial review of potential environmental and social impacts followed by a summary of justification for those elements which have been scoped out of the main assessment. For each assessment topic proposed for the full ESHIA, anticipated impacts, assessment methodology and preliminary mitigation considerations are discussed.

6.1. Screening of Potential Impacts

A review of the project description and the identified information on the social and environmental baseline was undertaken to identify potential impacts which are relevant for screening consideration as part of the scoping process. The results of the review for potential social and environmental issues are summarized in Table 6.1.

Where issues are readily mitigated through standard design included within the project description, this is discussed and these issues will be scoped out of the assessment, as discussed in Section 6.2.

Table 6.1 Screening of Potential Environmental Impacts

Potential Issue / Impact	Construction	Operation
Social	Construction employment opportunities and knock on economic benefits in the local community. Potential strain on local health and other municipal infrastructure, and increased risk of HIV/AIDS transmission if there is significant worker influx. Air quality and noise emissions, including transport. Increased occupational and community health and safety risk due to construction transport. NPA plans for resettlement of farmers will need to be monitored. Tourism is not expected to be impacted by the project	Operational impacts include skilled operational and maintenance employment and indirect economic benefits to suppliers and local business due to increased electrical provision. Key adverse impacts for operation phase are air emissions and noise impacts which will be carefully assessed.

Potential Issue / Impact	Construction	Operation
Atmospheric Emissions	Atmospheric emissions and dust from oil handling and plant movement (controlled by such activities as retaining vegetation and wetting of surfaces). Staff vehicular and construction plant emissions will also arise.	The thermal production of power is associated with a range of combustion related emissions including: Nitrogen oxides (NO, NO_2 and N_2O) associated with health effects, acid rain and ground level ozone Sulphur dioxide (SO_2) associated with health effects and acid rain Carbon oxides (CO and CO_2) – CO is associated with health effects while CO_2 is associated with climate change Unburnt hydrocarbons associated with health effects and ground level ozone. Particulate Matter (PM_{10}) associated with health effects For HFO projects of this capacity, 'end-of-pipe' mitigation technologies (e.g. filters, scrubbers etc.) are not generally feasible, therefore mitigation tends to focus on optimizing of stack height.
Energy Efficiency and Greenhouse Gas Emissions	The use of fuels for plant and vehicles during construction emits CO_2.	LPG and LNG emit CO_2. GHG emissions assessment and reporting will be required
Ecology	The site is developed with no identified ecological value. However, polluted run-off from oils, fuels and increased sediment loads represent a risk to aquatic ecology in the SLRE. Dust can also smother vegetation. Standard pollution prevention techniques in design and operation will be used to mitigate for these impacts.	Atmospheric emissions can potentially result in vegetation dieback and acidification of soils and water courses altering habitats and disrupting food-chains. Site run-off can include sediments, fuels and oils which can both directly affect organisms and reduce the oxygen capacity of the receiving water. Standard pollution prevention techniques in design and operation will be used to mitigate for these impacts.

Potential Issue / Impact	Construction	Operation
Water Supply	Construction sites need relatively limited supplies of water for cement manufacture, damping down for dust control and messing purposes.	Since Combustion Turbine Generators in this projects scope has a high-water demand, a desalination plant will be needed. The impacts from the desalination effluent will need to be taken into consideration Water will be taken from a borehole and potentially from the local municipal supply for other parts of the plant, which has the potential to impact on other boreholes in the area and users of the municipal supply.
Effluents	Storm water run-off from construction sites may include high sediment loads, oil, fuels and litter. These can be controlled using appropriate interceptors and other standard mitigation design. Sewage will be controlled either through use of portable toilets or a septic tank. Washout water from any concrete mixing on site will also need to be carefully controlled. Hazardous effluents such as used oils will either be incinerated during construction using temporary facilities or stored and incinerated once the main incinerator is operational.	Effluent from thermal power plants may contain various contaminants (e.g. particulates, oils, fuels, ash etc.). There will also be sewage and domestic effluents. Controls will include the use of appropriate runoff interceptors and oil/water separators, effluent treatment plant and sampling from an observation pond prior to discharge to ensure compliance with IFC EHS Guidelines.

Potential Issue / Impact	Construction	Operation
Solid Wastes	Construction phase wastes will come from general construction and maintenance of construction plant. This will include non-hazardous (inert topsoil, construction rubble, wood, surplus materials, plastics, packaging etc.) and hazardous waste (contaminated soils, oils, solvents, contaminated containers, used filters, batteries, etc.). General refuge (effectively domestic waste - non- hazardous materials including food residues, paper, bottles, cans, packaging etc.) will also be generated. All wastes should be recycled where practicable. Inert wastes may be disposed of at existing dump sites. Hazardous wastes may have to be incinerated or exported for disposal if no suitably licensed and controlled disposal facilities are developed.	Other hazardous waste includes used filters, lubricants, contaminated containers, rags, oil and filters from machinery/vehicles, oil from O/W separator. The small volume of inert (mainly domestic) wastes produced during operation may be disposed of at existing dump sites. It's likely that hazardous wastes will have to be incinerated if no suitably licensed and controlled disposal facilities are developed. A very small volume of items which cannot be incinerated (e.g. batteries) will need to be stored and exported for disposal.
Hazardous Materials	Hazardous materials may include oils, fuels, cleaning materials, and lubricants. These will need to be stored appropriately (e.g. bunded enclosures etc.) to prevent or control spills.	Hazardous materials will include on-site stores of HFO and diesel, other oils, lubricants, solvent-based cleaning materials and potentially water treatment reagents. These will need to be stored appropriately to prevent or control spills and will require appropriate oil spill response and clean up planning including staff training.
Landscape	Construction sites are often unsightly; however, the site is walled and will not be seen by general passers-by.	The scale and design of the plant is within the broader landscape character of the mainly commercial/industrial land-use in the area. Mitigation may include minimizing scale of buildings where possible and use of neutral color schemes and screen planting.

Potential Issue / Impact	Construction	Operation
Noise and vibration	Construction noise and vibrations can disturb neighbors (particularly residential areas especially if any construction activities are carried out at night. Controls can include limiting construction hours, silencing equipment on plant, use of acoustic fencing, etc.	Thermal power plants are typically operational on a 24hr basis and can emit noise from material handling, vents, stacks, generators and vehicle movements. Controls can include appropriate siting of infrastructure, acoustic insulation, limiting of delivery times, bunding, etc.
Traffic	Construction involves the transport of both materials and personnel which can have congestion and safety implications on access roads. Traffic management plans will be developed and will also assess community safety aspects.	Operational traffic includes staff vehicle movements and delivery of materials or replacement parts.
Soil and Groundwater Contamination	There may potentially be some contamination already on- site due to current/historical use and adjacent presence of the disused refinery. This contamination could be mobilized during construction. Any such contamination would need to be removed from site or treated as appropriate. If human health risks are identified, a remediation plan may need to be produced to prevent risk to future users of the site. Hazardous materials and wastes should be appropriately stored (e.g. on areas of fully bunded hard standing, as necessary). The potential for contamination in the existing borehole water supply will also be investigated and assessed.	Hazardous materials stored on site during operation (including HFO and diesel tanks, oils, lubricants and other hazardous materials) will always have the potential to cause contamination in the event of a spill or other type of accident. Hazardous materials and wastes should be appropriately stored (e.g. on areas of fully bunded hard standing, as necessary). Appropriate accident and spill response plans will be required.
Archaeological/ Cultural Heritage	Greenfield sites may contain archaeological resources or sites of cultural heritage value which may be damaged or destroyed during construction. As the site is already developed, it is unlikely to have archaeological or cultural heritage significance	Given the already developed nature of the site, the redeveloped site of the operational project is highly unlikely to have archaeological or cultural heritage significance.

6.2. Elements of Assessment Scoped Out (i.e. of no significance)

Information gathered from the initial consultation, site visits and desktop review has been utilized to scope out potential elements of the ESHIA assessment, including impacts which are not considered to be of significance for the project. These are summarized in Table 6.2.

Table 6.2 Elements of Assessment and/or Impacts Scoped Out

Potential Impact	Basis for Decision
Alternatives assessment	The GoSL selected the project site as part of a process predating the CECA development and therefore assessment of alternative sites are not within the scope of this ESHIA.
Ecology	On the basis of the highly degraded ecology of the project site and distance from the nearest protected areas, it is considered that further detailed assessment of terrestrial and aquatic ecology is not required although there will be strong mitigation put in place regarding oil spill prevention so as to avoid the potential for contamination effects on adjacent ecology the SLRE. The air quality assessment will consider potential depositional effects on the SLRE, but significant effects are considered unlikely.
Climate change	Impacts relating to climate change are not expected to be significant. Potential impacts reflect the possibility of increased rainfall and associated increased surface flooding during the wet season and the possibility of a decrease in engine efficiency due to temperature increase, resulting in a slight increase in greenhouse gas emissions. The project design includes design mitigation regarding increased rainfall and drainage and this is reflected in the draft ESMP. There is no identified mitigation for increasing temperature impacts on engine efficiency; however, the draft ESMP includes an action regarding engine selection to minimize temperature increase related impacts on emissions. The ESMP also includes an action regarding reporting of GHG emissions, as required under IFC PS
Cumulative and transboundary impacts	No confirmed projects have been identified to date which would likely result in significant cumulative impacts. Should any project prove to have the potential to cause significant cumulative impacts, they will be assessed as appropriate. The project is not located close to the national borders and is not of a scale that is likely to result in trans-boundary impacts.
Landscape and visual	The site is located within the Kissy Dock area of Eastern Freetown. The site is an operational commercial/industrial facility with three significant structures, which are relatively similar in height to the main features of the proposed plant (engine hall, radiators and main elements of the switchyard). The surrounding area is a mixture of industrial / commercial and densely urbanized areas including several telecommunications masts, emissions stacks (on the disused refinery) and fuel tank farms (in both the refinery area and the NP facility). These are numerous buildings of similar or greater proportions to those already on the site and those proposed for the development, interspersed with significant numbers of large trees. Essentially, the area's 'sense of place' is derived from this heavily urbanized and industrial setting and the area is not considered to have significant amenity value from a landscape and visual perspective Views of the site will mainly be restricted

Potential Impact	Basis for Decision
	to neighboring properties and the nature of this view will not change significantly from the current baseline. On this basis, landscape and visual impacts associated with the project are not expected to be significant and a detailed assessment will not be undertaken as part of the ESHIA. In the absence of a detailed assessment, it is highlighted that the visual implications of the development will still be considered appropriately within the project design.
Cultural heritage	No information regarding the archaeological or cultural heritage significance of the site has been identified. Consultations with representatives of identified users of the site – SLRA, MSU, CRCC and farmers – has not identified any practices of cultural heritage significance within the site. Given the developed nature and current use of the site, it is considered unlikely that the site has archaeological value of note. An assessment of potential impacts on archaeological and cultural heritage will therefore not be included within the scope of the main ESHIA. Further enquires will, however, be made during the baseline phase of the ESHIA and should relevant information be identified, this will be considered in the assessment as appropriate.

While these elements have been scoped out, further information may be identified which could indicate the potential for significant impacts in one or more of these areas (including cumulative impacts). The scope of the main ESHIA assessment will be amended accordingly.

6.3. Air Quality

6.3.1. Impacts

Atmospheric emissions will result from various activities during the following stages of the project lifecycle:

- Construction of the power plant; and
- Operation of the power plant.

The potential impacts on air quality during the construction phase are mainly associated with the generation of dust from road vehicles such as lorries and trucks travelling to and from the site and also on-site earthmoving and construction activities. If there is a large volume of road traffic associated with the construction phase then emissions associated with combustion of petrol and diesel could increase concentrations of some pollutants in the vicinity of the traffic route.

The potential impacts on air quality during the operational phase will be emissions from the combustion turbines. As mentioned previously, the pollutants of potential concern relating to the combustion of the LPG are NOx, CO and PM10. Emissions from the power plant combustion turbines will meet the relevant limits specified in the IFC EHS Guidelines 11 for non-degraded airsheds.

6.3.2. Assessment Approach

The air quality impact assessment will comprise the identification of baseline air quality levels, consideration of dust from construction phase activities, detailed dispersion modelling assessment of operational emissions, including optimization of the stack height(s) and the assessment of the potential impacts on air quality from all aspects of operation of the plant.

Baseline

Baseline data from the original HFO study was taken back in 2015. It included a more detailed review of the air quality baseline survey to monitor existing air quality at the site. A new survey has been conducted to update the findings from 2015 The data gathering / survey work will focus on understanding the existing short and/or long-term concentrations of the key pollutants identified (Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Sulphur Dioxide (SO2), Ozone (O3), Volatile Organic Compounds (VOCs), Particulate Matter aerodynamic diameter 10 µm (PM10) and Particulate Matter of aerodynamic diameter 2.5 µm (PM2.5)) using appropriate monitoring techniques –

The air quality monitoring will be undertaken using a portable air quality monitor Aeroqual Series 500 sensor, which enables accurate short-term fixed real-time surveying of common outdoor air pollutants. The sensors are housed within an interchangeable cartridge ("head") that attaches to the monitor base which can be removed and replaced in seconds, allowing users to measure as many gases as desired.

The measurements will be carried out by placing the equipment at a height of about 1.5 -1.7 meters from the ground level and sufficiently away from any disturbance or direct obstacle from the source(s) under consideration to ensure that the air that is monitored is representative of the air that most residents/visitors were breathing.

Construction

11 IFC (2008) Environmental, Health, and Safety Guidelines for Thermal Power Plants. Final Version, 19th December 2008.

A qualitative assessment will be undertaken, taking into account meteorological data, the volume of construction traffic, likely route, the types and duration of construction activities and the location of sensitive receptors to determine the impact from the construction phase. This will allow the construction phase activities to be categorized with regard to the level of risk associated with each activity. Based on the identified risk levels, a series of recommended mitigation measures will be proposed within the ESHIA to be adopted during the construction phase.

The impacts of traffic emissions during the construction will not be assessed quantitatively as the volume of project-derived traffic is likely to be very low and will not present a significant impact on local air quality.

Operation

As discussed above, the primary impact on air quality during the operation of the facility will be emissions from the power plant stack(s). A screening assessment will be undertaken to determine if emissions will have a significant impact in the local area by estimating the maximum pollutant concentrations based on the area topography and environment. The air quality assessment will follow the World Bank/IFC guidance as requested by the EPA-SL as there is currently no guidance for air quality assessment in Sierra Leone.

A screening assessment model will be developed using SCREEN3 software. SCREEN3 is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources, as well as concentrations in the cavity zone, and concentrations due to inversion break-up and shoreline fumigation.

The screening assessment will estimate concentrations of short and long term Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Sulphur Dioxide (SO2), Ozone (O3), Volatile Organic Compounds (VOCs), Particulate Matter aerodynamic diameter 10 µm (PM10) and Particulate Matter of aerodynamic diameter 2.5 µm (PM2.5)at sensitive receptors based on emissions from the power plant at the relevant emissions limits specified in the IFC EHS Guidelines for Thermal Power Plants

The concentrations of released substances will be calculated at specific locations in the vicinity of the proposed facility. These locations will include:

- Residential properties;
- Schools, hospitals, other public buildings etc.;
- Relevant commercial premises; and
- The nearest protected sensitive ecological sites (e.g. SLRE and WAPNFR).

The screening assessment will be used to determine the most appropriate height for the chimney stack(s) based on the resultant maximum short term and long term ground level concentrations predicted. The aim will be to identify a suitable height(s) whereby a higher stack will not lead to significantly increased ground level concentrations and that the contribution from the plant is not significant. This is defined in the IFC EHS Guidelines as a contribution of less than 25% of the applicable air quality standard or guideline.

The SCREEN3 model will be developed using provided inputs from the CTG supplier provided inputs along with the existing General Arrangement drawing for Western Area Power Generation Project, building/structure dimensions, property line designations, and the surrounding building coordinates for the stack “downwash” analysis.

The CTG supplier will provide data for input files that define exhaust volume flow (ACFM), exit temperature and exit velocity based on operation at the maximum allowable operating rate as well as any planned part-load operations. Stack emission data (pollutant emission rates) for full and partial load operations (if partial load operation is planned) will be provided by the CTG supplier for the bypass stack and HRSG stack while firing on LPG and diesel fuel oil.

The standard range of full meteorology conditions (all stability classes and wind speeds) option will be used. In addition, the discrete distance option for spacing receptors will be used with receptors placed at specific distances from the Project. For each distance used, the model will calculate the maximum concentration at each receptor.

Multiple modeling iterations of the main stack and bypass stacks (reflecting combined cycle and simple cycle operation, respectively) at the stack height proposed by OEM will be performed.

Modeled results will be presented as tabulated maximum ground level concentrations within the given study area, for the relevant averaging periods and for comparison with the air quality objectives specific to the pollutants of concern. Comparison of maximum modeled impacts to the ambient air quality limits will be made (i.e., World Health Organization and World Bank standards, local standards, etc.).

Direct comparison will be made between the predicted process contribution of relevant substances from the combustion turbines, the predicted environmental concentrations (i.e. process contribution added to the background levels) and the air quality standards/guidelines specified within the IFC EHS Guidelines or World Health Organization (WHO) air quality guidelines.

Changes in air quality levels will also be considered at the nearby SLRE and WAPNFR protected sites with regard to potential impacts on the ecological features of these sites with due to air pollution and deposition of nitrogen or acid.

Where appropriate, the significance of the potential impact will be determined using the criteria set out in ES. Sensitivity analyses will be carried out to investigate the effect of altering some of the model input parameters and to ensure l predictions are robust.

6.3.3. Mitigation

The primary mitigation regarding air quality effects will be through optimization of the power plant stack height(s). Additional mitigation will include appropriate operation and maintenance of the power plant and incinerator installation and management of fugitive dust emissions during construction. Secondary / end of pipe controls will also be considered where appropriate.

6.4. Noise

6.4.1. Impacts

The noise assessment will encompass a number of activities, including consultations with EPA-SL, baseline noise monitoring, setting of construction and operational noise limits, modelling and prediction of noise impact, reporting of findings and recommendations, and the development of a series of mitigation measures where necessary.

6.4.2. Assessment Approach

Baseline

A number of sensitive noise receptors were identified and discussed in Section 4.3. The nearest sensitive receptors are the neighboring residential and commercial properties, which include the schools/mosque/clinic complex to the southeast, residential dwellings on the south boundary, residential properties a short distance to the north of the site boundary along Factory Road, the Winston Churchill School and other schools in the area.

Preliminary estimates have been made of the potential operational noise associated with the current scheme and will be used to identify the receptors at which the greatest impacts are likely. The baseline noise measurements will be targeted to gather data for the worst affected receptors.

The baseline noise measurements will quantify the existing ambient noise levels in terms of the LAeq, LA_{90} and LAF_{max} statistical noise descriptors. Short sample measurements will be conducted over a representative 24-hour period at the selected noise monitoring locations, to give an indication of the typical daily range of noise levels at receptors. Measurements will be conducted in accordance with best practice guidance, and the equipment used will comply with relevant international standards. The baseline noise levels at the noise sensitive receptors will form the basis of the noise impact assessment, and will be one of the aspects considered when determining the potential noise impact of the power plant upon the local community throughout the construction period and its operational lifetime.

Construction Noise and Vibration

A construction noise and vibration assessment of the proposed development and construction areas will be undertaken. The exact construction methodology is unlikely to be defined until the EPC contractor is appointed, therefore an assessment will be undertaken using information available at that time and assumptions regarding typical equipment likely to be used for all of the construction-related works, including any drilling and piling activities. Where uncertainties exist, worst case assumptions will be used.

Construction noise and vibration will be predicted using the methodologies set out in:

- British Standard 5228-1: 2009: Code of practice for noise and vibration control on construction and open sites – Part 1: Noise
- British Standard 5228-2: 2009: Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

In the absence of Sierra Leonean standards, construction noise and vibration will be assessed in accordance with the above standards.

The ES will include a framework ESMP, containing relevant mitigation measures and roles and responsibilities for ensuring mitigation is carried through into detailed action plans (such as a Construction Environmental Management Plan) which will ensure any impact on sensitive receptors is minimized.

Operational Noise

Operational noise will be assessed against the requirements of the IFC EHS Guidelines and other relevant identified international guidelines where this is of benefit for the assessment. Noise levels from the site will be predicted within a computer-based noise model which implements the international methodologies set out in:

- BS EN 12354-4: 2000: Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Transmission of indoor sound to the outside, and,
- International Standard: ISO 9613-2: 1996(E): Acoustics - Attenuation of sound during propagation outdoors

Operational noise sources will be based on equipment selection, duty, location and dimensions. Wherever it is available, manufacturers' spectral noise emission data will be used. Where such data is not available, noise emissions will be estimated using recognized empirical formulae for the type of equipment, or measured data for similar equipment from different manufacturers.

A computer based model will be used to generate noise contour plots showing propagation of noise from the proposed development. Noise emissions for individual components and acoustic performance of the buildings will be predicted based on the design of the Site, example manufacturers' specifications and measurements previously taken of similar components on other facilities. Where uncertainties exist, worst-case assumptions will be made.

The potential significance of operational noise will be determined by comparison against the baseline ambient noise levels, and absolute noise levels, as recommended in guidance. If the model shows that there is potential for a significant effect to be generated by noise from any of the sensitive receptors, the level of noise mitigation that would be required would be specified, and measures that could be used to achieve this level of mitigation will be incorporated into the model, to provide a 'with mitigation' scenario.

The ES will recommend that a noise management plan for the operational phase of the development is completed during the final design phase. The plan will include updating the noise model to reflect the actual components and ensure that the final design incorporates appropriate mitigation measures.

It is not anticipated that there will be any operational vibration impacts from the power plant. However, qualitative assessments of operational sources of vibration, and a statement on low frequency noise, will be made as part of the assessment.

6.4.3. Mitigation

Various design mitigation measures will be considered as part of the main assessment, dependent upon the outcome of the study.

6.5. Socio-economics

The Project will create benefits for society in the form of electricity, jobs, and economic development. Employment will be created during both the construction and operations phases. Approximately 150 local people will be employed during construction and up to 50 personnel during operation, in roles commensurate with skill sets. Roles will include laborer's, engineers, safety, and construction personnel. Effects of employment on the local community will be analyzed as part of the Socio-economic assessment.

Indirectly, the increased electricity supply resulting from the Project will likely be associated with increased business investment within the country, and opportunities to increase tourism and tourism-related recreational activities. This may be associated with sources of income or employment for local people in the long term, which would have a beneficial impact. Tourism is not currently a large industry in the country, but increasingly Western visitors do travel to Sierra Leone, and as the country's infrastructure and security improves this it is considered likely to increase in popularity as a destination.

It was also identified that local farmers are cultivating parts of the site without legal tenure, but with the permission of SLRA. Clearance of this land will be associated with a loss of economic income for the approximately 16 women affected. The NPA will be relocating the farmers as part of the RAP process for the transmission line upgrade as part of the Energy Access Project. Therefore, effects of economic displacement will be addressed in minor detail here, as the livelihood restoration of current famers will be addressed in the NPA RAP.

However, in order to confirm that an appropriate process is being undertaken, CECA and the ESHIA team will engage with NPA to confirm the process and outcomes of the planned RAP, which will be reported in the ESHIA Study Report. The RAP outcomes may include measures such as the identification of alternative land and/or training with the overall aim of increasing the livelihood standards of the affected individuals beyond the pre- development status. Should it be determined that the process instigated by NPA would not meet the standards required by IFC PS5, then CECA will engage with NPA to address this and undertake remedial activities should this be required.

A demographic profile of the community affected by the project will be developed. Effects upon women and vulnerable communities will also be assessed with regard to the economic and social changes discussed. The issue of wider community benefits was raised by the EPA-SL during the initial introductory meeting and also during the site visit. Community focused social initiatives under consideration by CECA will be discussed within the main ESHIA.

The key socio-economic impacts that could result from the project are summarized in Table 6.3.

Table 6.3 Potential Socio-economic Impacts

Potential Issue / Impact	Construction	Operation
Demographics, Economy and Health	Given the densely populated Eastern Freetown baseline, it is expected that the project will source the vast majority of construction workers from the local community and a workers' camp will not be required. This means the potential for a significant influx of workers into the area (and associated potential spread of disease including HIV) may be limited. However, the potential for worker influx and associated health risks will be considered in the socio-economic assessment.	The primary operational benefit of the project for Sierra Leone will be the positive effect of increased power generation capacity and supply on the Freetown economy. There will also be direct and indirect employment benefits as discussed above. Air emissions implications for health are the only potential negative socio-economic impact associated with operation. These risks will be considered as part of the air quality assessment and associated mitigation, primarily in the form of optimized stack height will be including in the design.
Employment	The plant will provide direct temporary employment opportunities in the local area during construction. The development will also create indirect employment benefits to local traders selling to construction staff.	The plant will provide a small number of skilled jobs for operational and maintenance staff, but will also result in indirect economic benefits to suppliers of the plant such as the fuel supplier and local maintenance/cleaning firms.
Community and Occupational Health & Safety	Risks to the community (e.g. from increased transport) and workers (accidents during construction) will be assessed. The ESMP and detailed construction environment management plant will require compliance with IFC Performance Standard 2, Performance Standard 4, and the IFC EHS Guidelines, as well as any local health and safety regulations as these develop. Construction noise and vibration impacts on the local community are considered within the noise assessment.	The operational ESMP and associated plans and policies will also plant will also comply with IFC standards EHS Guidelines, as well as any local health and safety regulations as these develop. Operational noise and vibration impacts on the local community are not expected to be significant and are considered within the noise assessment. As with air quality impacts on health.
Land Acquisition and Resettlement	Relocation of the current occupants and resettlement of farmers is being addressed by the GoSL prior to hand over of the site to CECA. CECA will liaise closely with GoSL to ensure that the processes applied particularly to the resettlement of the farmers.	N/A

Potential Issue / Impact	Construction	Operation
Tourism	No information has been identified to suggest that tourism is a significant contributor to the economy of Eastern Freetown. The construction and operation of a power plant at the project site is considered unlikely to impact on wider tourism in Sierra Leone. We will attempt to identify additional information on tourism baseline in Sierra Leone.	

In assessing socio-economic impacts, information will be sourced from:

- Statistics Sierra Leone;
- Ministries of Finance & Trade and Industry;
- Local municipal office;
- Ministry of Public Health and Sanitation; and
- NGOs.

6.6. Community Health & Safety

6.6.1. COVID-19

Community impacts of COVID-19 could be seeing during the construction, commissioning, and operations phases. According to the World Health Organization (WHO), COVID-19 is spread through infected droplets released when a person coughs, sneezes, talks, or exhales. Most of these droplets fall on nearby surfaces and objects. People could catch COVID-19 by touching contaminated surfaces or objects, and then touching their eyes, nose, or mouth. If they are standing within 1 meter of a person with COVID-19 they can catch it by breathing in droplets coughed out or exhaled by them.[7] The WHO and GoSL have provided guidelines to help prevent or slow the spread of COVID-19.

COVID-19, during the construction phase, could possibly have the greatest impact on the project site and the surrounding communities. As workers, skill allowing, will be hired from the local area, an outbreak could extend to the adjacent districts.

At the time of this ESHIA the best measures to prevent the spread of COVID-19 are:

- Disinfecting shared spaces
  - Surfaces (e.g. desks and tables) and objects (e.g. telephones, keyboards) need to be wiped with disinfectant regularly
- Promote regular and thorough hand-washing by all personnel
  - Put sanitizing hand rub dispensers in prominent places around the jobsite. Make sure these dispensers are regularly refilled with hand sanitizer that is at least 60% alcohol-based.
  - Make sure all personnel have access to places where they can wash their hands with soap and water
- Wearing proper personal protective equipment (PPE)
  - Cloth masks and protective eyewear in combination with the measures above should be utilized.
- Avoid physical contact and keep safe distance (arms'-stretched length) from others

[7] https://www.who.int/docs/default-source/coronaviruse/advice-for-workplace-clean-19-03-2020.pdf

- Utilize quarantine as necessary for the following purposes
  - Personnel who are showing signs and symptoms include fever, tiredness, and cough.
  - Personnel who may have come in contact with COVID-19 but do not yet show signs and symptoms or know if they have the virus
  - Personnel who have tested positive for COVID-19

All mitigation strategies will comply with the guidelines released from the WHO and GoSL.

Whilst some social impacts will be positive (e.g. generation of taxation revenues, employment and training etc.), others may be negative including demographic change and potential increase in communicable diseases including HIV/AIDS. Impacts will be determined in consultation with all stakeholders and in particular, those most directly affected by the project who will be consulted in detail throughout the project. Should the ESHIA identify the potential for an increase in HIV/AIDS then a community HIV/AIDS plan will be developed, in conjunction with local health officials and other stakeholders, as part of the ESMP. The HIV/AIDS plan will cover relevant communicable diseases and be developed in line with IFC Good Practice Note for HIV/AIDS.

The project also has the potential to impact on community safety due to increased volumes of heavy traffic during the construction phase. The ESHIA will assess potential traffic impacts and effects on community safety to ensure that the traffic management plan takes full account of community safety.

6.7. Geology, Soils, Water and Contamination

There are a number of existing current and historical potential sources of contamination both onsite and in adjacent areas.

The EIA will consider potential impacts on soil and water considering:

- Potential for contamination due to on and off-site sources;
- Erosion and soil loss;
- Pollution of surface water; and,
- Impacts on nearby groundwater boreholes (including risk of saline intrusion) and farmers of the drainage land close to the site entrance.

Information used in the impact assessment will be derived from a number of sources including:

- Geological and hydrogeological studies where identified;
- A borehole census in the area immediately surrounding the site;
- Information from GVWC and the Ministry of Water (or the new regulatory authority if in place by then;
- Topographical information; and
- A physical site investigation including test pumping and monitoring of the on-site borehole (and any nearby boreholes which could conceivably be impacted by pumping of the borehole on site).

The design of mitigation measures will be based on IFC Performance Standard 2 (Resource efficiency and Pollution prevention), IFC EHS Guidelines and on good international industry practice.

6.8. Occupational Health and Safety

The ESHIA will address occupational and community safety identifying and assessing impacts associated with:

- Construction (including road safety associated with construction traffic), operation and decommissioning; and
- Normal and abnormal/emergency situations.

The health and safety plan that will be developed by the project will include HAZOPs, oil spill, fire safety and Emergency Response Plans in line with the requirements of PS 4. Where appropriate, these plans will consider potential effects on external receptors, including consideration of potential damage areas and domino effects. The ESMP will include relevant actions regarding the provision of this critical documentation.

6.9. Transport

6.9.1. Impacts

The main transport related impacts will be associated with the construction phase(s) of the project, and include:

- an increased volume of HGVs on the local roads and the need for abnormal/wide loads for delivery of construction machinery, plant components and construction materials; and,
- Construction staff arrival/departure, although it is expected that a significant majority of the construction workforce will come to site by other means than private car (on foot or by bicycle, motorbike or bus).

There is also the potential for existing transportation issues (HGV queues) in the vicinity of the site to impact on the construction program.

It is noted that there are currently two development phases for the project. Therefore, this would result in two phases of construction, with similar impacts anticipated for each phase. Decommissioning of the plant would be expected to result in similar impacts to construction, though to a lesser extent as it would likely require lower worker numbers.

As the project’s main operational requirement (LPG) will be delivered to the site by pipeline and water supply is available on site, significant impacts for the operational phase are not impacted. Operational phase movements are likely to be restricted to the small number of operational staff vehicles, occasional deliveries of spare parts, replacement lubricants or process chemicals etc., and periodic collections by a waste management contractor.

6.9.2. Assessment Approach and Mitigation

It has been identified that the road network in Freetown is extremely congested, particularly during the morning and evening rush hour. There are currently several road construction projects ongoing in Freetown that are likely to rapidly change the nature of the transport baseline. It was also identified that the commercial / industrial zone in the Kissy dockyard area regularly suffers from queues of HGVs (tankers and/or construction vehicles/plant) awaiting entry to the NP facility or other commercial premises. This includes Factory Road and South Road which are the two roads leading to the site entrance.

Further information on the transport baseline (including likely road construction projects and the potential for long standing queues of heavy vehicles in the area around the site) will be collected during the baseline phase of the ESHIA. This will include discussions with the SLRA to understand the planned road construction projects and confirm the most appropriate delivery routes.

Due to the potential for rapid changes in traffic and transport baseline, the transport chapter of the ESHIA is not currently proposed to include a full transport assessment (TA) at this stage. Instead, the chapter will include an overview of the baseline information collected to date and preliminary assessment of likely impacts of the first phase of the development (50 MW). Potential mitigation measures will be recommended for consideration in a full TA and Traffic Management Plan (TMP) to ensure any impacts associated with traffic generation do not result in adverse impacts on the road network.

The full TA and TMP will be included as actions within the ESMP and undertaken prior to the onset of the construction phase in order to reflect the transport baseline at that time. This will allow consideration of potential improvements in the road network due to ongoing road construction projects. Information from the TA and TMP should then be provided to the contractors and operator to enable the development and operation to be undertaken in full awareness of the sensitivity of the local transport issues.

The TA and ESMP will require review and potentially updating prior to Phase 2 and Phase 3 construction.

Where relevant, cumulative impacts of the construction phase(s) with other developments will be considered as appropriate. Developments potentially relevant to Phase 1 are indicated in Section 4.14.

7. Draft Environmental and Social Management Plan (ESMP)

This section presents the draft ESMP for the CECA WESTERN AREA POWER GENERATION project. The ESMP provides the management framework needed for planning and implementation of monitoring and management activities. The ESMP will be prepared in accordance with environmental commitments of CECA, and in compliance with the legal and regulatory requirements of Sierra Leone and the World Bank / IFC Performance Standards and EHS Guidelines.

The final ESMP will provide the management framework needed for planning and implementation of monitoring and management activities associated with environmental and social protection. The ESMP will be prepared in accordance with environmental commitments of CECA, and in compliance with the legal and regulatory requirements of Sierra Leone and the World Bank / IFC Performance Standards and EHS Guidelines.

The objective of an ESMP is to collate in one place and describe all mitigation measures and actions identified with the ESHIA which require implementation during the design, construction and operation (and decommissioning where appropriate) phases of the project to enhance positive benefits or eliminate or reduce key identified biophysical, socioeconomic and health issues and impacts to acceptable levels.

The final ESMP will identify organization roles and responsibilities (e.g. within the client organization, designers, contractors and operators) in administering the various actions and obligations. It must also state any reporting requirements, such as audits of performance against the ESMP requirements and GHG emissions reporting and the appropriate standards and legal requirements against which compliance will be measured.

An ESMP is a live document that will last the lifetime of the project and will be updated as appropriate as the project proceeds. It concerns both general environmental requirements that are common to most construction projects, and specific environmental initiatives unique to the development phases and infrastructure of this project, including:

- Construction;
- Operation; and
- Decommissioning.

Table 7.1 presents the draft ESMP for the project. It must be noted that the ESMP is preliminary at this stage and will be updated with costs and more detailed information when the full ESHIA is undertaken.

Table 7.1 Draft ESMP for the Project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Actions Requiring Implementation Prior to Construction						
Prior to construction	Develop and implement a construction management plan to minimize community health and safety and security issues.	A Construction Management Plan and procedures shall be designed to help to minimize land and community disturbance.	CECASL	IFC PS4 requirements	Surveying and observation	Throughout the construction phase
Prior to construction	Re-visit the ESHIA and modelling assessments following detailed design and confirmation of rights of way for associated infrastructure (pipelines, plant and roads). If the elements change significantly and additional properties could be affected, undertake appropriate environmental and social assessment of these facilities.	Verify findings within the ESHIA following detailed design.	CECASL	EPA-SL and WBG/IFC requirements	EPA-SL / lenders monitoring of implementation of requirements	Following detailed design
Waste Management						
Prior to construction	Pollution of the surrounding environment through improper management and disposal of wastes.	An audit of the proposed hazardous and non-hazardous land fill facilities to be undertaken prior to construction phase to ensure they meet the requirements of the project in both quantity and type of materials they take and their management of wastes.	EPC contractor(s)	EPA-SL and WBG/IFC requirements	Visual inspection Audit reports	Prior to construction activities commencing

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Prior to construction	Asbestos Exposure/ Contamination	A full building survey Demolition Plan	EPC Contractor	WBG/ International Labor Organization (ILO)	Emissions monitoring, inspection, and observations	At project design stage and during construction
Construction, operation and decommissioning.	Pollution of the surrounding environment through improper management and disposal of wastes.	A Waste Management Plan to be developed and implemented for the life span of the project. The plan is to identify waste streams, treatment, management, temporary management and final disposal procedures. The plan will define the roles and responsibilities of relevant departments and waste management contractors.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Visual inspection. Waste records and audit reports	Throughout the lifetime of the project
Construction, operation and decommissioning	Potential to harm human health and environment through uncontrolled disposal of wastes.	Provision of an on-site collection service. Waste streams to be kept segregated (hazardous, inert, industrial and domestic). Adequate provision of waste disposal containers at strategic locations around the site. Training of workers in waste management and safe handling of wastes.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Visual inspection and maintenance of site inspection and disposal records	Throughout the lifetime of the project
Construction and decommissioning	Unnecessary disposal of materials and use of natural resources.	Waste management procedures to be implemented which reduce the need for disposal of materials by	EPC contractor(s)	EPA-SL and WBG/IFC requirements	Visual inspection	Throughout the construction and

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		re-use on and / or offsite where possible.	Decommissioning contractor(s)			decommissioning works
Construction, operation and decommissioning	Odor from wastes	All wastes to be contained where possible. Regular uplift of normal domestic and inert wastes via municipal arrangements where appropriate.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Visual inspection. Waste management monitoring procedures to be implemented	Throughout the lifetime of the project
Terrestrial Ecology						
Construction	Minimizing direct impacts on intertidal and coastal habitats	Use temporary fencing to prevent inadvertent damage to mudflat, mangrove and coastal habitats adjacent to the construction zone Site temporary works areas away from coastal habitats where practicable;	EPC contractor(s)	EPA-SL and WBG/IFC requirements	Visual Inspection	Construction phase
Construction, operation and decommissioning	Introduction of non-native species into the terrestrial environment.	Implementation of procedures requiring the cleaning and visual inspection of machinery/ equipment entering and leaving the area. Material and construction / decommissioning equipment to be sourced locally where possible	EPC contractor(s) Plant operator (s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Visual Inspection	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Construction	Minimizing impacts on species and habitats	Minimize potential for pollutants and surface water runoff to migrate offsite through use of silt traps or similar measures and adherence GIIP regarding pollution prevention guidelines; Carry out tool-box talk to educate site staff about the sensitivity of coastal and intertidal habitats; Re-plant areas left undeveloped with native vegetation to prevent the incursion of opportunistic invasive species; Adherence to pollution prevention guidelines; Carry out tool-box talk to educate site staff about the sensitivity of threatened species and their protection; and Use floating barriers to contain any spillages and deter species from moving into work zone;	EPC contractor(s)	EPA-SL and WBG/IFC requirements	Visual Inspection	Construction phase
Marine Ecology						
Construction operation and decommissioning	Release of contaminants causing damage to sensitive marine receptors	Spill Response Procedures will be developed within the Emergency Response Plan and implemented following any accidental release of hazardous substances e.g. during refueling, and this plan shall include details of measures to be adopted	EPC contractor(s) Plant operator (s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Visual inspection	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		to stop, contain as far as practical on site, and clean up spills. As per provisions of maintaining land quality in "Contamination"				
Construction operation and decommissioning	General disturbance of the marine environment and aquatic flora and fauna	Marine areas encroached on to be restricted as far as possible, including areas used by vessels and cargos in the transportation of materials and equipment. Provision of fenders and/ or screens to prevent entrapment of aquatic life if necessary	EPC contractor(s) Plant operator (s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Monitoring of indicator species in vicinity of operations / construction and decommissioning activities	Throughout the lifetime of the project
Construction operation and decommissioning	Introduction of alien species into the marine environment	The requirement for the International Convention for the Control and Management of Ship's Ballast Water and Sediments (IMO) will be met at all times	Vessel operator (s)	EPA-SL and WBG/IFC requirements IMO Requirements	Visual inspection	Throughout the lifetime of the project
Climate Change/Greenhouse Gas Emissions						
Prior to construction	Climate change results in increased wet season rainfall which could overwhelm drainage if not considered.	Incorporation of appropriate increase in design drainage capacity (e.g. 20% on current best practice design) to account for potential increased rainfall relative to historical norm.	Owner's Engineer (OE) and EPC Contractor	EPA-SL and IFC requirements	OE sign off	As part of detailed design
Prior to construction	Greenhouse gas and emissions reporting.		Owner's Engineer (OE) and EPC Contractor	EPA-SL and WBG/IFC requirements	OE sign off	As part of detailed design

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Prior to construction	Climate events and hazards that impact on the development could lead to fuel spills and other impacts that could impact on the local environment	A detailed hazard assessment of the materials and fuels that are likely to be stored on site that may be released into the environment should be undertaken. Measures to minimize the risk of any substance that may be harmful to the environment or local population should be identified and mitigation strategies developed to minimize the risk. Strategies should also be developed if these mitigation strategies fail.	OE and EPC Contractor	EPA-SL and WBG/IFC requirements	NA	Pre-construction and maintained/updated throughout the lifetime of the project
Operation	Generation of Green House Gas (GHG) emissions during plant operation.	Use of monitoring and emissions data (see Air Quality section within this table) to calculate and disclose GHG emissions from the project the project annually.	Plant operator(s).	IFC PS3	Use monitoring and emissions data (see Air Quality within this table) to calculate and disclose annual GHG emissions from the facility.	Throughout operational lifetime of the project
Construction, operation and decommissioning	Generation of GHG emissions associated with transport movements.	Development of management plans and procedures to ensure traffic flow is minimized as far as possible and that all transportation vehicles used throughout the project are fit for purpose and adequately maintained High-efficiency low-emission vehicles to be preferentially used where possible.	EPC contractor(s) Plant Operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	N/A	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Contamination (for issues specific to waters see also water and wastewater measures)						
Prior to construction	Potential sources of contamination onsite and offsite	A contamination assessment will be carried out and any identified mitigation measures would need be included in the design. To support early tendering for the EPC role, contractors may wish to include a worst case assumption for protection of construction workers and end site users from potential ground and/or groundwater contamination.	OE and EPC Contractor	EPA-SL and WBG/IFC requirements	Inspection and observation Soil and groundwater monitoring and remediation plans if needed	Design, Construction and Operation
Construction and decommissioning	Contamination of ground, sediments, groundwaters, freshwaters and marine waters and groundwater following spills, leaks of chemicals used.	Chemicals to be stored at suitable location (preferably on hard surfacing to minimize potential for infiltration) and secondary containment to be provided. Workers to be trained in the handling, storing, and disposal of hazardous materials and emergency procedures in place for action following accidental release of hazardous materials. Emergency spill containment material and clean up equipment to be available to construction workers.	EPC contractor(s) / Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements Site inspection records.	Regular site inspections to monitor conditions Monitoring and Reporting Plan to include requirement regarding monitoring of river and estuarine water quality during construction	Throughout construction and decommissioning phases
Construction and decommissioning	Mobilization of contaminants into soils, sediments, marine waters and groundwater by	See mitigation for spillages, above. Drainage design and management to ensure that potentially	EPC contractor(s) /	EPA-SL and WBG/IFC requirements	Regular site inspections to monitor conditions	Throughout construction and

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
	water applied in construction or rainfall/storm water.	contaminated surface runoff does not flow directly into waterbodies.	Decommissioning contractor(s).	Site inspection records		decommissioning phases
Construction	Introduction of contamination to the site from imported soils.	Imported materials to be obtained from a reputable source. Soil testing to be taken on any imported soils to verify suitability	EPC contractor(s)	EPA-SL and WBG/IFC requirements	Periodic sampling of soil/fill materials brought for use in construction	Throughout the construction period.
Construction and decommissioning	Unknown contamination encountered (either within soils or groundwater) poses risks to human health and sensitive environmental receptors.	It is recommended that land quality assessments are undertaken prior to and following construction and demolition works and appropriate remediation of any contaminated materials found. Regular inspection of materials laboratory analysis of samples if contamination suspected. Upon identification of any suspected contamination, works are to cease until the source of contamination or the contaminated materials are removed. Any contaminated materials to be removed and disposed to an appropriately licensed waste disposal site. Security due diligence/ audit of waste disposal/landfill facilities to be undertaken prior to use. Workers to be trained in the identification and handling of potentially contaminated materials.	EPC contractor(s) / Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements Where laboratory analysis is thought necessary the WBG EHS guidelines recommend screening results against US EPA risk-based screening criteria .	Soil and groundwater monitoring as part of land quality assessments Regular inspections of materials removed to be undertaken as work progresses. If contamination is suspected this can be confirmed by laboratory testing A waste register to be used to record any contaminated soil taken offsite	Throughout construction and decommissioning phases.

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Appropriate Person Protective Equipment (PPE) to be provided. If any contaminated soils are identified they are to be isolated and maintained to prevent generation of dusts and the loss to surface runoff / drains/ watercourses.				
Construction, operation and decommissioning.	Release of pollutants into the environment through vandalism and theft	Lockable valves to be fitted on all storage tanks, fences should be secure, and doors and gates kept locked. Where possible, materials should be stored under cover and potential pollutants should be transferred into safe storage without delay.	EPC contractor(s) / Plant operator(s) / Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Regular inspection	Throughout the lifetime of the project
Operation	Contamination from unintended discharges / spills of fuel from the pipeline	All pipeline joints will be welded and the welds will be checked to insure that they will not leak. The area is fenced to insure no one would enter and tamper with the fuel The pipeline will have a CCTV network to insure security as far as is practicable. All valves be placed in adequately sized pits	CECASL in design EPC contractor(s) / Plant operator(s)	International standards regarding pipeline construction and fuels handling. Maintenance and inspection records to verify integrity of containment / ground surfacing	Pipeline commissioning Regular inspection	Commissioning and operation

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Operation	Contamination of ground, groundwater and surface water bodies following spills, leaks, failure of tanks or pipelines or deliberate discharges. Substances may include raw materials, fluids, intermediate produces, wastes and effluents.	Chemicals to be stored in designated bunded areas, bunds having the capacity to contain at least 110% of the volume of chemicals stored). Operational areas and roads to be constructed in concrete to minimize potential for infiltration of contaminants to ground. Tanker loading areas to be situated within bunds to ensure containment of spillage. Workers to be trained in the handling, storing, and disposal of hazardous materials and emergency procedures in place for action following accidental release of hazardous materials. Emergency spill containment material and clean up equipment to be readily available.	CECASL in plant design. Plant operator(s) in implementation of response measures	EPA-SL and WBG/IFC requirements Maintenance and inspection records to verify integrity of containment / ground surfacing WBG EHS and EPA discharge limits and soil and water quality standards	Visual inspection of containment systems. Monitoring of effluent prior to discharge	Throughout the operational lifetime of the project
Operation	Mobilization of contaminants in storm and firewater and subsequent contamination of land and waterbodies.	Stormwater and firewater will be routed to a storm water basin. If contamination is suspected stormwater can be routed to appropriate treatment / disposal facility. Plant designed to include capacity for potential firewater.	CECASLSL in plant design EPC contractor(s) in construction phase Plant operator(s) in the appropriate treatment /	EPA-SL and WBG/IFC requirements	Collected streams to be analyzed to determine appropriate discharge/ treatment/ disposal method	Throughout lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
			disposal of contaminated waters			
Local Air Quality						
Prior to construction	Generation of exhaust fumes and fugitive dusts from construction vehicles and traffic	Any road upgrades to ensure dust deposition on nearby receptors (e.g. roadside farmers) is minimized	EPC contractor and operator		Inspection and observation.	At project design stage and during construction as required
Design	Power plant to be designed to meet the relevant IFC emission limits for combustion turbines for the relevant pollutants (NO_x, SO_2 and Particulate Matter). Robust design and effective maintenance of the reciprocating engine is significant to the management of emissions to air during operation.	Careful and considered selection of technology provider and associated reciprocating engine and components. Selection of engine to ensure appropriate monitoring and controls are available to monitor turbine performance and identify malfunctions or failures which could affect emissions to air. Selection of engine to include consideration of ongoing maintenance aspects and demonstration of robust turbine design.	CECASL	WBG/IFC requirements	Operation phase monitoring regime in accordance with WBG EHS guidelines/ EPA-SL	At project design / procurement stage and detailed design stage
Design	Appropriate stack design and height has been undertaken to ensure ground level concentrations of NO_2, SO_2, particulates and CO are minimized.	This ESHIA will identify the stack height in order to appropriately manage the project's potential impacts on ambient air quality. Appropriate stack height assessment should be undertaken during any future phases of the project to ensure that future design	CECASL	WBG/IFC requirements	Operation phase monitoring regime in accordance with WBG EHS guidelines/ EPA-SL	At detailed design stage

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		phases are consistent with WBG/IFC requirements.				
Construction	Increase in fugitive dust release from plant vehicles moving to and from site and from construction activities on-site (demolition, earthworks and construction phases). Increase in construction vehicle and non-road mobile plant exhaust emissions.	Construction contractor to use best practice to minimize dust emissions. These could be formalized in a management plan and include mitigation such as: Hard surface roads at earliest opportunity in the construction program. Hoarding of the site boundary or appropriate fencing to capture dust release. Use of dust covers on all vehicles transporting materials with the potential for dust release. Stockpiles located away from receptors and covered and dampened. Impose speed limits for vehicles. Procurement of construction vehicles, with low emissions. Best practice when operating all vehicles and generators, e.g.no idling engines Use of bowsers to dampen site grounds/ stockpiles to reduce potential for dust.	EPC contractor(s)	EPA-SL and WBG/IFC requirements. Dust related complaints.	Inspection and observation. Auditing of activities against agreed management plan Obtain verbal and documented feedback from construction workers and neighboring communities.	Throughout construction and decommissioning phase

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		The use of wheel washers on entering and leaving site and between site areas as appropriate to prevent transfer of mud on site and onto public roads, which can be re-suspended. Engines to be switched off when vehicles are not in use. Marine transport to be minimized with engines switched off whenever feasible.				
Operation	Release of emissions during operation above the IFC emission limits during normal or abnormal operating conditions which could lead to adverse air quality impacts at offsite locations.	Continuous emissions monitoring (using Continuous Emissions Monitoring Systems (CEMS)) of required pollutants and emissions parameters to monitor emission performance and compliance with the emission limit values. Regular equipment checks and maintenance to ensure optimum efficiency is maintained Use of fuel with sulfur content which is within IFC guidelines	CECASL Plant operator	WBG EHS air emission limits and ambient air quality guidelines	Operation phase monitoring regime in accordance with WBG EHS guidelines as specified in Table 7 of the Thermal Power Plant EHS Guidelines.	Throughout the operation of the plant.
Operation	Release of emissions during operation above the IFC AAQ guidelines during normal or abnormal operating conditions which could lead to adverse air quality impacts at offsite locations.	An ambient air quality monitoring program (AAQMP) will be developed in consultation with the WBG and EPA-SL to monitor concentrations of NO_2, SO_2 and particulates (PM10 and PM2.5) on a monthly basis in the project	CECASL Plant operator	WBG EHS air emission limits and ambient air quality guidelines	Operation phase monitoring regime in accordance with WBG EHS guidelines as specified in Table 7 of the Thermal	Throughout the operation of the plant

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		vicinity during the operational phase of the project. NO_2 and SO_2 measurements shall be undertaken using passive diffusion tubes changed on a monthly basis. For particulates, secure monitoring locations and a continuous source of power would need to be in place to protect the sophisticated equipment required for measurement, so this is most likely to be feasible within the project site. Details of the monitoring locations for the AAQMP will be agreed with EPA-SL and the IFC/WBG prior to project operations.			Power Plant EHS Guidelines	
Decommissioning	Increase in fugitive dust release from plant vehicles moving to and from site and from decommissioning activities on-site (demolition, earthworks etc.). Increase in decommissioning vehicle and non-road mobile plant exhaust emissions.	Similar approach as specified for "Construction". Arisings / wastes with potential to generate fugitive dust emissions to be covered prior to removal and disposal / re-use. Mitigation for decommissioning vehicles as for construction vehicles.	Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements Dust related complaints	Inspection and observation. Auditing of activities against agreed management plan Obtain verbal and documented feedback from construction workers and neighboring communities	Throughout decommissioning period
Noise						

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Design and Operation	The plant shall be designed including the standard and enhanced measures considered in the noise modelling conducted for the project. Since these design measures will be incorporated, the project would not result in any noise impacts from operations. However, additional enhancement measures are proposed to address the potential health effects associated with the high nighttime noise levels predicted in the project area.	A Noise Management Plan will be developed to minimize nighttime noise at nearby residential receptors. Measures could include a noise insulation scheme or other measures developed in consultation with the community and EPA-SL and IFC/AfDB to reduce nighttime noise levels to 55dBA or lower.	CECASL	WBG/IFC EHS noise limits WHO AAQG Interim Targets Noise related complaints	Operational monitoring and reporting to EPA / lenders	Following detailed design
Construction	Generation of noise though construction activities, particularly during excavation works.	Construction contractor to use good international industry practice in terms of working practices and working hours to minimize impacts to workers.	EPC contractor(s).	EPA-SL and WBG/IFC requirements	Verbal and documented feedback from construction workers and neighboring communities. Noise related complaints	Throughout construction phase.
Construction	Generation of noise by construction vehicle movements.	Scheduling of road traffic movements to avoid noise sensitive periods (e.g. night-time).	EPC contractor(s)	EPA-SL and WBG/IFC requirements.	Verbal and documented feedback from construction	Throughout construction phase

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Route traffic away from noise sensitive receptors. Consultations with local communities to be undertaken, which may be impacted to be undertaken in advance of any noisy activities or works being undertaken outside of normal working hours.		Noise related complaints	workers and neighboring communities	
Design and Operation	Generation of noise from operational activities. The main sources of noise will be: boilers, steam and gas turbines, large pumps and fans (including inlets, outlets and stacks), cooling system and transformers.	Power plants to be designed to meet a maximum of 85dBA one meter from the source in line with international requirements. Mitigation in plant design to minimize noise exposure through equipment attenuation and the procurement of inherently quieter plant equipment. For example: • Use of silencers/ acoustic barriers on noisy equipment (e.g. cladding); • Use of physical barriers (e.g. machine housing, enclosures, walls); • Location of noisy plant equipment away from offices; Noise management and operational procedures to ensure safe working practices with respect to noise and limitations on working	CECASL in plant design. Plant operator(s).	WBG/IFC EHS noise limits and EPA noise limits Noise related complaints	Monitoring of noise levels at sensitive receptors	Throughout operational lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		hours and noise exposure where appropriate.				
Decommissioning	Noise generation through decommissioning and removal of exiting equipment	Good international industry working practices to ensure safety of workers with respect to noise exposure. Limitations on durations and timing of activities to avoid noise sensitive periods. (Nighttime)	Decommissioning contractor(s)	WBG/IFC EHS noise limits and EPA-SL noise limits Noise related complaints	Monitoring of noise levels at sensitive receptors	Throughout decommissioning period
Traffic and Transport						
Prior to construction	Assessment of traffic levels on and offshore including consultation with relevant statutory bodies and affected parties over proposed traffic routes. Cumulative traffic impacts associated with other development projects and existing developments in the area.	Assessment of traffic routing and existing traffic/vessel movements if required to ensure routes and minims disruption to existing users. Consultations with other developers and operators to be undertaken prior to commencement of project and throughout the project lifetime to identify any potential cumulative traffic impacts. Scheduling of deliveries to site/exports from site to avoid busy periods.	OE and EPC Contractor	N/A	Period monitoring of traffic levels in the development are to help inform the scheduling of activities	Throughout the lifetime of the project
Construction and operation	Impacts on fishing / fishermen encroaching into the exclusion zone presenting a security and health and safety risk.	Communication with fishing community throughout stakeholder engagement process prior to operation to inform them of inclusion zone limits.	Plant operator(s)	EPA-SL and WBG/IFC requirements. Marine Pollution (MARPOL) / International Maritime	Reporting and documenting of any security incidents	Throughout construction and operational period.

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Clear signposting to be placed delimiting exclusions zone and warning marine traffic.		Organization (IMO) requirements		
Construction and operation	Health and safety impacts from the currently poor local roadways.	A Traffic Management Plan will be developed for construction and operations that will include limited road grading and maintenance (of the construction route from the west during the construction period) and will carefully consider additional measures around community health and safety (particularly regarding risks to school children along the access road route and shanty houses adjacent to site entrance) to reduce these risks to as low as is reasonably practicable. Detailed mitigation measures will be determined as part of the detailed Traffic Management Plan.	OE and EPC Contractor	EPA-SL and WBG/IFC requirements	Reporting and documenting of any road safety incidents	Throughout construction and operational period
Construction, operation and decommissioning	Risk of accidents and congestion.	Develop a Traffic Management Plan for construction and operations for the project including limited grading of the construction route to from the west and other minor improvement as necessary to ensure safe transport for the project such as filling in potholes or improving uneven surfaces and ensuring that the project entrances, exits, and local access	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements Offshore aspects to meet requirements of MARPOL / IMO	Pre-construction and pre-demolition baseline traffic flow assessment to enable construction works to be planned to mitigate cumulative traffic impacts	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		routes meet good international industry safety standards. Warning signs and lighting to be installed on key transport routes / to aid marine navigation. Offshore transport routes to be clearly defined and marked appropriately. Roads and embankments to be strengthened as necessary to ensure they are adequate for safe transportation of heavy goods vehicles (HGVs). Access roads across the shoreline for offshore components to be developed prior to construction/ demolition, ensuring they are adequate for safe use by construction vehicles. Onshore and offshore transport routes to be agreed with planning authority. Schedule onshore transport movements (particularly HGV movements) to avoid peak transport movements associated with adjacent power stations and local communities (mitigate against cumulative impacts).				

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Emergency response plan for road traffic and barge incidents to be prepared and implemented.				
Construction, operation and decommissioning	Pollution of the environment associated with air emissions.	Mitigation as outlined within air quality assessment.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Baseline air quality assessment undertaken as part of air quality impact assessment	Throughout the lifetime of the project
Construction and decommissioning.	Transport of contaminated soils on vehicles during construction and decommissioning activities.	Mitigation measures and outlined within land quality assessment.	EPC contractor(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements. Offshore aspects to meet requirements of MARPOL / IMO	Visual inspection. Laboratory analysis of soils if contamination is suspected	Throughout construction and decommissioning periods
Construction, operation and decommissioning	Cumulative traffic impacts associated with other development projects and existing developments in the area.	Shift timings to be made in consideration of nearby operations and staggered to avoid cumulative impacts from movement of workers as far as possible.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	EPA-SL and WBG/IFC requirements	Periodic monitoring of traffic flows in the development area to help inform the scheduling of activities	Throughout the lifetime of the project
Water Resources						
Prior to construction	Potential contamination or overuse of groundwater or municipal supply with potential to restrict water availability for existing users.	Mitigation through design will consider hierarchical water supply options of rainwater harvesting (wet season), borehole supply and municipal network supply, with a potential backup via seawater from the firewater pumps on the National Petroleum jetty facility (if this is feasible)	OE and EPC Contractor	EPA-SL and WBG/IFC requirements	Inspection and observation (of records of water use and source)	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Construction	Potential contamination or overuse of groundwater or municipal supply with potential to restrict water availability for existing users.	Provisions for adequate and appropriate drainage to be made during the construction phase. A monitoring and management plan for monitoring of river water quality and estuarine water quality is to be developed and implemented. Provisions to be in place for the collection of sediments generated as far as possible. Stockpiled sediments to be covered where practicable. For marine aspects stockpiled extracted sediments to be located away from the shoreline. Stockpiled sediments to be placed in contained/ bunded areas such that any runoff generated is collected.	EPC contractor(s)	EPA-SL and WBG/IFC requirements Site inspection records.	Regular site inspections to monitor conditions Monitoring and Reporting Plan to include requirement regarding monitoring of river and estuarine water quality during construction	Throughout construction period
Construction	Contamination of soils, groundwater and surface water through release of wastewaters generated in construction.	All contaminated stormwater and waste waters from construction activities to be drained into a collection pit for either recycling / re use or disposal. Laboratory testing of waste waters may be required the most appropriate action. Monitoring of river water quality to be undertaken throughout construction period to identify any	EPC contractor(s)	EPA-SL and WBG/IFC requirements	Monitoring of river water quality Monitoring of wastewaters generated by visual inspection and laboratory testing Soil and groundwater monitoring as part	Throughout construction period

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		adverse impacts and enable appropriate mitigation measures to be implemented. It is recommended that land quality assessments are undertaken prior to and following construction works and appropriate remediation of any contaminated materials found.			of land quality assessments	
Construction and Operation	Potential contamination or overuse of groundwater or municipal supply with potential to restrict water availability for existing users.	Undertake surface and groundwater quality monitoring local to the project site to confirm no construction or operation impacts. If GVWC water is required, an assessment of potential impacts on water availability to other water users on the network will be undertaken at that time.	OE, EPC and operator	EPA-SL and WBG/IFC requirements Monitoring and Reporting Plan	Inspection and observation (sampling and monitoring)	Construction and operation phase
Construction	Contamination of groundwaters and surface waters following spillages.	Use appropriate storage with secondary containment where possible for potential pollutants such as fuels or cementitious material. Placement of pollution substances on hard ground and within secure, bunded areas where possible to minimize potential of infiltration to ground.	EPC contractor(s)	EPA-SL and WBG/IFC requirements Site inspection records	Regular site inspections to monitor conditions Soil and groundwater monitoring as part of land quality assessments and Monitoring and Reporting Plan	Throughout construction period

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		All workers to be trained in the handling, storing, and disposal of hazardous materials. In the event of an accidental release, emergency procedures will be in place. Emergency spill containment material and clean up equipment to be available to construction workers. It is recommended that land quality assessments are undertaken prior to and following construction works and appropriate remediation of any contaminated materials found.				
Operation	Contamination of groundwater and surface waters following spillages	Designated refueling and vehicle maintenance areas will be constructed. These will comprise bunded and sealed areas and all scheduled refueling and maintenance of construction and transportation vehicles will be undertaken within these areas. Procedures within the Emergency Response Plan developed by the EPC contractor will be implemented following any accidental release of hazardous substances e.g. during refueling, and this plan shall include details of measures to be adopted to stop, contain as far as practical on site,	OE, EPC and operator	Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors' (CIRIA, 2001) Environment Agency (EA) UK: Pollution Prevention Guidelines (PPG) 5: Works and Maintenance in/ or near Water;	Inspection and observation (sampling and monitoring)	Construction and operation phase

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		and clean up spills, and to inform the relevant authorities in the event that a spill migrates (or occurs) offsite. Hazardous material storage tanks, including for fuels, will be located within bunded and hard surfaced areas with adequate capacity for the volume of hazardous materials stored within. An adequate quantity of drip trays and spill kits/mitigation materials will be provided to contain and recover potential releases of hazardous substances. Pollution skill kits will be held at strategic locations on site and site personnel will be trained in their use. Lines of communication in the event of an emergency will be established, documented within the Emergency Response Plan and communicated to site personnel prior to commencement of works. Any accidental spill / leak will be fully cleaned immediately, and if required polluted soil / sand will be excavated and removed from site. Any accidental spill / leak will be recorded.		PPG21: Incident Response Planning; PPG22: Dealing with Spills; and PPG26: Drums and Intermediate Bulk Containers.		

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Hazardous effluents such as used oils will either be incinerated during construction using temporary facilities or stored and incinerated once the main incinerator is operational. Storage tanks and area will be maintained and inspected regularly. Records will be kept of all liquids/ tanks / containers on site.				
Construction	Contamination of waterbodies following discharge of sanitary wastes from contractor facilities	Sewage generated from domestic facilities will be treated in a temporary treatment facility before discharged to outfalls	EPC Contractors	WBG IFC EHS and, EPA-SL water discharge standards	Monitoring of effluent discharge	Throughout construction period
Impacts on Landscape						
Prior to construction	Disturbance of the baseline landscape through the introduction of foreign features into the baseline urban landscape	Selecting finishes to the building/infrastructure so that they blend into the surrounding urban landscape Designing the buildings to reduce the height/spread where possible	Architect, OE and EPC Contractor	N/A	OE Oversight	Design and construction
Post-construction / pre and during operation	Visual amenity of the plant.	Landscaping of the site upon completion of construction works. This will both mitigate visual impact and reduce erosion from any surface waters during heavy rains and flood periods Soils excavated	EPC contractor(s)	N/A	Visual inspection	Post-construction. Maintenance of landscaped areas may be required in operational period

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		during construction could be used for landscaping if suitable.				
Construction, operation and decommissioning	Increase in lighting may impact nearby residential receptors and road users at night. For offshore aspects lighting may attract fish, birds and other species. This may deplete fish reserves elsewhere and encourage fishermen to encroach into the exclusion zone presenting a security risk.	Lighting will be minimized as far as reasonably practicable and safe. Use of unnecessary floodlights will be avoided. Light sources to be hooded and directed downwards. Use of low-intensity lighting used where possible.	EPC contractor(s) Plant operator(s)	Feedback from communities	Visual inspection	Throughout the lifetime of the project
Socio-economics						
Prior to construction	Implement community gain measures through social development initiatives in communities neighboring the proposed project.	Develop and implement a social investment strategy that will support social development initiatives in communities neighboring the proposed project.	CECASL	EPA-SL and IFC requirements	Surveying and observation	Throughout the lifetime of the project
Prior to construction and construction	Prepare a Livelihood Restoration Plan (LRP)/Abbreviated Resettlement Action Plan (ARAP).	The LRP/ARAP will be developed in consultation with the NPA and the affected farmers, prior to commencement of project per the requirements of IFC PS5. Continue consultation with the Affected Community including the local farmers and ensure that the stakeholder engagement for the project meets the requirements of	CECASL	IFC PS5 IFC PS1	CECASL monitoring SL government implementation of livelihood restoration action planning	Resettlement required prior to ground works commencing, and during construction

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		IFC PS1 including the establishment of a grievance mechanism for the project that would be available to the local community. Provide training and livelihood assistance programs to the community including the potential to diversify, savings and credit opportunities, and business and enterprise training.				
Prior to construction and construction	Potential for chance finds of cultural significance during pre-start update of ESIA and construction period	With no identified cultural resource features within the study area the topic has been scoped out of this ESHIA. In the event that evidence is identified during construction that indicates items of cultural significance may be present, a cultural resource expert should be appointed.	CECASL EPC Contractor(s)	IFC PS7 IFC PS1	Updated ESIA EPC Monitoring	Pre-construction and construction
Construction, operation and decommissioning	Exploitation of workers and contractors.	CECA SL to develop and implement a PS2 compliant HR policy with a requirement for contractor adherence. Comply with national law regarding workers' rights to join organizations for workers of their choosing and to allow workers to elect representatives. Measures to be taken to prevent and address any harassment,	CECASL EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2	Human Resources (HR) management systems to include the monitoring and document details of all workers and contractors Reporting of any incidents to be documented and monitored to	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		intimidation and exploitation in the workplace. Provision of a grievance mechanism for workers to raise workplace concerns. Ensure there is no forced labor. Ensure contractors have access to a grievance mechanism. Implement policies on the quality and management of the accommodation offered to workers.			enable appropriate action to be taken Implementation and monitoring or an appropriate workers grievance mechanism	
Construction, operation and decommissioning	Exploitation of workforce by contractors.	Measure to be in implemented to ensure contractors are legitimate enterprises with appropriate Environmental and Social; Management Strategies. Management procedures to be established for managing and monitoring the performance of contractors.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2	Reporting of any incidents to be documented and monitored to enable appropriate action to be taken	Throughout the lifetime of the project
Construction, operation and decommissioning	Unfair dismissal of workers.	Ensure that all workers receive notice of dismissal and timely severance payments mandated by law and any outstanding back pay and social security benefits and pension contributions	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2	Human Resources (HR) management systems to include the monitoring and documentation of dismissals and their circumstances	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Carry out an analysis of alternatives to retrenchment prior to implementing any dismissals. Where there are no alternatives to retrenchment development and implementation of a retrenchment plan to be undertaken. The retrenchment plan is to be based on the principle of non-discrimination and will follow consultation with workers, their organizations, and, where appropriate, the government. It is to be compliant with collective bargaining agreements, legal and contractual requirements related to notification of public authorities, and provision of information to, and consultation with workers and their organizations				
Health, Safety and Security						
Construction, operation and decommissioning	Workers exposed to unsafe working conditions.	A health and safety system for construction and operational activities will be developed for routine activities. The operational system will be based on the requirements of ISO18001 for Occupational Safety and Health Management Systems (OSHMS). The health and safety plan will include a process hazard analysis and HAZOP will be prepared for the	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2	Construction and Operation phase Training Plan Continued monitoring, reporting and documentation of any incidents	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		steam extraction facilities and specifically focusing on the issue of well blowouts and pipeline failures, hydrogen sulfides (H_2S) emissions and monitoring. The information generated from the HAZOP will be used to prepare the blowout and pipeline failure safety plan. Fire safety and Emergency Response Plans will be developed and implemented as part of the EMMP. Develop a training and skills program (Training Plan) to impart best practice in the skilling of local people for construction and operational jobs. First Aid and Safety training will be provided to workers. Preventative and protective measures to be implemented where necessary. Workers to have access to appropriate personal protective equipment.				
Construction, operation and decommissioning	Confined space hazards in this and any other industry sector are potentially fatal. Confined space entry by workers and the potential for accidents may vary among	Engineering measures will be implemented to eliminate, to the degree feasible, the existence and adverse character of confined	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	WBG EHS Guidelines for Thermal Power Plants	Construction and Operation phase Training Plan Continued monitoring,	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
	power facilities depending on design and on-site equipment. Therefore, confined spaces on site could result in adverse health and safety impacts to workers.	spaces. Other mitigation should include: • Permit-required confined spaces will be provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible; • Safety precautions will include Self Contained Breathing Apparatus (SCBA), life lines, and safety watch workers stationed outside the confined space, with rescue and first aid equipment readily available; and, • Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, use of the necessary personal protective equipment (PPE), as well as the serviceability and integrity of the PPE will be verified.			reporting and documentation of any incidents.	
Construction, operation and decommissioning	Occupational exposure to heat occurs during construction activities, and during operation and maintenance of pipes, wells,	Prevention and control measures to address heat exposure include: • Reducing the time required for work in elevated temperature	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	WBG EHS Guidelines for Thermal Power Plants	Construction and Operation phase Training Plan Continued monitoring,	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
	and related hot equipment. Therefore, heat associated with operational and construction equipment on site could result in adverse health and safety impacts to workers.	environments and ensuring access to drinking water; • Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc.; • Use of PPE as appropriate, including insulated gloves and shoes; and, • Implementing appropriate safety procedures during the exploratory drilling process.			reporting and documentation of any incidents.	
Construction, operation and decommissioning	Workers could be exposed to noise particulate emissions during construction activities diesel engines, drilling and other heavy machinery are utilized. Operational noise and air quality emissions could also expose workers to excessive noise and air quality emissions.	Noise abatement technology includes the use of rock mufflers, sound insulation, and barriers during drilling. Adherence to mitigation measures outlined in "noise" section.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	WBG EHS noise limits Noise related complaints.	Construction and Operation phase Training Plan Continued monitoring, reporting and documentation of any incidents.	Throughout the lifetime of the project
Construction, operation and decommissioning	Injury or harm to site workers / communities as a result of badly designed plant and construction / decommissioning management.	The designing, construction, operation, and decommissioning of the structural elements or components of the project to be in accordance with industry best practice.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2 and PS4	Continued monitoring, reporting and documentation of any incidents	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Use of competent personnel in design and construction. Design and construction to consider safety risks to third parties or Affected Communities as well as project workers. The designs for the plant will incorporate provisions for fire prevention (developed procedures), fire detection (sensors and alarms), and fire suppression (water and foam and portable extinguishers). The facility will have equipment installed including gas detection, heat sensors and manual pull stations in the event of a fire and an audible alarm system. Typically National Fire Protection Association (NFPA) recommendations will be implemented for insurance purposes.				
Construction, operation and decommissioning	Injuries to workers / communities as a result of transportation of deliveries and exported good on surrounding roads.	A Transport Management Plan shall be implemented for any construction/operation traffic to reduce the potential for accidents. All project operations vehicles and contractor vehicles will have a speed limit set for travel through settlements and areas where there are no posted speed limits.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2 and PS4	Continued monitoring, reporting and documentation of any incidents	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Mitigation measures as specified in section on traffic and transport. Measures include routing of loads away from sensitive receptors and timing pf delivers to avoid busy periods. Community Emergency Response Plans will be developed and tested including workers and nearby residents in the vicinity of project-related traffic. These will include emergency response related to traffic accidents and potential releases of chemicals and other hazardous materials.				
Construction, operation and decommissioning	Increased incidence of communicable disease	An important aspect of minimizing the spread of communicable diseases within the community is worker health screening, particularly as many workers are local people. A worker health screening program (including considerations for AIDS/HIV) shall be developed and implemented during the peak construction period or at any time when workers on site number more than 100.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2 and PS4	Continued monitoring, reporting and documentation of any incidents	Throughout the lifetime of the project
Community safety and site security	Prevent access to the site by community members	Ensure appropriate fencing is in place preventing non-construction personnel from entering the construction site.	EPC contractor(s) Plant operator(s)	Requirements of IFC PS 2 and PS4	Continued monitoring, reporting and	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		Construction of fences of adequate height to prevent unlawful access to the site. Hire staff to be responsible for control of access to the site. Establish a registry/ identification system for employees and visitors to and from the site. Establish a visitor orientation program. A Worker Policy and Code of Behavior shall be developed which includes guidance on visits, prescribed actions for conduct violations and a grievance mechanism for complaints. Ensure appropriate signage around site perimeter especially in areas of high security and hazardous installations.	Decommissioning contractor(s)		documentation of any incidents	
Community safety and site security	Prevent community unrest and conflicts security guards	The EPC contractor shall involve external stakeholders (i.e. police or local authorities) in any on-site security incidents and ensure that appropriate incident response procedures are implemented.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2 and PS4	Continued monitoring, reporting and documentation of any incidents. No complaints received. Implementation of effective grievance mechanism.	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
Community safety and site security	Enhance employment opportunities	Employment policies requiring preferential hiring of local community members where they are appropriately skilled. Pass through of this policy to the EPC Contractor and supply chain partners including sub-contractors to the EPC contractor; Ensure a transparent hiring process is conducted help the community to understand strategic staffing decisions for the project to avoid conflict. A Construction Management Plan and procedures shall be designed to help to minimize land and community disturbance. Develop a Workforce Development Strategy – a commitment to maximize employment and skills opportunities for local people. Develop a training and skills program to impart good international industry practice in the skilling of local people for construction and operational jobs. The following enhancement measures would contribute to maximizing the benefits of the project and will be considered by	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2 and PS4	Continued monitoring, reporting and documentation of any incidents. No complaints received. Implementation of effective grievance mechanism.	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		CECASL as part of consultations around community benefits: Short term training programs for women and youth: Additional training programs including savings, meeting food and health safety standards and other technology training programs for youth shall be offered that will help them to establish new and/or improved livelihoods. Encourage contractors to provide apprenticeship opportunities to local people. Establish a local job readiness program and encourage the construction supply chain to continue to invest in workers.				
Construction, operation and decommissioning	Exposure of workers and communities to hazardous materials.	The potential for workers and communities to be exposed to hazardous materials to be minimized (see wastes section within this table). Exposure should be avoided by modifying, substituting, or eliminating the condition or material causing the potential hazards. Deliveries and transportation of hazardous materials to be effectively managed. Appropriate and legitimate waste disposal	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS2 and PS4	See section on waste	Throughout the lifetime of the project

Project Phase	Environmental Aspect and Identified Impacts	Action/ Mitigation Measures	Responsible Party	Applicable Standard(s)/ recommended basis of assessment	Monitoring Means	Time Frame
		contractors to be used (see wastes section within this table).				
Construction, operation and decommissioning	Exposure of communities to water borne diseases as a result of project activities.	See section on waters and wastewater and solid waste. Monitoring of river water quality is to be undertaken throughout the lifetime of the project. Operations will be stopped and mitigation measure employed if any adverse impacts are detected which exceed the relevant standards.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS4 EPA-SL and WBG/IFC requirements	Monitoring of river water quality	Throughout the lifetime of the project
Construction, operation and decommissioning	Risks to plant operations workers and communities from security personnel.	All security personnel to be fully trained and competent and not implicated in past abuses. Due diligence of security staff to be undertaken.	EPC contractor(s) Plant operator(s) Decommissioning contractor(s)	Requirements of IFC PS4	Continued monitoring, reporting and documentation of any incidents	Throughout the lifetime of the project

In addition to the mitigation actions listed above, the EPC Contractor will be required to prepare management plans as appropriate to the actions above including, but not limited to:

- Environmental and Social Management System;
- Construction Management Plan;
- Health and Safety Plan including Emergency Response Plan;
- Community Safety Plan (including traffic management plan);
- Community and Stakeholder Consultation Plan;
- Monitoring and Reporting Plan;
- HIV/AIDS management Plan;
- Training Plan; and
- Waste Management Plan.

All plans produced will need to demonstrate compliance with legal and IFC requirements and will be reviewed and approved by the Developer and its advisors at draft stage. The draft of these plans will also be shared with the EPA-SL and project lender(s) to ensure that all necessary requirements are accounted for.

8. Terms of Reference (TORs) for Main ESHIA

8.1. Introduction

The proposed TORs for the main ESHIA were formed by the information and assessment of the original HFO ESHIA and any additional information found from this scoping report. Following approval of the scoping report and these TORs by the EPA-SL, the ESHIA consultants will undertake baseline studies so as to acquire the required outstanding data necessary for evaluation of the potentially significant impacts identified in this Scoping Report. Whilst the currently anticipated approach for the main ESHIA is determined by this Scoping Report, it is emphasized that the process of scoping continues throughout the ESHIA, and should any additional potentially significant impacts be identified during the course of the ESHIA phase, these will be brought into the scope of the ESHIA and assessed accordingly.

After preparation of the draft ES, the document will be submitted to the EPA-SL and the project lender for review. Following receipt of comments, the document will be disclosed in two formal community and stakeholder consultation and disclosure events for discussion. All comments received from the EPA-SL, lenders and the public and other stakeholders will be recorded and addressed in the final version of the study.

8.2. Indicative Structure of the ESHIA

Introduction and Overview

Project Description

Policy, Legal, and Administrative Framework

Socio-Economic Baseline

Physical Environmental Baseline

Environmental, Social and Health Impact Assessment Methodology

Socio-Economic

Health and Safety

Noise

Air Quality

Soils, Geology, Hydrogeology, and Hydrology

Ecology

Waste

Traffic and Transport

Stakeholder Consultation

8.3. Assessments to be Undertaken

a) Social

i. Demography;

ii. Social conditions of communities;

iii. Socioeconomic condition of the communities;

iv. Socio-political structure/ organization, political/ dispute resolution institutions, and mechanisms;

v. Archaeological and historical data;

vi. Social structure/ trends and social groups;

vii. Social facilities;

viii. Social needs of the communities; and

ix. Community perceptions/ views/ opinions/ benefits of the Project.

b) Health

i. Socioeconomic/ vital health statistics

ii. Individual/ family/ community health determinant

iii. Health outcomes; and

iv. Environmental health determinants

c) Public consultation and disclosure

8.4. Project Screenings

A Climate Resilience Screening will provide the expected impacts of climate change on the Project, including on the Project's technical, commercial, and environmental viability.

8.5. Impact Review

The Desalination Plant Impact Review will identify the necessary marine ecology baseline surveys and thermal and salinity plume modeling for a desalination plant, as well as identify the cost of such surveys and modeling

8.6. Management Plans

A list of Environmental, Social, Health and Safety Action Plans will be included as actions in the ESMP covering:

- Construction;
- Operation; and,
- Decommissioning phases.

The draft ESMP for the project is included in Section 7 of this report.

Appendix A. **Site Plans and Project Description**

A.1 Power Engineers Draft Project Description Document

A.1.1 Introduction

General Plant Description

CEC Sierra Leone ("Owner") is developing the Western Area Power Generation Project in Sierra Leone, which will consist of two (2) combined cycle power blocks with a 128-megawatt (MW) nominal output.

The development will be divided into two (2) Phases:

- Phase 1 - 85-MW combined cycle power plant fueled by liquefied petroleum gas (LPG).
- Phase 2 - 43-MW of additional capacity from a second combined cycle power plant. Both power blocks will be fueled by liquefied natural gas (LNG) and LPG infrastructure will be removed.

The description and scope contained within relates to Phase 1 (the "Project"), with future expansion considerations for Phase 2.

Preliminary general arrangement plot plan drawings have been prepared for the facility. These drawings are included in the Appendix.

The Project will consist of two (2) Combustion Turbine Generator (CTGs); two (2) Heat Recovery Steam Generator (HRSGs); one (1) Condensing Steam Turbine Generator (STG); an air-cooled condenser; and associated support and auxiliary equipment. The project will include a standby generator for black start capability and emergency shutdown.

The CTG exhaust gases will be used to generate steam in the HRSG. The HRSG will be a two-pressure design (HP and LP) without duct firing. Steam from the HRSG will be admitted to a condensing STG. The steam cycle will be dry cooled using an air-cooled condenser.

LPG is the primary fuel for the Project, which will be delivered by ship to the New Kissy Jetty, located to the north of the plant. The Project includes a new pipeline that will connect the jetty LPG unloading line with the on-site storage system. LPG will pumped to site and stored in horizontal bullet tanks, which are mounded beneath earth for improved fire protection.

Diesel fuel oil will be a backup fuel for the facility, should LPG not be available due to a delivery delay or LPG system outage. Diesel fuel oil will be brought to site by truck and unloaded into an on-site storage tank sized for one day of baseload fuel consumption.

Associated equipment will include emission control systems necessary to meet the proposed emission limits. The combustion turbines will require water injection to meet NO_x emission limits. NO_x emissions may be additionally controlled by a selective catalytic reduction (SCR) system in the HRSG. An oxidation (CO) catalyst may be installed in the HRSG to control CO emissions.

To meet needs for water injection, cooling cycle make-up, and service/fire protection water requirements, the Project will use both well water and a desalination system. Raw water will be primarily sourced from on-site wells and supplemented by the desalination system to provide additional capacity. The desalination system will intake seawater near the New Kissy Jetty and will discharge treated wastewater to the northeast of the site. Both the seawater intake and discharge pipelines will follow a common right-of-way with the LPG pipeline.

Potable water for drinking, safety showers, and sanitary uses will be served from the Project's water treatment system.

The electrical transmission interconnection will link the Project into the Sierra Leone National Grid through a 33kV Indoor Metal Glad Switchboard located at the CC Plant and a 33kV transmission line between the CC Plant's Switchyard and two nearby substations: Ropiti to the southeast and Black Hall Road to the west.

Additional 33/11kV distribution substation upgrades will be included in the Project, as determined by the Grid Impact Assessment.

Specifications

The purpose of the Technical Specifications is to define the minimum scope, plant features, and quality standards for the design, procurement, construction, startup and testing of the combined cycle power plant which shall be provided by Contractor on a turnkey basis. Except as specified herein, Contractor scope of work shall include all materials and labor required for, or incidental to, the engineering, design, procurement, installation, construction, startup, testing and training. Contractor scope shall include the installation and supply of all construction utilities including electricity, fuel, water, chemical disposal, wastewater disposal, and solid waste disposal. Contractor scope shall also include all consumables, special tools, training, spare parts, and documentation as specified herein.

The Owner has prepared conceptual plant design documents for the purpose of permit applications and to specify the minimum scope and features of the facility. The conceptual design includes plant heat balances, one-line diagrams, general arrangement plot plan drawings, and plant water balances. The conceptual design is included in Appendices B through Appendix K of this Exhibit. Contractor shall provide detailed specification and design of the plant in conformance with these Specifications.

Location of buildings, equipment, structures, tanks, roads, parking, and laydown areas shall follow the general intention of the "General Arrangement Plot Plan" drawing. However, location of exhaust stacks shall be as shown on Contract Drawing SKM211, "Emission Point Locations".

Facility design and construction shall be accomplished by Contractor to provide a complete functional facility with the highest degree of reliability, integrity, maintainability, efficiency, and environmental compatibility in accordance with generally accepted industry standards. The Contractor shall conform to the requirements of the project permits (e.g. Air Emissions Permit and PSD, Pollutant Discharge Elimination System (LPDES, etc.), and all local, state, federal, and industry codes and standards. In Case of a conflict, the most stringent requirement shall govern.

Contractor shall coordinate with the Freetown Fire Marshall, and all other applicable Authorities, for the inspection and approval of construction or work as required by applicable codes and regulations. Contractor is responsible for addressing all associated issues to obtain the required approvals to meet the project schedule.

Plant Design Criteria

The purpose of this Exhibit is to define the criteria and requirements which shall form the basis for the design of the Facility. However, this Exhibit is not intended to be an all-inclusive set of specifications. To this extent, the plant design and construction shall maximize the following goals:

- Level of reliability through component redundancy, quality construction implementation, quality equipment selection, and plant maintainability
- Operational flexibility, dictated by the power demand and environment
- Low initial capital costs combined with low overall Plant’s life cycle cost
- Efficient operation and maintenance through proven equipment arrangements, convenient access, and convenient/adequate laydown areas
- Enhanced plant performance by optimization of system and equipment designs
- Utilization of safe, competitive, and environmentally sound practices

Redundancy in Design

Standby components shall be provided for auxiliary components that would cause an electrical or steam production shutdown by their failure. Standby components shall also be provided for auxiliary components that would cause a reduction in plant capacity by their failure when the resulting product of their probability of failure, the size of the resultant curtailment, and the probable value of power during curtailment exceeds the cost of the standby component. Additionally, a standby component shall be provided for those items that would cause a plant shutdown or reduced capacity by their potential long-term unavailability. The standby component shall be installed and kept in a ready status for immediate service. Redundancy for the facility electrical systems shall be compatible with mechanical systems. Specific minimum redundancy requirements are as specified in these specifications.

Overall Scope Description

This subsection provides general descriptions of the work to be performed by the Owner, Contractor and Others. Table 1-1 of this Section is a Division of Responsibility (DOR) matrix listing the work activities to be performed during project implementation and which organization shall be responsible of such activities.

Contractor-Furnished Equipment and Systems

Contractor shall provide all materials and labor for the engineering, design, procurement, installation, construction, startup and testing of all systems and equipment necessary to integrate the Owner’s purchased equipment into a complete, functional power generating facility. The equipment and systems to be provided by Contractor shall include, but not be limited to, the following:

<u>Contractor's Mechanical Scope</u>

Contractor shall provide all materials and labor for the engineering, design, procurement, installation, construction, startup, and testing of all mechanical systems and equipment necessary for a complete, functional power generating facility. As a minimum, the Mechanical Scope shall include the systems and components listed below; detailed requirements are specified in Section A-5, Mechanical Scope, of this Exhibit.

- Combustion Turbine Generators and Auxiliaries
- Heat Recovery Steam Generators

- Steam Turbine Generator and Auxiliaries
- Air Cooled Condenser
- Condensate System
- Feedwater System
- Steam Systems
- Steam Turbine Bypass System
- Mechanical Draft Cooling Tower
- Circulating Water System
- Condenser Air Extraction System
- Reclaimed Water System
- Service Water System
- Water Treatment System [electro deionization with reverse osmosis pretreatment (RO/EDI)]
- Closed Cooling Water System
- Potable Water System
- Fire Protection Systems
- Chemical Injection Systems
- Sampling System
- Steam Turbine Lube Oil Purification System
- Aqueous Ammonia Receiving and Storage System
- Fuel Gas System
- Raw Water Supply and Pretreatment System
- Demineralized Water Transfer System
- Instrument/Service Air System
- Heating, Ventilating, and Air Conditioning (HVAC) System
- HRSG Blowdown System
- Plant Vent Systems
- Plant Drains Systems
- Wastewater Collection and Disposal (including oily wastewater)
- All Miscellaneous Mechanical Systems and Equipment
- All temporary facilities and systems needed to implement this work

Contractor's Electrical Scope

Contractor shall provide all materials and labor for the engineering, design, procurement, installation, construction, startup, and testing of all electrical systems and equipment necessary for a complete, functional power generating facility. As a minimum, the Electrical Scope shall include the systems and components listed below; detailed requirements are specified in Section A-8, Electrical Scope, of this Exhibit.

- 138 kV Switchyard
- 138kV Transmission Line
- Generator Terminal Equipment (GTE) (To be supplied by Owner as part of CTG)
- Unit Auxiliary Transformer (UAT)
- Medium Voltage Bus Connections
- Auxiliary Power System
- Medium Voltage Distribution System

- 480 Volt Secondary Unit Substation
- 480 Volt Motor Control Centers
- Black Start Diesel Generator
- Direct Current (DC) Power Supply Equipment
- Uninterruptible AC Power System (UPS)
- Protection System
- Revenue Metering System
- Communication System
- Security /Surveillance System
- Lighting and Miscellaneous Power
- Lightning Protection
- Grounding System
- Cathodic Protection System
- Heat Tracing
- Electric Motors
- Cables
- Raceways
- Fire Detection and Alarm System
- All Miscellaneous Electrical Systems and Equipment

<u>Contractor's Instrumentation and Control Scope</u>

Contractor shall provide all materials and labor for the engineering, design, procurement, installation, construction, startup, and testing of all instrumentation and control systems and equipment necessary for a complete, functional power generating facility. As a minimum, the Instrumentation and Controls Scope shall include the systems and components listed below; detailed requirements are specified in Section A-9, Instrumentation and Controls Scope, of this Exhibit.

- Fully Integrated Central Control Room
- Plant Control System (PCS)
- Programmable Logic Controllers (PLC)
- Hard-Wired Emergency Trips
- Continuous Emission Monitoring Systems
- Performance Monitoring System
- Steam and Water Sampling System
- Combustible Gas Detection System
- Vibration Monitoring System
- Plant Master Clock
- All Instrumentation and Recording Devices
- Controls interfacing with switchyard, water supply system, and gas supply system
- All Miscellaneous Instrumentation and Control Systems and Equipment

<u>Contractor's Civil Scope</u>

Contractor shall provide all materials and labor for the engineering, design, procurement, installation, construction, startup, and testing of all civil work necessary for a complete, functional power generating facility. As a minimum, the Civil Scope shall include the items listed below; detailed requirements are specified in Section A-6, Civil Scope, of this Exhibit.

- Additional Geotechnical Investigations (If required. Owner provides Geotechnical Engineering Report in Appendix K)
- Construction Surveys (Owner provides Topographic Survey of Parcel 25B-2, Appendix Q and Property Survey of Parcel 25B-2, Appendix G)
- Site Preparation
- All rough grading and drainage
- Drainage During Construction
- Construction Wastewater Treatment and Disposal
- Temporary Construction Facilities, including trailers, furniture, and phones for Contractor, Owner, and vendors of Owner-furnished equipment (See A-1.2.1 above)
- Site Perimeter Fence
- All Power Block Sub-grade Work and Foundations
- Final Grading and Drainage Systems (excluding switchyards)
- Roads and Parking (Construction and Permanent)

Structural and Architectural Scope

Contractor shall provide all materials and labor for the engineering, design, procurement, installation, construction, startup, and testing of all structural and architectural facilities necessary for a complete, functional power generating facility. As a minimum, the Structural and Architectural Scope shall include the items listed below; detailed requirements are specified in Section A-7, Structural and Architectural Scope, of this Exhibit.

- Structural Materials
- Concrete
- Masonry
- Piling
- Steel
- Siding and Roofing
- Finishes
- Furnishings
- Buildings and Structures

Construction Facilities, Services and Utilities

General

Contractor shall plan, organize, and control the work to construct the plant. Contractor shall provide construction, erection, and installation services necessary for the completion of the plant in a safe and orderly manner. The scope shall include, but not be limited to, labor, supplies, materials, equipment, tools, transportation, and anything else required for performance of the required construction.

Contractor shall purchase, expedite, inspect, and pay for labor, materials, equipment, services, tools, machinery, water, temporary utilities, transportation, and other facilities and services necessary for the construction of the Plant, whether of a temporary or permanent nature, including without limitation, facilities and services necessary for potable and non-potable water, sewage, waste disposal, and electric power.

Contractor shall secure applicable local and state construction permits required for the conduct of the required construction scope.

The construction and erection site shall be maintained in a neat and clean condition. Materials shall be protected from damage due to dirt, debris, or the elements. Upon completion of the Plant, Contractor shall dispose of all temporary buildings, rubbish, unused materials, and other equipment and materials belonging to and used in the performance of the work. Contractor shall be responsible for the disposition of any contamination caused by Contractor.

<u>Construction Facilities and Services</u>

Contractor shall furnish and maintain temporary construction facilities and provide construction services including, but not limited to, the following:

a. Temporary Storage Facilities

b. Construction Power and Distribution

c. Temporary communication system

d. Temporary lighting system

e. Site drainage, sedimentation control, and dewatering systems

f. Temporary roads

g. Fire protection service (until turnover)

h. Construction sanitary facilities including construction offices

i. Temporary water supply and distribution (potable and non-potable

j. Parking Facilities

k. Site Security

l. Construction testing services (e.g. weld NDE, hydro-testing, megger-testing, concrete strength and placement compaction testing, steel testing etc.), including any independent testing services as required by these specifications.

m. Construction Materials

n. Site environmental compliance and protection.

o. First Aid Services

p. Temporary Construction Facilities for Others

Provide one (1) additional trailer for the use of the Owner and Vendors providing Owner-furnished equipment. All the services discussed above apply to this trailer.

Production Inputs

Owner will provide the following production inputs:

- All fuel gas necessary for startup and commissioning of the plant. Fuel for the CTG is limited to pipeline-quality natural gas meeting the Specification contained in Appendix L.
- Water necessary for commissioning of the plant. Construction water shall be provided by Contractor.
- Electricity necessary for startup and commissioning of the plant by back-feed through the main step-up transformers. Construction power shall be provided by Contractor.

The Contractor shall provide the following production inputs:

- Chemicals necessary for operation of systems during startup and commissioning of the plant shall be provided by Contractor.
- Lube oils necessary for operation of systems during startup and commissioning of the plant shall be provided by Contractor. Flushing oils shall also be provided by Contractor.

Operating Consumables

Contractor shall provide all operating consumables required for the startup and commissioning of the power plant including but not limited to the following:

- Lubricants
- Chemicals required during construction of the plant (such as boiler chemical cleaning chemicals)
- Nitrogen (N_2) required for system inerting and blanketing, as required.
- Aqueous Ammonia (19%) for SCR system
- Filters
- Strainers
- Spare parts such as gaskets, filter cartridges, light bulbs, lamps, fuses, etc.

Contractor Acquired Permits

Contractor shall procure all permits required for the construction of the project with the exception of Owner's Acquired Permits listed in Appendix M, Compilation of Applicable Permits obtained by Owner, of this Exhibit.

Plant Operating Profile

Contractor shall provide a plant designed to operate at all load conditions between Minimum and Peak operation while meeting all the requirements of this Specification.

Contractor shall provide a plant designed to allow continuous bypass operation at combustion turbine full load with all steam being bypassed around the steam turbine to the condenser and without any steam being vented to the atmosphere.

Plant Operating Philosophy

Contractor shall design the plant with suitable equipment, automation, and controls to allow the plant to start-up, operate normally at any load between Minimum load and Base load, and shutdown with one operator in the control room and one operator in the unit.

Plant Reliability

Contractor shall provide a plant with full redundancy of all equipment and systems prone to failure that are required to support operation of the plant in Base Load operation. The plant shall be provided with redundancy for all equipment or systems for which a failure during any operation (Minimum, Base, Peak, or anywhere in between) could result in the damage to the equipment or to the system.

Provide redundancy of equipment and systems required to support operation of the plant in Peak Load operation only where specified within this Specification.

Where redundant (standby) equipment is supplied, the idle component shall be capable of automatic and immediate initiation into operation upon failure of one or more of the operating components. Necessary instrumentation shall be supplied to sense a failure of one or more of the operating components.

A.1.2 Site Requirements

Introduction

The Project site is located in the New Kissy Dock area. This site is an approximate 7.5 acre parcel that is bordered to the north by the Magram Water Producing Company, to the south by a cleared lot, to the east by a Mosque compound, to the west by the German Technical Academy, and to the southwest by residential properties.

The site is relatively flat, with a gradual downward slope from south to north. Existing ground cover consists of grass and slight tree cover. The site has been used for light automotive repair and has small existing warehouse and office structures.

Site Design Conditions

Specific site design conditions are summarized in Table below, Site Design Conditions.

Site Design Conditions	
Applicable Code	IBC 2018
Location	Freetown, Sierra Leone
Elevation	+35-m average above mean sea level, varying from approximately +33 to +37-m above mean sea level
Seismic Criteria	TBD
Wind Design (Based on ASCE 7-05)	TBD
Design Storm Event	100 year, 24 hour

Site Design Temperatures

Site design temperatures are summarized in the Table below

Site Design Temperatures	
Process Equipment (Max/Min)	35°C/20°C
HVAC System Design	1% Summer, 99% Winter Values from ASHRAE Handbook of Fundamentals
Air Cooled Condenser Design	TBD

Geotechnical Conditions

A Geotechnical Engineering Report, "HFO Project – Freetown Power Station Geotechnical Site Investigation, Kissy Dockyard, Freetown, March 2015" is attached in Appendix K. Contractor shall use this report to finalize all design parameters and construction details related to foundations, roads, paving, slope stability, etc. Any additional information/testing that Contractor feels is required for final design, shall be performed in accordance with the applicable codes and standards, and federal, state and local requirements, under the direction of a Geotechnical Engineer.

Site Security

From the time of initial mobilization to the turnover of the plant to the Owner, the Contractor is responsible for security and access to the power plant construction area. Security shall include secured warehousing of plant equipment and materials and security guards. Contractor is responsible for controlling all access to, and egress of, the site.

Site Access

Contractor shall establish a temporary access point into the site if necessary. Contractor shall determine size and location of temporary staging/laydown areas.

Construction of the proposed facility shall follow all permit requirements and the requirements of this Exhibit. Owner and/or his representatives will be onsite continuously to monitor that construction is compliant with all applicable requirements.

The plant shall be constructed without obstructing public thoroughfares. All warning and traffic signs shall be provided and maintained. A safe workplace environment shall be maintained.

The proposed facility site and roadway layout on the existing site is shown on the General Arrangement Plot Plan Drawing included in Appendix C.

Site Environment

Contractor shall be responsible for protecting and maintaining the site in accordance with local, state and federal requirements, which shall include but not be limited to the following:

Proper storage and disposal of all materials, waste and contaminants such as debris, paints, solvents, lubricants, oils, etc. No materials, wastes or contaminants shall be disposed of on-site. Records of all disposals shall be retained and provided to the Owner at the end of the project. Contractor must maintain Material Safety Data Sheet (MSDS) information for all materials brought to the site. All waste must be handled in accordance with the applicable rules and regulations.

Contractor shall maintain the project site in a neat and clean condition at all times. Materials shall be protected from damage due to dirt, debris or the elements. Upon completion, all temporary buildings, rubbish, unused materials, and other equipment and materials belonging to and used in the performance of the work shall be disposed of. During construction, stormwater and fugitive dust emissions shall be controlled by use of proper construction practices or other suitable means.

The Contractor shall be responsible for maintaining the Storm Water Pollution Prevention Plan (SWPPP) including inspection and reporting requirements. Erosion and Sedimentation Control Plan shall be designed and implemented in accordance with the local, state, and federal laws and regulations.

Site Fuels

The fuels, in the table below, will be utilized at the site.

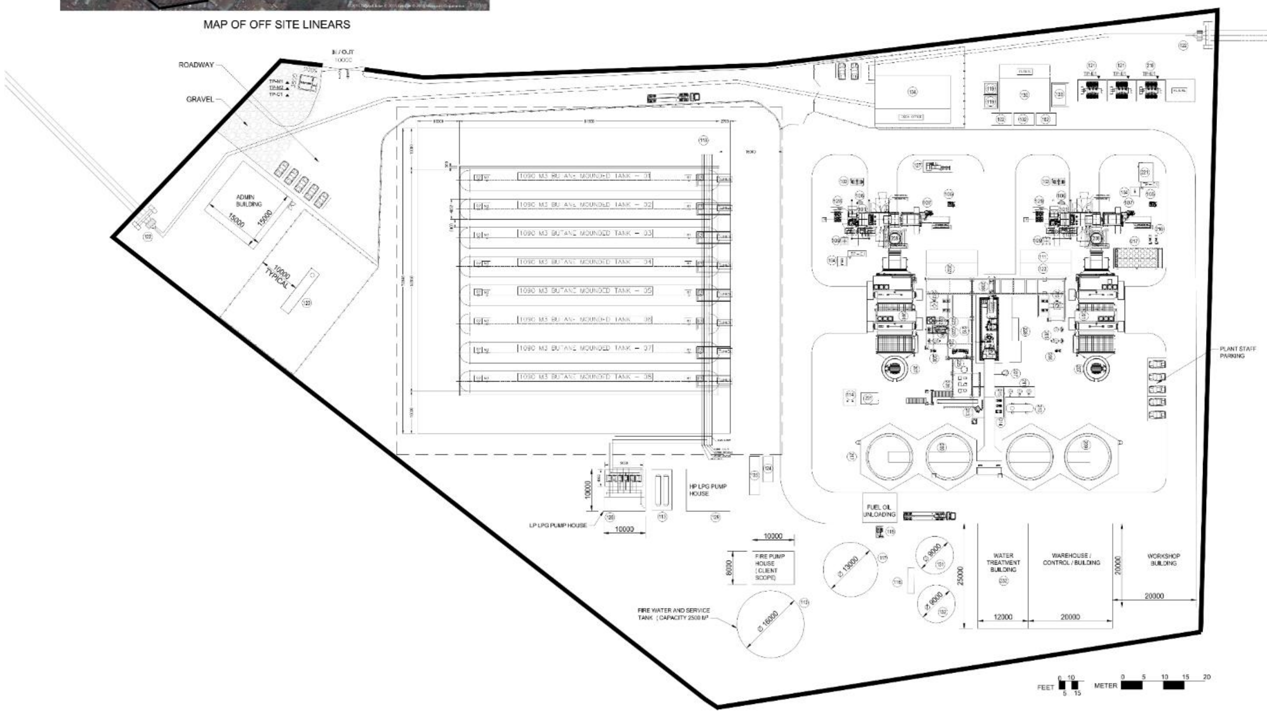
Site Fuels	
Equipment Description	**Fuel**
Combustion Turbine	Liquefied Petroleum Gas (stored in on-site mounded tanks) #2 Diesel Fuel Oil (separate storage tank located adjacent to water treatment building)
Diesel Engine Driven Fire Pump	#2 Diesel Fuel Oil (separate storage tank located adjacent to engine)
Diesel Generator (Standby and Black Start Generator)	#2 Fuel Oil (Tank integral to diesel generator skid)

Site Utilities

The external utilities, in the table below, are associated with the site:

Site Utilities		
Utility Description	**Line Size**	**Tie-In Location**
Seawater Intake	6” [TBD by EPC Contractor]	New beach wells or seawater intake structure
Wastewater Discharge	6” [TBD by EPC Contractor]	New outfall structure
Liquefied Petroleum Gas	8” [TBD by EPC Contractor]	New Kissy Jetty

MAP OF OFF SITE LINEARS



EQUIPMENT LIST:-

TAG No	DESCRIPTION (SIMPLE CYCLE)	TAG No	DESCRIPTION (COMBINED CYCLE)
101	LM2500 UNIVERSAL	201	HRSG
102	GCB	202	HRSG / STG PCM
103	FUEL GAS FILTER SKID	203	ST GENERATOR
104	WASTE DRAINS TANK	204	HP/LP STEAM TURBINE
105	WATER WASH CART	205	FEED WATER PUMPS
106	CO2 SKID	206	RECIRCULATION PUMP
107	GENERATOR LUBE OIL SKID	207	HRSG STACK
108	AUXILIARY SKID	208	BY PASS STACK
109	TLO/HYDRAULIC & GLO FIN FAN COOLR	209	ACC
110	AIR FILTER	210	CONDENSATE TANK
111	BOP PCM	211	CONDENSATE PUMPS
112	RAW AND FIRE WATER TANK	212	BDT WITH TRANSFER PUMP
113	LPG BUFFER TANKS	213	ADV
114	DRAIN PIT WITH TRANSFER PUMP	214	ADV PUMPS
115	DIESEL FORWARDING PUMPS	215	DRAIN POT PUMPS
116	PRETREATMENT TANK	216	CCW PUMP SKID
117	DIESEL FUEL OIL STORAGE TANK	217	CCW FIN FAN COOLERS
118	MOUNDED LPG STORAGE AREA	218	GSUT 33/11.5kV
119	UAT 11.5kV/400V	219	SAMPLING SKID
120	INCINERATOR / FLARE	220	DOSING SKID
121	GSUT 33/11.5kV	221	COMPRESSED AIR SKID
122	RISER TOWER	222	START-UP EJECTOR
123	COMBINED GT PCM	223	SERVICE EJECTOR
124	CONTROL MODULE (LPG VAPORIZER)	224	GSC
125	LPG HEAT EXCHANGER	225	CCW TANK
126	LOW PRESSURE LPG PUMPS	226	HP / LP BYPASS STATION
127	BLACK START DIESEL GEN	227	FLASH TANK
128	WATER INJECTION BOOST SKID	228	STG LAYDOWN AREA
129	HIGH PRESSURE LPG PUMPS	229	-
130	11-KV SWITCHGEAR BLDG	230	MAIN PIPE RACK
131	DEMINERALIZED WATER TANK	231	BDT FINFAN COOLER
132	FILTERED WATER TANK	232	WATER TREATMENT SYSTEM
133	SST 33kV/400V		
134	33-KV SWITCHGEAR BLDG (EDSA)		

LEGENDS:

BSDG-BLACK START DIESEL GENERATOR

GSUT-GENERATOR STEP-UP TRANSFORMER

TERMINAL POINTS (TP) :

TP-M1 LPG
TP-M2 WATER
TP-E1 OUTGOING POWER
TP-C1 WASTE DRAIN SYSTEM

OFF SITE LINEARS WILL BE BROUGHT TO THE PLANT SITE VIA UNDERGROUND PIPELINES.

DIESEL FUEL OIL STORAGE TANK WILL BE A DOUBLE-WALL DESIGN WITH FIRE RESISTANT INSULATION PER NFPA 30.

2X1 LM2500_ACC_WP_10J_07 10N_2.DWG

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPR
0	ISSUED AS FINAL	07/10/2020	RAI	JT	JT	GC

REFERENCE DRAWINGS

DSGN	JT	08/06/2020
DRN	RAI	08/06/2020
CKD	JT	08/06/2020
SCALE:	NTS	

FOR 297x420 DWG ONLY

POWER ENGINEERS

CEC Africa

WESTERN AREA POWER GENERATION PROJECT

GENERAL ARRANGMENT

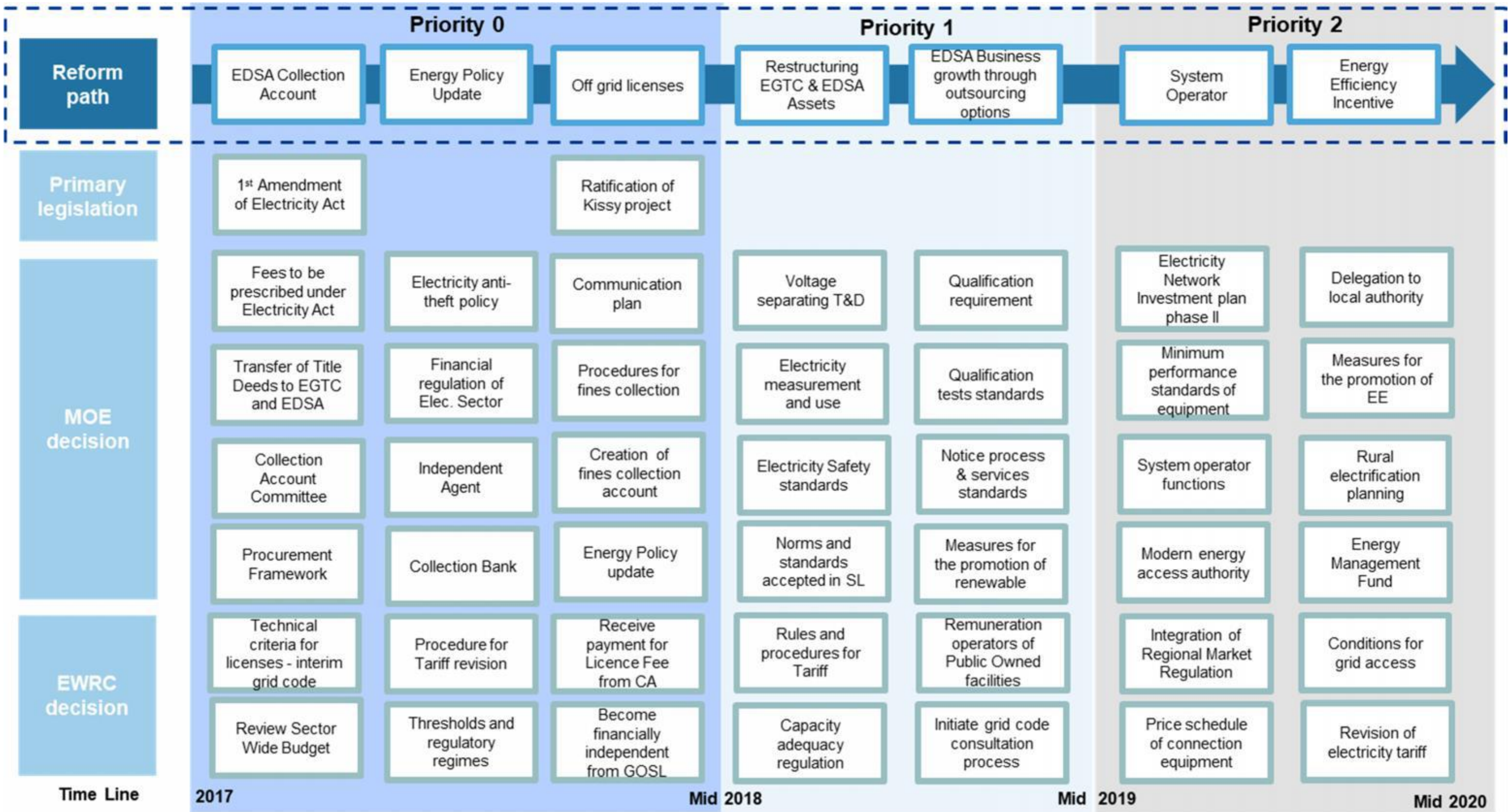
JOB NUMBER: 163110

REV: 0

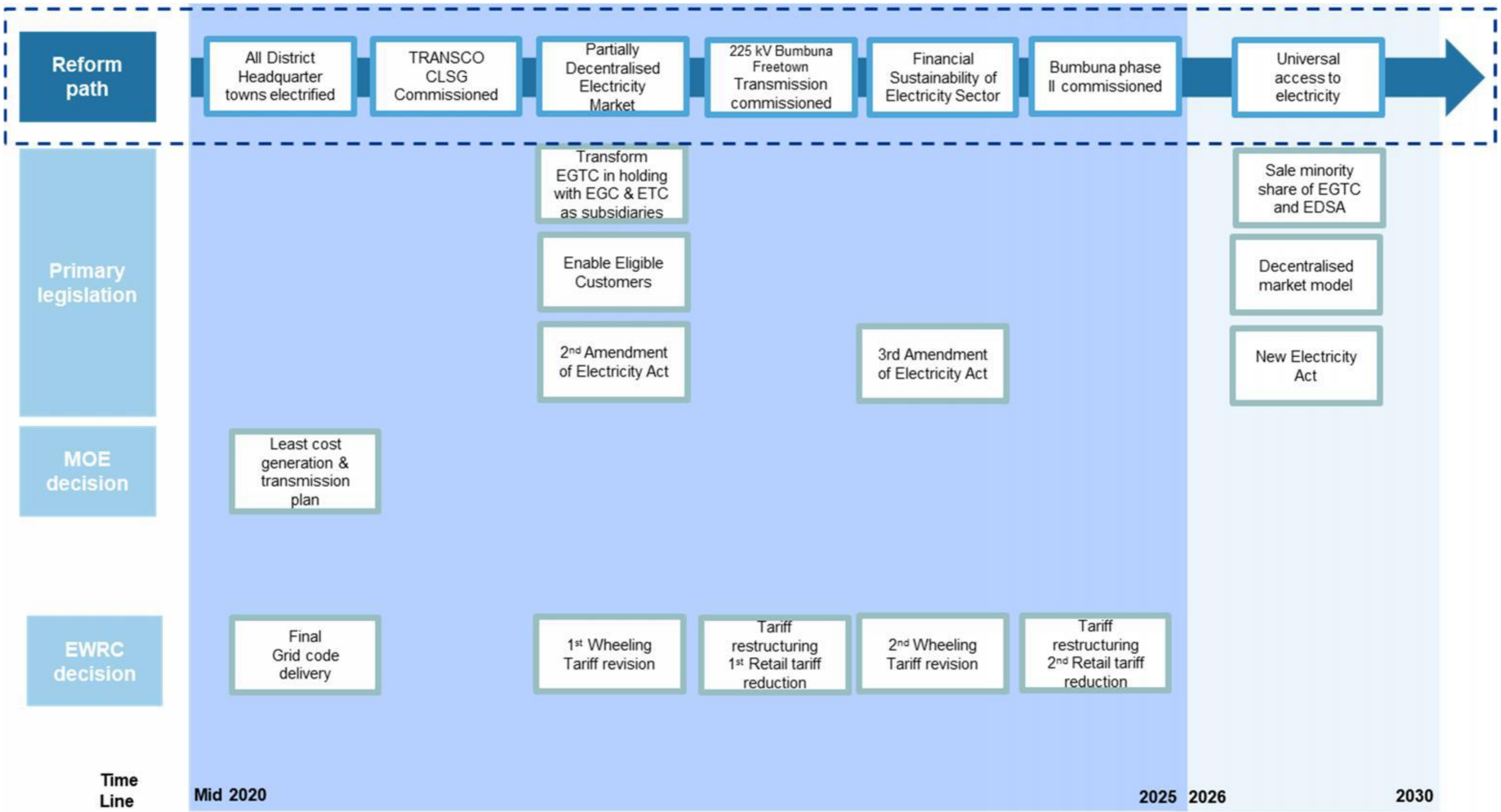
DRAWING NUMBER: M1-01-01

A.1.3 Need for Development

GoSL draft short-term roadmap for reform of the electricity sector



GoSL draft long-term roadmap for reform of the electricity sector



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Appendix B. **Climate Change**

B.1 Climate in Sierra Leone

The climate of Sierra Leone can be characterized as wet tropical, with one wet season and one dry season. The wet season runs from approximately May to October, with the heaviest rains falling in July and August. The dry season runs from approximately November to April and brings hot dusty air from the Harmattan trade winds.

Average annual rainfall for the whole country is approximately 3000mm, and average annual temperature around 26°C, making Sierra Leone one of the hottest and wettest countries in West Africa. During the dry season the average daytime temperature climbs to around 32°C, dropping to 15°C at night. The country is largely humid (40-60%, although there are sea breezes along coastal areas which reduce the impact felt of this somewhat.

B.2 Climate Change Assessment in ESHIA

As part of the ESHIA, the potential impacts of climate change must be considered on the proposed development. Any future predicted changes in parameters such as temperature, precipitation and the frequency or magnitude of extreme weather events should be considered from the project outset. This is necessary in order that the project design can be tailored to cope with such changes, or appropriate mitigation implemented. Thus climate change is assessed from the perspective of the need to mitigate contributions to climate change (e.g. the use of efficient technologies to minimize the emissions of greenhouse gases generated by the use of fossil fuels) and also to building in climate resilience to the project by incorporating adaptation measures so that the project can live with the effects of climate change (for example increased flooding due to higher rainfall).

In addition to any project-specific design and operation measures implemented, it is a requirement of the IFC's Performance Standard 2 that annual reporting of greenhouse gas emission takes place for projects of this nature and scale. This will commence once the plant is operational.

B.2.1 Predicted Climate Change in Sierra Leone

A wide range of data sources is available concerning observed and projected future climate conditions globally. These can be applied to assess how changing climate conditions may affect the performance of a project over its lifetime and gain an understanding of the range of possible outcomes, depending on various scenarios.

Projections at a given location can be drawn from a wide range of climate models called General Circulation Models (GCM). The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report used data from a large number of models to inform the most extensive global study of climate change undertaken. Based on modelled results the future direction of climatic parameters such as temperature, rainfall, and extreme events can be forecasted and this can be factored into design considerations.

There is some inconsistency between models, which is perhaps not surprising given their individual assumptions and input data. The summary of predicted changes in precipitation, temperature and other weather phenomena is provided, based on information from Sierra Leone's Second National

Communication on Climate Change (2012), with supplementary information from the IPCC's Climate Wizard[8] tool.

B.2.2 Precipitation

Annual change in precipitation

Within the Second National Communication, projections of future changes in rainfall were assessed based on a number of models which used raw data from 1961 – 1990, sourced from five meteorological stations across the country. Some of the models, including ECHAM4 and HDCM2 showed little change in precipitation by 2100 compared with current averages. Other models however, including CSIRO-TR and UKTR, showed a decrease in rainfall of 3-10% for both monthly and annual values. Assuming an approximately linear decrease in precipitation between 2012 (the date of issue of the Second National Communication) and the end of the century, the change by 2050 can be expected to be 1.5–5% lower than current levels.

Mid-century predictions can be useful for assessments of projects such as this one, which has an expected operational lifespan of 30-50 years, with the duration of the current power purchase agreement (PPA) being 20 years. It is critical to note, however, that past activity has resulted in climate change happening at the present time. Thus the impacts felt as a result of the described 1.5-5% decrease in precipitation in 50 years' time will occur in addition to those changes already being felt. Already there is evidence for increased temperature and increased storm incidence, and the potential for these current changes to impact the project must be considered also.

Seasonal Change in Precipitation

The Climate Wizard tool allows seasonal changes to be modelled separately. This appears to show a slight increase in precipitation during the wet season, although a decrease during the dry season (March to May); however the data are not conclusive.

B.2.3 Temperature

Annual change in temperature

The whole of the African continent is very likely to warm during the 21st century, with the warming very likely to be greater than the global annual mean warming.

Amongst the models used to model temperature change were a GCM used in in the IPCC Third Assessment Report called the Hadley Centre Coupled Model, version 3 (HADCM) and the ECHAM model. Temperature projections were again based on data from 1961 – 1990 from across the country. Based on these models, the average temperature is expected to increase from 26.7°C to between 28.6°C – 29.1°C, a change of 1.9 - 2.4°C. Assuming an approximately linear increase in temperature over the course of the century, the average value in 2050 can be expected to be approximately 27.7°C – 27.9°C. Again, this should be considered in addition to the changes currently being experienced with respect to increasing temperature.

[8] http://www.climatewizard.org/

Seasonal change in temperature

Climate Wizard data in indicate that the temperature change is during the height of the wet season is broadly similar to the annual average (around 1.6°C), whilst the increase during the dry season is a little larger.

B.2.4 Extreme Weather Events

The global expected trend in extreme weather events is for increasing frequency and increasing magnitude, or in some cases, both. Such events may include drought, flooding, tsunamis and hurricanes. Indeed, there is already evidence for increased storm incidence, which is the result of previous activity, of whatever nature.

Flooding

Flooding and inundation affects the coast around the Freetown peninsular although accurate assessment of future sea level rise is limited by the lack of accurate topography data for the area around Freetown. The Second National Communication suggests that for the year 2020 the sea level rise will be 1m. The population potentially at risk from such a rise is about 2.3 million people – a significant proportion of Sierra Leone's total population of 5.9 million. It is expected that in the absence of any mitigation, 26.4km^2 could be lost as a result of climate change induced sea level rises.

45% of the coastal zone of Sierra Leone could be inundated, with mangrove systems and many of the low-lying beaches in the Freetown area likely to be lost.

Drought

Under extreme scenarios a temperature rise of 3.0°C or more is possible, and could result in serious impacts from drought, particularly in the agricultural sectors of arable and livestock farming, and fisheries. Although Sierra Leone has large resources of water, management of resources is relatively limited, and demand for water for industry has increased dramatically in recent decades. Thus, the potential for decreasing rainfall in future to result in drought is considerable.

Seismic hazard

Although geological, rather than climatic phenomena, seismic and volcanic events should also be considered in the long-term planning of the project design and its implementation.

The WHO's Seismic Hazard Distribution Map for Sierra Leone[9] indicates that the Freetown area has a Seismic hazard rating of Low 0.2-0.8 PGA m/s^2. No records of significant earthquakes were identified, and there is no history of volcanic activity in the area. It is therefore considered that there is no significant risk of such events occurring on a scale that would warrant consideration in the ESHIA.

B.2.5 Potential Project Impacts

Despite the small to moderate predicted changes in climate predicted for Sierra Leone, it is considered that most of these parameters are unlikely to have a significant impact on the proposed plant.

[9] http://www.who-eatlas.org/africa/images/map/sierra-leone/sle-seismic.pdf

Sea level rise

The site is located more than 450m from the sea, and over 200m from Cow Water / Wellington Creek. In addition, the topography of the area is such that the site lies approximately 15-20m above sea level, although the exact elevation will be confirmed during the topographic survey. The site will therefore not be subject to flooding as a result of sea-level rise within the lifetime of the plant, as such a rise is only likely to be in the order of 1-2m at most.

Precipitation

Data from the Second National Communication indicated a small to moderate decrease in precipitation. Climate Wizard data indicated a small increase over the wet season, and annually, and a small decrease during the dry season. Regardless of the disparity in results, such trends are given over a relatively long temporal scale and thus variation on a seasonal or shorter scale in either case may result in periods of increased rainfall. One potential risk that could arise as a result of heavy rainfall is local flooding around the site, due to the limited capacity for local drainage. Currently there is currently no recognized storm water drainage system on the site, apart from some small perimeter drains around the hard standing around the SLRA administration building.

Sea level rise could impact the petrojetty where the fuel supply will come from and the intake and outfall of the desalination plant.

Temperature

A predicted increase in temperature of up to 2.5°C is unlikely to have an impact on most aspects of the plant's operation. However, engine efficiency does decrease above a certain temperature. The point at which this occurs and the extent of the reduction varies by manufacturer and model

Beyond the possibility for an increase in localized flooding, with implications for drainage capacity, and the possibility of decreased engine efficiency (and therefore slight increase in emissions) as a result of temperature increase, no other potential impacts are anticipated in relation to climate change.

B.2.6 Mitigation

As regards the need for mitigation, risks to the project are generally considered to be low. The risk of flooding occurring can be planned for by a consideration of predicted climate changes in the drainage system design. A recommendation will therefore be included within the ESMP that an appropriate increase in drainage capacity is incorporated into the design, to account for potential increased rainfall relative to the historical and current norm.

With regard to the decreased engine efficiency as a result of increased temperature, no specific mitigation can be implemented to prevent efficiency decrease. However, data relating to engine efficiency should be considered in the selection of the engines to be used. Selecting an engine with a high threshold point over which efficiency decreases occur, and/or a exhibits a slow rate of efficiency decline will ensure that output can be maintained as near as possible to the optimum, and thus minimize operation costs and emissions.

Appropriate steps will also be described within the ESMP regarding annual reporting of greenhouse gas emissions in line with the requirements of the IFC Performance Standard 2.

In summary, due to the location and topography of the project site, and the relatively small climatic changes predicted for this part of Sierra Leone, it is considered that climate change considerations are unlikely to be a significant project constraint for the proposed power plant. A separate climate change report has been requested and will be prepared along with the ESHIA.

Appendix C. **Ecological Review**

C.1 Current Site Conditions

The proposed power plant site, which lies between Factory Road and Parsonage Road, and its immediate surroundings up to approximately 150m comprise industrial and degraded areas with little vegetation remaining. The area is highly built-up, and lies within the densely populated suburbs of eastern Freetown. Part of the site is occupied by the Sierra Leone Roads Authority, Western Region, and along the western and southern walls of this area, farming takes place on former waste ground. This area is cultivated to produce crops potato, cassava leaves and soya.

Beyond approximately 150m, the habitats and thus potential species are less well understood and will require further clarification in the event that these or other areas are identified as likely to be impacted by the development. The busy Bai Bureh Road 90m to the south of the site, and Wellington Creek 200m to the east, may act as barriers to some species' movement. The disused oil refinery site to the north of the site appears from aerial imagery to contain some vegetated habitats, with additional vegetation visible beyond this to the north and northwest.

Due to the project site's development history of disturbance and the lack of natural or semi-natural habitats, the potential for protected or otherwise notable species (e.g. species included on the International Union for Conservation [IUCN] Red List) to be present on site is likely to be very limited. The cultivated area is likely to support a limited range of invertebrate species and may also attract animals such as rodents.

Electricity generated by the plant is likely to be evacuated via an upgrade of the existing 11kV transmission line to 33kV for approximately 2 km east and west of the site. Beyond this, the existing electricity system will be used (any upgrades to which are not part of this project).

The route of the upgrade line is likely to cross highly modified areas with little or no remaining natural or semi- natural habitat, and with limited potential to support protected or notable species.

There is a lack of information relating to species known from the site and its immediate vicinity, which is likely to be in part a reflection of the lack of ecologically valuable habitat, although is also likely to reflect a lack of ecological information more generally, as with other disciplines.

C.2 Local Priorities

The National Biodiversity Strategy Action Plan (2004-2010)[10] is the primary source of information identified on conservation priorities in Sierra Leone. The plan outlines 19 priority projects, of which the following are of most relevance to the project and study area:

- Post-conflict reconstruction and management of protected areas;
- National reforestation and rehabilitation of degraded forest resources ;
- Nationwide forest inventory to restore and redefine the forest estate after the civil conflict;
- National marine biodiversity and museum for Sierra Leone;
- Assessment of the marine finfish and shellfish stocks of the inshore coastal waters of the continental shelf; and

[10] National Biodiversity Strategy Action Plan (2004), https://www.cbd.int/doc/world/sl/sl-nbsap-01-en.pdf (last accessed 23rd September 2014)

- Studies on the biodiversity of major estuarine systems.

The Conservation Society of Sierra Leone (CSSL) is actively involved in conservation, and undertakes an annual waterbird census of Yawri Bay, an International Bird Area (IBA) to the south of the Freetown peninsula.

C.3 Protected Areas

In the wider area of the site, internationally designated nature conservation sites within 10 km were considered to be of relevance to the study. Nationally designated sites within 5 km and local designations within 2 km were also considered.

Within this search zone two internationally protected sites were identified - the Sierra Leone River Estuary (SLRE) and the Western Area Forest Reserve (WAFR). The latter is also considered nationally as a non-hunting forest reserve, though it is unclear if this is a legal status. No locally protected sites were identified within the area, and indeed no evidence of locally protected sites within Sierra Leone as a whole was identified.

C.3.1 Sierra Leone River Estuary

The project site lies approximately 400 m south of the Sierra Leone River, which is the drowned estuary of the Rokel (also known as Seli) river, and which is internationally designated a Ramsar site. Ramsar sites are wetlands of international importance, designated under the Ramsar Convention. The project site also lies 200m west of Wellington Creek, which may also be included within the Ramsar site, though this is yet to be confirmed.

The Ramsar covers 295,000 ha, with the northern reaches comprising lowland coastal plains innervated by numerous creeks and bounded by the mountainous Western Area peninsula to the south. The site contains nearly a fifth of Sierra Leone's total mangrove habitat, much of it untouched. The estuary is lined by 110 ha of mud and sand foreshore, and 1,800 ha of intertidal mudflats and muddy sandflats. The distance to the closest mangroves is not clear, although site visit observations indicate that the stretch of coast closest to the project site does not include this habitat type due to its highly disturbed and industrial nature. This will be clarified during the ESHIA process.

The SLRE qualifies as a Ramsar wetland under criteria 6 and 9[11], which state that a wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird (criteria 6) or of wetland-dependent non-avian animal species (criteria 9). The SLRE exceeds the 1% threshold for at least eight waterbird species: ringed plover (*Charadrius hiaticula*), Kentish plover (*Charadrius alexandrinus*), sanderling (*Calidris alba*), curlew sandpiper (*Calidris ferruginea*), whimbrel (*Numenius phaeopus*), greenshank (*Tringa nebularia*), redshank (*Tringa totanus*), and Western reef heron (*Egretta gularis*)[12]. Breeding habitat is present for some of these species.

The SLRE is also designated as an IBA by Birdlife International. The SLRE qualifies under criteria A4i (a site known or thought to hold, on a regular basis, ≥ 1% of a biogeographic population of a congregatory waterbird species) and A4iii (a site known or thought to hold, on a regular basis, ≥ 20,000 waterbirds or ≥

[11] Criteria for identifying Wetlands of International Importance, http://www.ramsar.org/cda/en/ramsar-about-faqs-what-are-criteria/main/ramsar/1-36- 37%5E7726_4000_0 (last accessed 23rd September 2014)

[12] The Ramsar Sites Database, http://ramsar.wetlands.org/Database/SearchforRamsarsites/tabid/765/Default.aspx (last accessed 23rd September 2014)

10,000 pairs of seabirds of one or more species). The species for which the SLRE is listed are broadly similar to those under the Ramsar designation.

A total of 626 bird species have been recorded in Sierra Leone, of which around 22% are regular seasonal migrants[13]. 23 species are of global conservation concern and of those, 13 are globally threatened[14]. Sierra Leone's coastline forms part of the eastern Atlantic flyway for Palearctic migrant waterbirds and is considered one the two major stop-over and wintering sites for many of the Palearctic waders that winter along the West African coast. Of the 13 globally threatened species, 4 have distributions which cover the Freetown peninsular:

Timneh Parrot (Psittacus timneh), Rufous fishing-owl (Scotopelia ussheri), yellow-casqued hornbill (Ceratogymna elata), white-necked picathartes (Picathartes gymnocephalus). The habitat preferences of these species indicate, however, that they are unlikely to be found in the degraded areas of the SLRE and some have distributions which cover much of the Upper Guinea area. The IBA is not designated for any of these four species.

C.3.2 Western Area Forest Reserve

The WAFR is a nationally and internationally protected area which lies south of the project site. The WAFR receives national protection as a non-hunting reserve and covers an area of 17,688 ha of the Western Peninsular mountains. The reserve has been proposed for National Park status and is on the UNESCO tentative list for World Heritage Site status. The demarcations of the WAFR and proposed National Park appear to be the same, lying approximately 2.4km from the project site at the closest point. Within non-hunting forest reserves, the hunting and capture of animals is prohibited except with authorization from the Chief Conservator of Forests. It is considered by some that such reserves provide insufficient protection, and the reserve has also suffered from significant deforestation as a result of the rapid expansion of Freetown and other urban areas.

The Tacugama Chimpanzee Sanctuary is located within the reserve, approximately 6.8km from the project site.

Non-hunting forest reserves and National Parks (if this status is granted) are understood to be national designations within which the avoidance of significant impacts is a key priority. This is in line with one of the National Biodiversity Strategy Action Plan's strategic objectives to *"establish and properly manage all protected areas (national parks, wildlife sanctuaries, strict nature reserves) in representative ecosystems across the country"*.

The site is also an IBA, which is designated under the criteria A1 (globally threatened species), A2 (restricted- range species) and A3 (biome-restricted species). 314 species have been recorded from the site, including 91 certain/probable breeders and a number of migrants that occasionally visit water-bodies in and around the reserve. Five species are of global conservation concern.

C.4 Species

There is little or no survey information available on marine or terrestrial mammals in the mangrove forests in the SLRE, although it is thought that the West African Manatee (*Trichechus senegalensis*) occurs there.

[13] Okoni-Williams, A.D., Thompson, H.S., Wood, P., Koroma, A.P. & Robertson, P., Important Bird Areas in Africa and Associated Islands – Sierra Leone, http://www.birdlife.org/datazone/userfiles/file/IBAs/AfricaCntryPDFs/Sierra_Leone.pdf (last accessed 23rd September 2014)

[14] Birdlife International, http://www.birdlife.org/datazone/speciessearchresults.php?cty=188&cri=CR+EN+VU&rec=N&vag=N&hdnAction=ADV_SEARCH (last accessed 23rd September 2014)

The coastal forests are also known to support three game species, including the IUCN Near Threatened Maxwell's Duiker (*Cephalopus maxwelli*). Crocodiles, monkeys and forest genet have been observed, and crabs, oysters and the amphibious fish mudskippers are widespread.

The WAFR supports five species of primate, three species of duiker and a frog endemic to West Africa, the Freetown Long-fingered Frog (*Cardioglossa aureoli*). Three of the primate species, one of the Duiker species and the frog are classified as endangered.

At both protected sites it is considered likely that the most ecologically sensitive species - and thus those most likely to be threatened or rare - are unlikely to be found on the fringes of the forest habitat or mangrove areas. Instead they are likely to be found within the less disturbed areas that are further from Freetown. The southern extremity of the WAFR lies 30km from the project site, such that the central areas are therefore approximately 12-25km away. Similarly, for the SLRE, it is likely that the distribution of wetland habitat specialist species for which the site is most important will be concentrated within the pristine or little disturbed and degraded areas of mangrove.

C.5 Valued Ecological Receptors

C.5.1 Assessment Method

In the absence of an appropriate national equivalent, the assessment method used for determining the value of the ecological receptors identified will be that of the Institute of Ecology and Environmental Management (IEEM)[15] guidelines for ecological impact assessment in the UK[16] (henceforth referred to as the IEEM guidelines).

These guidelines set out a process of identifying the value of each ecological receptor (termed a Valued Ecological Receptor, VER) and then characterizing the impacts that are predicted, before discussing the effects on the integrity or conservation status of the receptor, proposed mitigation and residual impacts.

The initial action within the scoping assessment is to determine which features should be subject to detailed assessment within the EIA. Those identified as such should be of sufficient value that impacts upon them may be significant in terms of either legislation or policy. The receptors should also be vulnerable to significant impacts arising from the development.

The value of ecological receptors is determined based on a geographic frame of reference. For this project the following frame of reference is used:

- International;
- National (Sierra Leone);
- Council Area (defined here as Western Province);
- District (defined here as Western Area Urban District);
- Local (within 2km); and
- Less than local.

[15] In February 2013 IEEM became the Chartered Institute of Ecology and Environmental Management (CIEEM)
[16] IEEM (2006) Guidelines for Ecological Impact Assessment in the United Kingdom http://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/EcIA_Guidelines/TGSEcIA- EcIA_Guidelines-Terestrial_Freshwater_Coastal.pdf (last accessed 23rd September 2014)

C.5.2 Identified Valued Ecological Receptors

The VERs identified as relevant to the project site and the search zones indicate above are provided in Table 1. Although a large number of bird species is designated at the two protected sites the species have not been listed as individual receptors, since the sites are designated for their importance to the bird assemblages as a whole, and it is thus more meaningful to consider the sites and their bird assemblages as such. For non-avian species, known species of importance are included.

Table 1 - VERs relevant to the project assessment

Valued ecological receptor	Level of value assigned
SRLA	
Sierra Leone River Estuary IBA	International
Sierra Leone River Estuary Ramsar	International
Wetland habitats	International
Bird assemblage (breeding and non-breeding)	International
West African Manatee (if present)	National
WAFR	
Western Area Forest Reserve IBA	International
Western Area non-hunting forest reserve	National
Bird assemblage (breeding and non-breeding)	International
Western chimpanzee (*Pan troglodytes verus*)	International
West African Red Colobus *(Procolobus badius*)	International
King Colobus (*Colobus polykomos*)	National
Sooty Mangabey (*Cercocebus atys*)	National
Diana monkey (*Cercopithecus diana*)	National
Jentink's Duiker (*Cephalophus jentinki*)	National
Black Duiker (*Cephalophus niger*)	Less than local
Maxwell's Duiker (*Philantomba maxwellii*)	Less than local
Freetown Long-fingered Frog	International

Predicted impacts on each of the receptors evaluated as of at least local importance and/or subject to legal protection will be investigated as part of the EIA. Those receptors included within the assessment will therefore be those included in the table above with the exception of the Black and Maxwell's Duikers). The baseline will be updated with relevant identified data from local, national and international organizations and detailed in the EIA.

C.5.3 Scope of Assessment

C.5.3.1 Potential for Impacts

<u>Construction Impacts</u>

Impacts relating to construction of the project plant and associated infrastructure may include limited habitat loss in the immediate vicinity of the site, and potential disturbance or dust impacts on species and habitats. As described above, given the highly industrialized and degraded nature of the site and transmission corridor and its associated lack of vegetated habitats, the site itself is likely to have low ecological value. No habitat loss will take place sufficiently close to the protected areas that any significant impact on habitat integrity is likely, and thus species within these areas are considered not at risk of impacts as a result of this.

Impacts as a result of construction are therefore unlikely to be significant, since the protected and notable species and habitats present within the sites identified as VERs are considered unlikely to present in the zone of impact, given application of standard design mitigation (e.g. for fuels storage and pollution prevention and control). If potentially significant impacts on terrestrial or aquatic ecology are identified during the ESHIA, mitigation will be developed in consultation with organizations such as the CSSL.

<u>Operational Impacts</u>

Operation impacts may potentially include bird collision, air deposition impacts and issues associated with intake and outflow of water, as described below. No operational impacts are anticipated on the mammal or amphibian species at the WAFR.

The interactions between the designated interests at the SLRE Ramsar/IBA and the surrounding areas are not well documented. It is considered that migratory birds are likely to be stopping over at the River Estuary as they travel along the West African coast and thus spend relatively little time flying over Freetown and surrounding areas. Those species resident at the site year-round may travel over the project site more frequently, but will likely spend most time close to the shelter and breeding grounds provided by the mangroves and nearby habitats, and to the food sources exposed by the tidal mudflats and in the sea. Wintering waders are present in the highest densities in areas such as Aberdeen Creek, which is nearly 10km west of the project site.

On this basis it is considered that flight lines of birds from the SRLA Ramsar/IBA are likely to be directed predominantly to the north, east and west, rather than the south. Similarly, flightlines from the WAFR are likely to be predominantly directed away from Freetown. Thus, the possibility of bird strikes against project buildings or smoke stacks is considered to be low. Given the 600m distance from the project site, birds are unlikely to be flying low to the ground over this location, further reducing the risk of strikes. The presence of other tall structures (such as tall communications masts and other industrial stacks) in the area means that bird populations will already be habituated to similar features.

Since a transmission line is already present in the area, any birds and bats passing through the area are also likely to be habituated to the presence of these features and therefore unlikely to experience impacts as a result of this. This potential impact of bird and bat strikes on the smokestacks or associated with the transmission line will therefore not be considered in the EIA and no bird surveys are considered necessary.

A further potential impact pathway is through air quality depositions from the power plant’s emissions. Mangrove habitat could potentially be impacted by pollutants such as particulate matter and gases such as NOx and SOx. Given the distance of both protected nature conservation sites from the plant it is considered that impacts are likely to be minimal. However, an assessment of the potential for depositional impacts on sensitive ecological features will be carried out as part of the ESHIA.

It is understood that wastewater and other waste products released to the environment will be relatively limited. HFO sludge waste will be burned in a small on-site incinerator, with the resulting ash disposed of in the central dump. The project does not have significant process raw water requirements. Beyond periodic filling of firewater tanks and the closed water circuit within the fin-fan radiators, water requirements will be limited to those required for domestic supply, cleaning and washdown. The waste water that is produced will be treated and ultimately likely discharged to the local stream, adjacent storm drains, or (in the unlikely event that no alternative can be found) directly to the sea. Since the water will be treated in line with World Bank / IFC EHS Guidelines, and will be at or close to ambient temperature, no significant impacts on valued ecological receptors are likely and it is proposed to scope out this effect from the EIA.

C.5.3.2 Proposed Survey and Study Work

Based on the VERs considered within the assessment and the potential impacts outlined above, it is considered that baseline surveys are not required, as they are unlikely to provide significant useful information in the context of this site and proposed development.

Given the lack of baseline information on species groups such as marine and aquatic life, and on the location and nature of habitats such as the mangroves, a comprehensive desk study is proposed to clarify any additional VERs which may be required for inclusion within the EIA. The desk study should look in further detail at records of protected and notable species, particularly those identified as national (or local, if these exist) priorities. It should also characterize the habitats within 2km of the site, and any additional priority habitats within the search area (up to 10km for internationally important habitats, and up to 5km for nationally important habitats).

Following the desk study, the IEEM guidelines will be used to predict and characterize impacts on the VERs identified and support the application of appropriate mitigation. In the event that potentially significant impacts are identified, further studies may be required, which may include field studies.

C.5.3.3 Relevant Legislative and Planning Documents

Documents relevant to the assessment will include:

- IFC Performance Standards, and potentially IFC PS 6 (PS6)[17] and associated Guidance Note[18];
- National legislation, such as The Environment Agency Protection Act, 2008 (No. 11 of 2008);
- The National Biodiversity Strategy Action Plan (2004-2010); and
- Any further national or local legislation or guidelines identified as part of the desk study.

The IFC's Performance Standard 6 (PS6)[19] and its associated Guidance Note[20] sets out requirements in relation to Biodiversity Conservation and Sustainable Management of Living Natural Resources. By implementing the recommendations of PS6 it is hoped that developers will: protect and conserve biodiversity; maintain the benefits from ecosystem services and promote sustainable management of living natural resources.

The Standard requires that relevant threats to biodiversity and ecosystem services are considered, notably habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution. The importance of these should be viewed in the context of

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[17] http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES (last accessed 23rd September 2014)
[18] http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES (last accessed 23rd September 2014)
[19] http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES (last accessed 23rd September 2014)
[20] http://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES (last accessed 23rd September 2014)

values attached to them by affected communities and local stakeholders. As described above, the potential for such processes to occur is considered to be low, with the possible exception of pollution due to air emissions. The desk study will provide further information on additional VERs and associated potential impacts. PS6 will only apply to the project if it is identified that significant impacts to biodiversity are likely.

Appendix D. **Stakeholder Consultation Event Report**

DRAFT SUMMARY OF STAKEHOLDER CONSULTATIONS AND ENAGAGEMENTS

CECA SL GENERATION PROJECT

Objectives

The main objectives for stakeholder engagement are:

- To inform the relevant stakeholders about the proposed project
- To capture views and concerns of the relevant stakeholders with regard to the proposed project;
- To enhance ownership of the project within the host community;
- To provide a basis for stakeholder participation in the ESHIA process.

Project Stakeholders

We have identified the key stakeholder groups and analyses how they are likely to be affected by the project. These include persons or groups institutions and business who:

- Are directly and/or indirectly affected by the project;
- Have “interests” in the project;
- Have the potential to influence the project outcomes operations.

Stakeholders Engagement Methods

The stakeholder engagement methods that have been used include qualitative methods such as key informant interviews, community meetings and focused group discussions, consultation letters and formal meetings. A key informant guide was developed and this was used during stakeholder consultations/engagements. A summary Project Information Document (PID) was also distributed to the stakeholders with a feedback report sheet for stakeholders to provide written feedback and comments. This was done to provide an opportunity for stakeholders who cannot participate in the meetings, to give them extra time to review the documentation and to adequately research and document their position. this was also helpful in adhering to COVID-19 measures and restrictions.

Notification letters have been sent and consultation meetings, interviews and focus group discussions have been undertaken with the local communities, and some of the MDAs who were available. Other stakeholders will be engaged as they become available. An attendance sheet is provided in the meetings to document attendance.

The list of stakeholders who have been identified and notified are listed in the table below:

No	Institution/Organization	No	Institution/Organization
1	Ministry of Environment	25	Freetown City Council (FCC)
2	Ministry of Health and Sanitation	26	Councillor - Ward 415

3	Ministry of Energy	27	Parliamentarian - Constituency 119
4	Ministry of Trade and Industry	28	Sierra Leone Association of Non-Governmental Organizations
5	Ministry of Fisheries and Marine Resources	29	Native Consortium and Research Centre (NCRC)
6	Ministry of Lands, Housing and Country Planning	30	Conservation Society Sierra Leone (CSSL)
7	Ministry of Water Resources	31	Friends of the Earth Sierra Leone (FESL)
8	Environment Protection Agency, Sierra Leone (EPA-SL)	32	Environmental Foundation for Africa - Sierra Leone (EFA-SL)
9	Electricity Distribution and Supply Authority (EDSA)		**Project Neighbors**
10	Electricity Generation and Transmission Authority (EGTC)	33	National Petroleum (SL) Limited
11	Guma Valley Water Company (GVWC)	34	Total (SL) Limited
12	Sierra Leone Water Company (SALWACO)	35	Petro Jetty
13	Electricity and Water Regulator Commission (EWRC)	36	AfriGas (SL) Limited
14	National Water Resources Management Agency (NWRMA)	37	Magram Water Company
15	Sierra Leone Ports Authority (SLPA)	38	Sierra Fishing Company
16	Sierra Leone Meteorological Agency	39	All Petroleum Product Limited
17	Sierra Leone Maritime Administration	40	Islamic Mission School and Clinic Facility adjacent Project
18	Sierra Leone Police (SLP)	41	Government Independent Memorial Secondary School
19	National Fire Force (NFF)	42	German Technical Academy
20	West Africa Regional Fisheries Programme	43	Sir Winston-Churchill International Secondary School
21	Sierra Leone Standards Bureau	44	Occupant of former Bollore Compound - adjacent Project Site
22	Climate Change Secretariat	45	Residences adjacent Project Site
23	Statistics Sierra Leone	46	Fomel Industries and National Industrialisation Centre (FINIC) Kissy Industries
24	Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone		

Results of the Stakeholder Engagement During the Scoping Stage

Focus Group Discussions results are shown in the table below.

Category	Date and Venue	Purpose of Engagement	Key Observations/Outcomes
Focus Group Discussion			
Key community stakeholders **Participants:** Councillors Area chiefs Religious leaders Youth leaders Disable community Women's leaders Political party representatives.	**17/08/2020** Kissy Dockyard Community (Councillor Bintu's house)	To notify them about the Project and the ESHIA update. To acquire in-depth information on community issues that should be considered by the project and the ESHIA process. To provide guidance on how to conduct the ESHIA especially with regards to cultural and other sensitive issues.	There were thirteen participants (9 male and 4 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project and pledge to provide support where needed. They believe that the operations of the project will contribute to boost local business in terms of electricity supply • They expressed dissatisfaction over the compensation package that wasn't paid for the remaining year(s) for the Project Affected People (PAPs). • They expressed concern about noise and air pollution that will be generated from the operations of the company especially those in close proximity to the project site. • They requested CECA should consider locals within the community for employment particular for unskilled labour. • They stated that the movement of CECA vehicles will likely contribute to further degradation of the roads in the area and therefore requested that CECA provide support to rehabilitate the roads in the community. **Activities suggested for the CDAP:** • Support to health (Construction of a health centre) • Support to road rehabilitation

Category	Date and Venue	Purpose of Engagement	Key Observations/Outcomes
			• Support to education and skill training
Youth Group **Participants:** Youth men and women	**17/08/2020** In front of CECA compound	To notify them about the Project and the ESHIA update. To get their own perspective as youths about the project and to understand their major concerns in the community.	There were sixteen participants in total (14 male and 2 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project and expressed their commitment to provide support where needed. • They are concern about impacts of noise and air pollution that will be generated form the operations of the company especially for those living closer to the project site. • They are expected to benefit from the project in the area of employment opportunities and particularly requested CECA to prioritise the youths. • They are also keen to know when the project implementation will commence. • They requested CECA to support in rehabilitating the roads within the community. **Activities suggested for the CDAP:** • Support to health (Construction of a health centre) • Support to road rehabilitation • Support to education and skill training
Mix Group **Participants:** Community authorities	**18/08/2020** South road (Kissy Dock Yard)	To notify them about the Project and the ESHIA update. To acquire in-depth information on community issues that should be considered by	There were twenty-three participants (7 male and 16 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project since 2015.

Category	Date and Venue	Purpose of Engagement	Key Observations/Outcomes
Young and old people Disable community		the project and the ESHIA process. To have a further understanding of the socio-economic settings and issues within the community.	• Impacts of noise and air pollution that will be generated from the operation of the company was a general concern. • Community members complained that they haven't been given job opportunities by other existing companies and requested CECA should consider locals within the community for employment particularly for unskilled labour. • Some of the community members also suggested that CECA should directly engage the local community members to give them an opportunity expressed their genuine concerns/constrain. • Community members are keen to know when the project implementation will commence. • Movement of CECA vehicles will possibly add to further degradation of the roads in the community and therefore requested the support of CECA in the rehabilitation of the roads. **Activities suggested for the CDAP:** • Support to road rehabilitation. • Support to education (Construct primary school). • Micro-finance support to business people.

The table below shows Interviews/Meeting results.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
Abdala Abdelgani Medical Centre	**15/08/2020** Clinic facility	Mariatu Moseray **In-charge**	The purpose is to notify health centre authorities about the project and to obtain information on the health status of the community and also understand the potential health impacts of the project from a health expert perspective. **Comments and concerns:** • There is no public health centre in the community and the only one present is a mission owned which constrained with insufficient water supply and lack of building infrastructures. • The common sicknesses prevalent in the community are Malaria, Typhoid and high blood pressure. Malaria and Typhoid are mainly caused by mosquito bite and consumption of contaminated water or food. While high blood pressure is mostly associated with aging. • The major health related concern for the project would be air and noise pollution which can cause respiratory diseases and hearing deformities with prolong exposure to pollutant sources.
Government Independence Secondary School	**15/08/2020** School Compound	Alhassan Mamoud **Principal**	Government Independent Secondary School is approximately 250m from the project site. It is therefore important to engage the school authorities to inform them about the project; understand the general status of the educational facilities within the community and to obtain concerns they might have relating to the project. **Comments and concerns:** • Most schools in the project area are government and government assisted schools. • Some of the challenges in the schools are lack of electricity, unequipped libraries, water shortage and computer labs etc. • Electrical fault, noise and air pollution are major concerns about the project that will potentially affect schools. • Expected benefits are access to electricity, support to education and road rehabilitation.
Sierra Leone Parliament	**16/08/2020** Residence	Hon. Wurroh T. Jalloh	The Project site falls within Constituency 119 in Kissy community which is the most populated area in the entire Western Area Urban.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
		Member of Parliament (Constituency 119)	The consultation was held with the MP for constituency 119 to brief him about the project and inform him about the ESHIA process and obtain any concerns may regarding the project. The MP is also member of the parliamentary oversight committee on environment on was important to seek guidance on key issues/factors to consider particularly with regards to legislative provisions relevant to the project. **Comments and concerns:** • Petty trading is the major livelihood activity within the community. • Education challenges are inadequate class rooms and learning materials. • There is no market and public health centre. • Guma Valley Water Company is the main provider of water within the community but there are still faced some challenges. • There are wastes collectors (FCC) within the community but there are general challenges on waste management. • There is access to electricity within the community but there are issues with voltage fluctuation. • Noise and air pollution are major concerns about the project that will potentially affect residents within the community. • Access to electricity, job creation, improve local business are expected benefits from the project. • Key social issues to be considered in the CDAP are support to education, health care and construction of market. • The MP emphasised that CECA should consider and prioritise locals within the community for job opportunities.
Freetown City Council	**16/08/2020** Resident	Bintu D. Konjor **Councillor** (Ward 415)	The Project site falls within Ward 415 in Kissy community which is the most populated area in the entire Western Area Urban. The local council is the highest political authority in the locality and have legislative and executive powers to exercise in accordance with the local government Act of 2004 or any other enactment. The council is also responsible to promote development within the community and the welfare of the

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			people with the resources at its disposal and with such resources and capacity as it can mobilise from the central government and its agencies, national and international organisations, and the private sector. The councillor is responsible to: a) Maintain close contact with his ward or chiefdom, consult the electorate on issues to be discussed in the local council and collate their views, opinions and proposals for that purpose, and present them to the local council; b) Report to the electorate the decisions of the Council and the actions he has taken to solve problems or deal with issues raised by the electorate; and c) Promote communal and other development activities in the locality. **Comments and concerns:** • Petty trading is the major livelihood activity within the community. • Education challenges are inadequate class rooms and learning materials. • There is no market and public health centre. • Guma Valley Water Company is the main provider of water within the community but supply is limited and there is need for water tanks in some parts of the community to help supply areas without reach. • There are wastes collectors (MASADA and FCC) within the community but there are general challenges on waste management. • There is access to electricity within the community but there are issues with voltage fluctuation. • CARITAS and GOAL are the few NGOs operating the community but mostly provide their support to disaster response. • Noise and air pollution are major concerns about the project that will potentially affect residents within the community. • Access to electricity, job creation, improve local business are expected benefits from the project.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• Key social issues to be considered in the CDAP are support to education, health care and construction of market. • The MP emphasised that CECA should consider and prioritise locals within the community fir job opportunities.
Sierra Leone Police	**19/08/2020** Shell police post	Neneh Koroma **Officer in Charge** (Shell Police post) Kallay Kargbo **Admin Officer**	Shell police post was consulted because they are within the project area of influence approximately within 100m from the project site. Issues of community safety and security is one of the key responsibilities of the police. Therefore, the police were consulted to understand security status and concerns within the community. **Comments and concerns:** • Assault, larceny, pickpockets are the common crimes prevalent within the community. • The men are mostly the culprit of these crimes. • Generally, crime rate has reduced due to pro-activeness of police. However, crimes are mostly reported during festive seasons. • There is no vehicle or any form of mobility to ease the work of police personnel. • The Shell police post are not aware about CECA and the project but pledged their support where needed. • Access to electricity, provision of clean water, job creation, improve local business are expected benefits from the project. • They anticipate that the project will lead to influx of workers and this will add to their responsibilities especially in the area of security.
Sir Winston Churchill Secondary School	**19/08/2020** School Compound	Abdul Frederick Sesay Principal and Proprietor	Sir Winston Churchill Secondary School is approximately less than 100m from the Project Site and the only private secondary school within the delineated 500m study area. It is therefore important to engage the school authorities to inform them about the project; understand the general status of the educational facilities within the community and to obtain concerns they might have relating to the project. **Comments and concerns:** • Most schools in the project area are government and government assisted schools.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organization	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• Some of the challenges in the schools are lack of electricity, unequipped libraries, water shortage and computer labs etc. • Electrical fault, noise and air pollution are major concerns about the project that will potentially affect schools. • Expected benefits are access to electricity, support to education and road rehabilitation.

Appendix I: Topographic Survey Report

TOPOGRAPHIC SURVEY REPORT

December 2020

Western Area Power Generation Project
CEC Africa (Sierra Leone)

Prepared by
INTEGEMS

Integrated Geo-information and
Environmental Management Services Limited

1 RESULTS FROM SITE TOPOGRAPHIC SURVEY

1.1 Stormwater Discharge Pipeline Row

The proposed stormwater discharge pipeline ROW starts from the site drains east of the site entrance through a drainage channel which empties into a broken drainage channel along the roadside just outside the site gate. The route follows the channel along South Road, passing in front of squatter buildings and traversing a road by FINNIC fence to as far as Parsonage Street/south Road junction where it branches off in two directions left and right.

The portion on the left runs along Parsonage Street for about 100 m and bends left to feed in the Wellington Creek through Independence school compound. The other link crosses the main entrance of AfriGas and feeds into the drainage channel from NP's first security post. The route continues parallel to AfriGas fence to as far as the second NP security post from where it branches off right to feed into the wellington creek through a very steep slope and vegetable gardens. An indicative route map is shown in **Figure 1-1**, and critical features along the route are shown below.

Point ID:	SDP 01	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.192004	8.476611
Description:	• The stormwater route will collect stormwater from CECA-SL site and passes by the security post at CECA-SL main gate. • The link feeds into the local drainage network outside of the fence. There is no existing drainage network on site.	

Point ID:	SDP 02	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.192035	8.476769
Description:	• The route collects water from the site and passes along this path which is mostly occupied by fuel tankers. • The land surface is bare and covered by laterite with some broken open drains. • There is no critical facility along the route.	

Point ID:	SDP 03	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.191982	8.476869
Description:	• There is old drainage on this portion that feeds into the remaining local drainage channel. • The link crosses the entrance of Magram compound at a distance of about 10 m to the gate. • The surface of the driveway is concrete. • No critical facility is found along the path.	

Point ID:	SDP 04	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.191094	8.477180
Description:	• The route continues to along the drainage network and passes in front of residential buildings where the drainage network has been constructed. • The surface is covered with concrete to direct stormwater along the channel.	

Point ID:	SDP 05	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.189856	8.477241
Description:	• The route continues along the existing drainage path and crosses Queen Elizabeth Road at FINNIC. • Local drainage has been clogged with debris materials. • There are potholes on the road.	

Point ID:	SDP 06	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188381	8.477299
Description:	• The link by SALWACO fence passes through the local drainage and continues to the junction at South Road/Personage Street. • The drain is occupied with stagnant water due to blockages	

Point ID:	SDP 07	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187860	8.476965
Description:	• The stormwater link from the site will split left and right at South Road/Personage Street junction. • The link along Personage Street passes along the fence. • The road is covered with laterite.	

Point ID:	SDP 08	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188127	8.476772
Description:	• The route continues in front of a gate to the end of the link on Personage Street where it branches off to the left and feed into Independence School compound.	

Point ID:	SDP 09	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188352	8.476515
Description:	• The point around the residential area where the route branches off on the left to feed into Independence School compound.	

Point ID:	SDP 10	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188112	8.476234
Description:	• Independence school compound crossing vegetable garden closer to the fence. • The route will pass through the fence from Personage Street through the compound and to the fence by the water tank pillar towards the wellington creek.	

Point ID:	SDP 11	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187889	8.476169
Description:	• Back of independence school from where the route will pass unto the wellington creek. • There are patches of vegetation in the vicinity. • There is an access road (footpath) immediately by the fence that is widely used by the Pipeline Community.	

Point ID:	SDP 12	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187861	8.476029
Description:	• A steep slope that runs down to the creek with some rocky surfaces. • Significant vegetation present.	

Point ID:	SDP 13	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187512	8.475885
Description:	• The terminal point of the stormwater discharge point into the wellington creek (upstream). • The area is predominantly occupied with vegetable gardens.	

Point ID:	SDP 14	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187732	8.477158
Description:	• South Road/Personage Street Junction that branches off towards NP gate. • The road surface is bare, with laterite.	

Point ID:	SDP 15	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187569	8.477302
Description:	• Stormwater route measured at 10 meters along the main access road to AfriGas gate. • The link crosses the main access road to AfriGas with mud surface. • There is an existing drainage network closer to AfriGas gate, but the link does not follow the path.	

Point ID:	SDP 16	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187498	8.477343
Description:	• Stormwater route measured at 10 meters along the main access road to NP's first gate. • The land has a concrete surface. • The security post lies critical to the vicinity, and the road is busy most times of the day. • There is an existing drainage network closer to the gate, although it does not continue outside of the gate.	

Point ID:	SDP 17	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.186843	8.477807
Description:	• Stormwater route from NP security post two along AfriGas fence. • There is an established drainage network on the link.	

Point ID:	SDP 18	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.186508	8.478216
Description:	• The stormwater route along the main access road entering NP's second gate • The land is a concrete surface • The security post lies critical to the vicinity, and the road is busy for most times of the day • There is an existing drainage network closer to the gate which accommodates the current stormwater load from the first gate but terminates before reaching this point.	

Point ID:	SDP 19	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.186216	8.478249
Description:	• Stormwater route measured at 2 meters close to the main entrance gate at NP • Patches of vegetation present • Old decommissioned pipes and tanks are within the vicinity. • The land is a level slope 2 m intervals were taken for the elevation	

Point ID:	SDP 20	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.186116	8.478187
Description:	• The route passes close to the security observation unit mounted on four pillars • Huge boulders are found within the vicinity. • No concrete floor • Patches of vegetation present.	

Point ID:	SDP 21	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.185986	8.478090
Description:	• Near NP fence towards Wellington Creek. • Patches of vegetation present. • No critical facility found. • The land is rocky and steep in slope.	

Point ID:	SDP 22	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.185867	8.478013
Description:	• Stormwater route outside NP fence through vegetable gardens to Wellington creek (downstream)	

Point ID:	SDP 23	
Name:	Stormwater Discharge Pipeline	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.185435	8.477748
Description:	• The point where the stormwater empties into the Wellington Creek (downstream) via NP compound.	

Figure 1-1: Map Showing Stormwater Discharge Pipeline Row

1.2 LPG Pipeline RoW

The proposed LPG pipeline would originate at Petro-Jetty's facilities and follows an independent route that would run parallel to Total's Pipeline for approximately 200 m, where it diverges at about 90 degrees close to NP's LPG bullets. Thereafter, the pipeline would follow the RoW along the perimeter fence between NP and Total to the point branching off and entering the APP's compound.

The line would continue maintaining 3 m ROW along the perimeter fence to as far as near the main entrance to APP facility where it crosses the road. The route would thereafter follow the established RoW back of the building located near the main entrance where it branches slightly right to meet the corner of the fence intersecting the area where MASADA's temporary waste holding site is currently located in the outside.

The pipeline then crosses Factory Road to meet Africa Terminal's fence at its corner and running through to hit CECA-SL fence where it will terminate in the proposed facility. An indicative route map is shown in **Figure 1-2**, and critical features along the route are shown below.

Point ID:	LPG 01	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187486	8.482197
Description:	• The LPG utility pipeline runs from Petro-Jetty Abutment Area • Petro-Jetty's administrative building, pipeline and other ancillary infrastructure are present. • A septic tank is also located in this area.	

Point ID:	LPG 02	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188030	8.481961
Description:	• The pipeline follows an independent route parallel to Total's pipelines through a lower ground level to the corner of the fence separating NP and Total. • There is no major obstacle on this route; only wire mesh fence is traversed along the route. • No significant vegetation is encountered on this route.	

Point ID:	LPG 03	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188873	8.481357
Description:	• The point at the fence after the LPG bullets in NP where the pipeline takes a bend to the left. • The route follows AfriGas LPG pipeline and runs parallel to the fence.	

Point ID:	LPG 04	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188634	8.481121
Description:	• Empty LPG canisters are found along the way to meet the junction where it will branch off into APP compound.	

Point ID:	LPG 05	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.188386	8.480862
Description:	• The pipeline will cross a gate to Total's compound. • LPG pipeline has been buried at this point by AfriGas	

Point ID:	LPG 06	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187932	8.480245
Description:	• The route branches into APP compound and follows a 3 m ROW from the fence • The relatively dense vegetation of mostly savanna grass is found on this portion. • Brushing has already begun at some portion along this route.	

Point ID:	LPG 07	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.187587	8.479253
Description:	• The route continues along the 3 m ROW as indicated on the signpost.	

Point ID:	LPG 08	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.191216	8.477680
Description:	• The route crosses the road at the main entrance into APP facility. • The route crosses major drainage that has been constructed at APP site. • No significant vegetation is encountered. • The route runs through APP compound along an established ROW to the point immediately at the back of the temporary waste holding site constructed by MASADA.	

Point ID:	LPG 09	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.192316	8.476878
Description:	• Masada waste collection point where the route crosses Factory Road towards Africa Terminal's fence.	

Point ID:	LPG 11	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.192325	8.476609
Description:	• The Pipeline paste by Africa Terminal's fence through gathering point ('*Long Bench*') and goes through the fence into CECA-SL compound. • Many youths, mostly unemployed converge at this point to spend leisure time, and relocation of this point requires community engagement.	

Point ID:	LPG 12	
Name:	LPG Pipeline Route	
GPS Coordinates:	**Longitude**	**Latitude**
	-13.192218	8.476420
Description:	• The point within CECA-SL compound where the LPG pipeline terminates. • Vegetable gardens are present.	

Figure 1-2: Map Showing LPG Utility Pipeline RoW

1.3 Outfall Discharge Row

The proposed outfall discharge ROW would originate from Petro-Jetty's distribution network located in the abutment area and runs through to hit outside of the wire mesh fence. The line will take a bend right for about 10 m and then continues straight to the back of the security post at the entrance of the old Kissy Oil Refinery jetty.

The route then continues through rugged terrains and terminates in the Wellington Creek. An indicative route map is shown in **Figure 1-3**. Critical features along the route are shown below.

Point ID	ODP 01	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.187385	8.482193
Description	• Discharge pipe route within Petro Jetty • Total and NP pipes identified within Petro Jetty	

Point ID	ODP 02	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.187223	8.482165
Description	• Discharge pipe route cut across access to the ocean from Petro Jetty	

Point ID	ODP 03	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.187133	8.482152
Description	• Discharge pipe route within Petro Jetty compound • Several critical facilities identified within Petro Jetty	

Point ID	ODP 04	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.186976	8.481854
Description	• Discharge pipe route diverted from the main road at NP to the fence at petro jetty • A slight change in slope was observed with vegetation present	

Point ID	ODP 05	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.186825	8.481784
Description	• Discharge pipe route close to petro jetty • Vegetation identified along the route	

Point ID	ODP 06	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.186000	8.481408
Description	• Discharge pipe route back of security post at the old jetty • The route continues to the Petro Jetty	

Point ID	ODP 07	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185911	8.481403
Description	• Discharge pipe route cut across the old jetty entrance and along the security post • Several pipes identified	

Point ID	ODP 08	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185911	8.481403
Description	• Close to the old jetty showing damage structures	

Point ID	ODP 09	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185657	8.481089
Description	• Path close to the old jetty • Damage pipes and slippers identified along the pipe	

Point ID	ODP 09	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185657	8.481089
Description	• Path close to the old jetty • Damage pipes and slippers identified along the pipe	

Point ID	ODP 10	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185386	8.480604
Description	• The path along NP fence leading to the old jetty • Old pipes identified along the route	

Point ID	ODP 09	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185657	8.481089
Description	• Path close to the old jetty • Damage pipes and slippers identified along the pipe	

Point ID	ODP 11	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Easting**	**Northing**
	-13.185284	8.480417
Description	• The path along the fence leading to the old jetty • Damage slippers along the fence identified	

Point ID	ODP 12	
Name	Outfall Discharge Pipeline Route	
Coordinates	**Longitude**	**Latitude**
	-13.185282	8.480393
Description	• Close to NP boundary with the Wellington Creek • There is a cliff from the fence inward to the main road at NP • No critical infrastructure identified • Patches of vegetation present	

<table>
<tr><td>Point ID</td><td colspan="2">ODP 13</td></tr>
<tr><td>Name</td><td colspan="2">Outfall Discharge Pipeline Route</td></tr>
<tr><td rowspan="2">Coordinates</td><td>Longitude</td><td>Latitude</td></tr>
<tr><td>-13.185236</td><td>8.480376</td></tr>
<tr><td>Description</td><td colspan="2">• Close to NP boundary with the Wellington Creek
• There is a cliff from the fence inward to the main road at NP
• No critical infrastructure identified
• Patches of vegetation present</td></tr>
</table>

Figure 1-3: Map Showing Outfall Discharge Pipeline Row

Integrating innovative Geographic Information Systems (GIS) and remote sensing technologies with geo-information, environmental management and research expertise and experience to effectively and efficiently respond to socio-economic, environmental and natural resources management challenges and opportunities

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Appendix J: Stakeholder Consultations and Key Observations

DRAFT SUMMARY OF STAKEHOLDER CONSULTATIONS AND ENAGAGEMENTS

CECA SL GENERATION PROJECT

Objectives

The main objectives for stakeholder engagement are:

- To inform the relevant stakeholders about the proposed project
- To capture views and concerns of the relevant stakeholders with regard to the proposed project;
- To enhance ownership of the project within the host community;
- To provide a basis for stakeholder participation in the ESHIA process.

Project Stakeholders

We have identified the key stakeholder groups and analyses how they are likely to be affected by the project. These include persons or groups institutions and business who:

- Are directly and/or indirectly affected by the project;
- Have "interests" in the project;
- Have the potential to influence the project outcomes operations.

Stakeholders Engagement Methods

The stakeholder engagement methods that have been used include qualitative methods such as key informant interviews, community meetings and focused group discussions, consultation letters and formal meetings. A key informant guide was developed and this was used during stakeholder consultations/engagements. A summary Project Information Document (PID) was also distributed to the stakeholders with a feedback report sheet for stakeholders to provide written feedback and comments. This was done to provide an opportunity for stakeholders who cannot participate in the meetings, to give them extra time to review the documentation and to adequately research and document their position. this was also helpful in adhering to COVID-19 measures and restrictions.

Notification letters have been sent and consultation meetings, interviews and focus group discussions have been undertaken with the local communities, and some of the MDAs who were available. Other stakeholders will be engaged as they become available. An attendance sheet is provided in the meetings to document attendance.

Table 1: The list of stakeholders who have been identified and notified are listed below:

No	Institution/Organization	No	Institution/Organization
1	Ministry of Environment	28	Sierra Leone Association of Non-Governmental Organisations
2	Ministry of Health and Sanitation	29	Native Consortium and Research Centre (NCRC)
3	Ministry of Energy	30	Conservation Society Sierra Leone (CSSL)
4	Ministry of Trade and Industry	31	Friends of the Earth Sierra Leone (FESL)
5	Ministry of Fisheries and Marine Resources	32	Environmental Foundation for Africa - Sierra Leone (EFA-SL)
6	Ministry of Lands, Housing and Country Planning		**Project Neighbours**
7	Ministry of Water Resources	33	National Petroleum (SL) Limited
8	Environment Protection Agency, Sierra Leone (EPA-SL)	34	Total (SL) Limited
9	Electricity Distribution and Supply Authority (EDSA)	35	Petro Jetty
10	Electricity Generation and Transmission Authority (EGTC)	36	AfriGas (SL) Limited
11	Guma Valley Water Company (GVWC)	37	Magram Water Company
12	Sierra Leone Water Company (SALWACO)	38	Sierra Fishing Company
13	Electricity and Water Regulator Commission (EWRC)	39	All Petroleum Product Limited
14	National Water Resources Management Agency (NWRMA)	40	Islamic Mission School and Clinic Facility adjacent Project
15	Sierra Leone Ports Authority (SLPA)	41	Government Independent Memorial Secondary School
16	Sierra Leone Meteorological Agency	42	German Technical Academy
17	Sierra Leone Maritime Administration	43	Sir Winston-Churchill International Secondary School
18	Sierra Leone Police (SLP)	44	Occupant of former Bollore Compound - adjacent Project Site
19	National Fire Force (NFF)	45	Residences adjacent Project Site
20	West Africa Regional Fisheries Programme	46	Fomel Industries and National Industrialisation Centre (FINIC) Kissy Industries
21	Sierra Leone Standards Bureau		
22	Climate Change Secretariat		
23	Statistics Sierra Leone		
24	Institute of Marine Biology and Oceanography, Fourah Bay College, University of Sierra Leone		
25	Freetown City Council (FCC)		
26	Councillor - Ward 415		
27	Parliamentarian - Constituency 119		

Results of the Stakeholder Engagement During the Scoping Stage

Focus Group Discussions

<table>
<tr><th>Category</th><th>Date and Venue</th><th>Purpose of Engagement</th><th>Key Observations/Outcomes</th></tr>
<tr><td colspan="4">FOCUS GROUP DISCUSSION</td></tr>
<tr><td>Key community stakeholders

Participants:
Councillors
Area chiefs
Religious leaders
Youth leaders
Disable community Women’s leaders
Political party representatives.</td><td>17/08/2020
Kissy Dockyard Community
(Councillor Bintu’s house)</td><td>To notify them about the Project and the ESHIA update.
To acquire in-depth information on community issues that should be considered by the project and the ESHIA process.
To provide guidance on how to conduct the ESHIA especially with regards to cultural and other sensitive issues.</td><td>There were thirteen participants (9 male and 4 female).
Comments and concerns are as follows:
• Majority of those present confirmed that they are aware of the project and pledge to provide support where needed. They believe that the operations of the project will contribute to boost local business in terms of electricity supply
• They expressed dissatisfaction over the compensation package that wasn’t paid for the remaining year(s) for the Project Affected People (PAPs).
• They expressed concern about noise and air pollution that will be generated from the operations of the company especially those in close proximity to the project site.
• They requested CECA should consider locals within the community for employment particular for unskilled labour.
• They stated that the movement of CECA vehicles will likely contribute to further degradation of the roads in the area and therefore requested that CECA provide support to rehabilitate the roads in the community.
Activities suggested for the CDAP:</td></tr>
</table>

Category	Date and Venue	Purpose of Engagement	Key Observations/Outcomes
			• Support to health (Construction of a health centre) • Support to road rehabilitation • Support to education and skill training
Youth Group **Participants:** Youth men and women	**17/08/2020** In front of CECA compound	To notify them about the Project and the ESHIA update. To get their own perspective as youths about the project and to understand their major concerns in the community.	There were sixteen participants in total (14 male and 2 female). **Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project and expressed their commitment to provide support where needed. • They are concern about impacts of noise and air pollution that will be generated form the operations of the company especially for those living closer to the project site. • They are expected to benefit from the project in the area of employment opportunities and particularly requested CECA to prioritise the youths. • They are also keen to know when the project implementation will commence. • They requested CECA to support in rehabilitating the roads within the community. **Activities suggested for the CDAP:** • Support to health (Construction of a health centre) • Support to road rehabilitation • Support to education and skill training
Mix Group	**18/08/2020**	To notify them about the Project and the ESHIA update.	There were twenty-three participants (7 male and 16 female).

Category	Date and Venue	Purpose of Engagement	Key Observations/Outcomes
Participants: Community authorities Young and old people Disable community	South road (Kissy Dock Yard)	To acquire in-depth information on community issues that should be considered by the project and the ESHIA process. To have a further understanding of the socio-economic settings and issues within the community.	**Comments and concerns are as follows:** • Majority of those present confirmed that they are aware of the project since 2015. • Impacts of noise and air pollution that will be generated from the operation of the company was a general concern. • Community members complained that they haven't been given job opportunities by other existing companies and requested CECA should consider locals within the community for employment particularly for unskilled labour. • Some of the community members also suggested that CECA should directly engage the local community members to give them an opportunity expressed their genuine concerns/constrain. • Community members are keen to know when the project implementation will commence. • Movement of CECA vehicles will possibly add to further degradation of the roads in the community and therefore requested the support of CECA in the rehabilitation of the roads. **Activities suggested for the CDAP:** • Support to road rehabilitation. • Support to education (Construct primary school). • Micro-finance support to business people.

Interviews/ Meetings

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
Abdala Abdelgani Medical Centre	**15/08/2020** Clinic facility	Mariatu Moseray **In-charge**	The purpose is to notify health centre authorities about the project and to obtain information on the health status of the community and also understand the potential health impacts of the project from a health expert perspective. **Comments and concerns:** • There is no public health centre in the community and the only one present is a mission owned which constrained with insufficient water supply and lack of building infrastructures. • The common sicknesses prevalent in the community are Malaria, Typhoid and high blood pressure. Malaria and Typhoid are mainly caused by mosquito bite and consumption of contaminated water or food. While high blood pressure is mostly associated with aging. • The major health related concern for the project would be air and noise pollution which can cause respiratory diseases and hearing deformities with prolong exposure to pollutant sources.
Government Independence Secondary School	**15/08/2020** School Compound	Alhassan Mamoud **Principal**	Government Independent Secondary School is approximately 250m from the project site. It is therefore important to engage the school authorities to inform them about the project; understand the general status of the educational facilities within the community and to obtain concerns they might have relating to the project. **Comments and concerns:** • Most schools in the project area are government and government assisted schools. • Some of the challenges in the schools are lack of electricity, unequipped libraries, water shortage and computer labs etc.

<table>
<tr><th colspan="4">KEY INFORMANT INTERVIEWS/MEETINGS</th></tr>
<tr><th>Organisation</th><th>Date and Venue</th><th>Participants</th><th>Key Observations/Outcomes</th></tr>
<tr><td></td><td></td><td></td><td>Electrical fault, noise and air pollution are major concerns about the project that will potentially affect schools.
Expected benefits are access to electricity, support to education and road rehabilitation.</td></tr>
<tr><td>Sierra Leone Parliament</td><td>16/08/2020
Residence</td><td>Hon. Wurroh T. Jalloh
Member of Parliament (Constituency 119)</td><td>The Project site falls within Constituency 119 in Kissy community which is the most populated area in the entire Western Area Urban.
The consultation was held with the MP for constituency 119 to brief him about the project and inform him about the ESHIA process and obtain any concerns may regarding the project. The MP is also member of the parliamentary oversight committee on environment on was important to seek guidance on key issues/factors to consider particularly with regards to legislative provisions relevant to the project.
Comments and concerns:
Petty trading is the major livelihood activity within the community.
Education challenges are inadequate class rooms and learning materials.
There is no market and public health centre.
Guma Valley Water Company is the main provider of water within the community but there are still faced some challenges.
There are wastes collectors (FCC) within the community but there are general challenges on waste management.
There is access to electricity within the community but there are issues with voltage fluctuation.
Noise and air pollution are major concerns about the project that will potentially affect residents within the community.
Access to electricity, job creation, improve local business are expected benefits from the project.</td></tr>
</table>

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• Key social issues to be considered in the CDAP are support to education, health care and construction of market. • The MP emphasised that CECA should consider and prioritise locals within the community for job opportunities.
Freetown City council	**16/08/2020** Resident	Bintu D. Konjor Councillor (Ward 415)	The Project site falls within Ward 415 in Kissy community which is the most populated area in the entire Western Area Urban. The local council is the highest political authority in the locality and have legislative and executive powers to exercise in accordance with the local government Act of 2004 or any other enactment. The council is also responsible to promote development within the community and the welfare of the people with the resources at its disposal and with such resources and capacity as it can mobilise from the central government and its agencies, national and international organisations, and the private sector. The councillor is responsible to: a) Maintain close contact with his ward or chiefdom, consult the electorate on issues to be discussed in the local council and collate their views, opinions and proposals for that purpose, and present them to the local council; b) Report to the electorate the decisions of the Council and the actions he has taken to solve problems or deal with issues raised by the electorate; and c) Promote communal and other development activities in the locality. **Comments and concerns:** • Petty trading is the major livelihood activity within the community. • Education challenges are inadequate class rooms and learning materials. • There is no market and public health centre. • Guma Valley Water Company is the main provider of water within the community but supply is limited and there is need for water tanks in some parts of the community to help supply areas without reach.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• There are wastes collectors (MASADA and FCC) within the community but there are general challenges on waste management. • There is access to electricity within the community but there are issues with voltage fluctuation. • CARITAS and GOAL are the few NGOs operating the community but mostly provide their support to disaster response. • Noise and air pollution are major concerns about the project that will potentially affect residents within the community. • Access to electricity, job creation, improve local business are expected benefits from the project. • Key social issues to be considered in the CDAP are support to education, health care and construction of market. • The MP emphasised that CECA should consider and prioritise locals within the community fir job opportunities.
Sierra Leone Police	**19/08/2020** Shell police post	Neneh Koroma **Officer in Charge** (Shell Police post) Kallay Kargbo **Admin Officer**	Shell police post was consulted because they are within the project area of influence approximately within 100m from the project site. Issues of community safety and security is one of the key responsibilities of the police. Therefore, the police were consulted to understand security status and concerns within the community. **Comments and concerns:** • Assault, larceny, pickpockets are the common crimes prevalent within the community. • The men are mostly the culprit of these crimes. • Generally, crime rate has reduced due to pro-activeness of police. However, crimes are mostly reported during festive seasons. • There is no vehicle or any form of mobility to ease the work of police personnel.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			• The Shell police post are not aware about CECA and the project but pledged their support where needed. • Access to electricity, provision of clean water, job creation, improve local business are expected benefits from the project. • They anticipate that the project will lead to influx of workers and this will add to their responsibilities especially in the area of security.
Sir Winston Churchill Secondary School	**19/08/2020** School Compound	Abdul Frederick Sesay Principal and Proprietor	Sir Winston Churchill Secondary School is approximately less than 100m from the Project Site and the only private secondary school within the delineated 500m study area. It is therefore important to engage the school authorities to inform them about the project; understand the general status of the educational facilities within the community and to obtain concerns they might have relating to the project. **Comments and concerns:** • Most schools in the project area are government and government assisted schools. • Some of the challenges in the schools are lack of electricity, unequipped libraries, water shortage and computer labs etc. • Electrical fault, noise and air pollution are major concerns about the project that will potentially affect schools. • Expected benefits are access to electricity, support to education and road rehabilitation.
National Water Resources Management Agency (NWRMA)	01/09/2020 NWRMA Office, Kingharman Road Freetown	Ishmail Kamara (Manager, Hydrological Services) Eva Boi Mary Jabati (Volunteer, Hydro-Technician	The purpose for engaging the Agency was to formally notify them about the project and to understand the regulatory provisions the project needs to comply with regards to water use. The following are the concerns and comments from NWRMA on the Project: • The Agency would like to know the quantity of water the project intends to use over the life cycle of the project and how CECA intend to abstract the water. • The Agency is keen to receive the report on the baseline water quality analysis undertaken. • CECA-SL is required to apply for water use permit if the project intends to mechanically

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			abstract water for its operations • There was recommendation for CECA to undertake routine ground and sea water quality monitoring during project implementation; and the Agency should be duly informed about such activities.
Sierra Leone Meteorological Agency (SLMet)	08/09/2020 SLMet Office, Charlotte Street, Freetown	Gabriel Kpaka (Deputy Director-General)	The purpose of engaging SLMet is to seek their expertise in areas of weather forecast, climate-related issues and solicit their comments and concern on the project. Mr Kpaka expressed satisfaction with the project for shifting away from HFO to a less environmentally harmful substance (LPG/LNG). However, he expressed concerns on the negative environmental impact of the Project on specifically air quality and the release of greenhouse gasses from combustion engines. He requested for a detailed description/specification of the LPG/LNG products that will be used and the potential greenhouse gasses that will be flared. He expressed willingness to share historical climate data.
Ministry of Water Resources (MWR)	08/09/2020 MWR Office, 127 Kuku Drive, Off Jomo Kenyatta Road, Freetown	Shaka Musa (Personal Assistant to the Honorable Minister)	Mr Musa acknowledges receipt of the ESHIA notification letter addressed to the Minister but however stated that the latter had been minuted to NWRMA for action.
Artisanal Fishing Group	09/09/2020 Crab Town, Pipeline Community, Kissy Dockyard, Freetown	Madam Yamborah Kamara (Chief), Sallu Conteh (fisherman), Mohamed Conteh (fisherman-Habourmaster), Idrissa Conteh (fisherman).	The purpose of the engagement was to notify the fishing group in the community about the Project and enquire to understand how the project might affect their fishing activities or how their activities might impact the project. The Crab Town and Pipeline communities falls within 600m away from the project site. The following issues were highlighted from the engagement: • Fishing is one of the livelihood activities in Crab Town and Pipeline communities. However, only six people are engaged in the activity which each of them having one canoe. The group is headed by the Harbourmaster. • The group noted that they fish in the estuary using hook and line with small dug-out canoes. Fishing is mostly done during periods of low tides and on daily basis with weather being an important factor. *Spanish, Mackerel, Kuta, Corel, catfish, Whittie, Lady, Shine nose and*

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
			Cocos are among the fishes mostly caught. • Other boats from Tasso Island, Pepel, Samgblema and Kakum anchors boats docks at the wharf on a weekly basis. • The LPG product that CECA-SL intends to use was perceived as a poisonous gas associated with breathing discomfort to humans. This claim was supported by perception and experience from the current operations of AfriGas in the area. • Concerns were raised about the engagement strategy that will be put in place to prevent interruption of fishing activities by CECA's fuel vessel. The fishermen recommended that CECA provide them with improved engine boats so they can fish far away from the jetty. • Another concern was that CECA vessels will scare the fishes away from the specific areas where they fish. This was considered as a potential negative effect on their livelihood. • The fishermen also raised concerns about the potential for noise pollution from the project. • The fishermen claimed to have a skilled driver, fitter, electrician and bricklayer amongst them and appealed for CECA-SL to provide employment for them. When asked to identify the general needs of the community for CDAP consideration, the participants highlighted the construction of a small crossing bridge, provision of safe drinking water and construction of a health facility and school.
Sand Ground – Ground Committee	10/09/2020 Sand Ground – Kissy Dockyard	Gibril Fofanah Secretary-General Kelfala Ansumana Kamara Financial Secretary	The purpose of the meeting was to notify the sand miners about the project and enquire to understand how the project might affect their sand mining activities or how their activities could affect the project. The sand Ground is about 600m away from the project site. Comments and concerns from the engagement are summarised below: • Mr Fofanah noted that he was engaged during the 2015 ESHIA study on community-related issues and highlighted that sand mining started as far back as 1990 with just 3 boats. The business became highly attractive over time and is a major source of livelihood for many young men living in the community. • The sand ground is managed by different groups including the Ground committee (the highest body that provides supervision to the other sub groups), Sierra Leone United Boats Owners Organisation – Kissy Dockyard Branch, Drivers Union - Kissy Dockyard Branch, and Labour Committee. • Sand is mainly mined across the estuary in Kaffu Bullum Chiefdom and its surroundings. The Miners noted that they work daily except on Fridays and/or during unfavourable weather conditions.

<table>
<tr><th colspan="4">KEY INFORMANT INTERVIEWS/MEETINGS</th></tr>
<tr><th>Organisation</th><th>Date and Venue</th><th>Participants</th><th>Key Observations/Outcomes</th></tr>
<tr><td></td><td></td><td></td><td>Some of their major challenges are insufficient life jackets and bad weather conditions.
They recommended that CECA SL should establish a channel of communication in order to avoid boat collision, adding that, if their operation need to be halted during CCECA vessel reception, they should be adequately compensated.
Expectations from the projects include; provision of scholarship for deserving students, employment of locals, provision of access to pipe-borne drinking water, and provision of motorboats for sand mining.</td></tr>
<tr><td>Guma Valley Water Company</td><td>17/09/2020
Guma Building, Lamina Sankoh Street, Freetown</td><td>Ibrahim C Bah (Planning, Research and Development Manager)</td><td>GVWC is the statutory body established to provide water supply services to Freetown, mainly from the Guma Dam. It is Sierra Leone's largest provider of potable water, and a major stakeholder in the water sector.
GVWC was engaged to understand the water resource context in the study area, as there could be GVWC water utility pipeline within the study area that may be affected by the projects' operation. The company was also engaged to understand the procedure for sourcing water from their pipelines.
Below is a summary of the comment highlighted during the engagement:
GVWC can supply water for the project at least three times a week. However, the Project should make provision for a water storage facility on site. The company enquired about the Project's average water demand for 48 hours.
The proposed desalination plant for water sourcing is viewed as a suitable option if the associated environmental impact relating to the disposal of the brine is addressed in a manner that does not pose harm to marine life.
The company also considers abstracting groundwater as a viable option. However, CECA must be cautious about water recharge potential of the boreholes as the proposed project area average has groundwater average yield of 2.5 - 5.0 m^3 per hour. the company also highlighted the tendency of saltwater intrusion giving that the area is close to the shore.
It was suggested that CECA-SL should consider GVWC and other water suppliers as back-up as it is done at the EGTC facility at Kingtom.
The GVWC welcomes the Project and is willing to provide support.</td></tr>
<tr><td>National Fire Force (NFF)</td><td>17/09/2020</td><td>Mr Sylvester Taluva, Deputy Chief Fire Force</td><td>The NFF is a statutory body established to provide emergency response service, including fire prevention and firefighting to protect civilian lives and property as part of the ESHIA
The Project will develop and implement Emergency Preparedness and Response Plan (EPRP), which should be in line with the standard practises and process of NFF. CECA-SL will include</td></tr>
</table>

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
	NFF Headquarters, AJ Momoh Street, Tower Hill, Freetown		inspection of firefighting equipment and training of site personnel in response to potential explosions and fire outbreak. NFF was engaged to solicit input into the EPRP and to give recommendations for Project design considerations. Comments and concerns from the engagement are summarised below: • NFF Emergency hotline is on Africell. For Western Area the Headquarters (Tower Hill) - 300; Kissy - 302 and Aberdeen - 303. • There is a fire station at Kissy dockyard that is located at the Kissy bye-pass old road, adjacent the Police Station. • The Project should institute a very reliable and efficient fire system that complies with local and international best practice. • NFF is requesting for the Project's site plan to be able to make detailed input based on where hot processes are proposed to be located. • Currently, NFF has a proposed Bill to be enacted in Parliament and later a regulation would be developed. It was suggested that CECA-SL should have its hydrant and fire engine.
Environmental Foundation for Africa (EFA)	18/09/2020 EFA Headquarters, 16 Peninsular Road, Banga Farm, Western Area	Tommy Garneth (Executive Director)	EFA has been in existence for 25 years and its activities amongst others includes; creating awareness among schools, policymakers, etc.; promoting reforestation activities; reclaiming land reformation by mining; protect nature sanctuaries etc. EFA has been broadly involved in the planting of over 2 million trees, the management of natural protected areas and the planting of mangroves and protection of nature sanctuaries. The purpose of the engagement was to notify them about the project and solicit their input on areas of the conservation and protection of richly bio-diverse environment (The SLRE) and to generally discuss the potential effects on the environment • EFA Director is a member of the NWRMA Board • EFA has been indirectly involved in the protection of the SLRE and the Director is a member of the Conservation Trust Fund. • The Director highlighted the need to implement the appropriate mitigation measures that will be proposed for the Project's associated impacts.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
Electricity Generation and Transmission Company (EGTC)	21/10/2020 EGTC Headquarters, Kingtom	Munda M Lewis, Ag. Deputy Director General Harry H Reider, Thermal Generation Manager Milton M Gegbai, Director General	EGTC is responsible for the generation and transmission of electricity and the sale of electricity to the Authority subject to a power purchase agreement approved by the commission. The purpose of the engagement was to notify them about the project and to solicit their comment and concerns on regulatory provisions relevant to the provision. • The EGTC is aware of the project and has been following it progress since the inception. • The Company also has plans to implement similar LNG project at Kingtom and therefore sees the WAPG project as a competition. • The DG perceives the project would be a burden on consumers with potentially high tariff. On the other hand, as a public institution, the EGTC proposed to provide much cheaper cost if they succeed in implementing their project. • The EGTC also expressed interest in partnering with CECA. • The DG expressed concerns regarding the ability of the market to absorb two or more electricity power generation companies. • The DG will have internal engagement with his technical team and will provide additional information and comments as deemed necessary and relevant to the project.
Ministry of Fisheries and Marine Resources			After several attempts to engage the ministry until October 21, 2020, when we met with the PS and other staff. The ministry expressed their willingness to provide support to the ESHIA team and asked to be given a day or two to respond accordingly. We hope to receive their comments and concerns on the project not later than 30 October 2020.
Ministry of Energy			The ministry has been contacted and follow up calls have been made to engage the team. However, it has been very difficult to get the availability of the key technical personnel to engage.

KEY INFORMANT INTERVIEWS/MEETINGS			
Organisation	**Date and Venue**	**Participants**	**Key Observations/Outcomes**
Electricity Distribution and Supply Authority (EDSA)			Several attempts have been made to engage EDSA but it has been difficult to get the available staff. However, a meeting has been scheduled for Monday 2 November, 2020.
Sierra Leone Standards Bureau			Letters have been sent to the Executive Director. Several visits have been made to engage SLSB but none has been fruitful due to unavailability or conflicting schedules. A comment sheet has also been shared with the institution to provide their comments on the project and we hope to receive that by the end of October.
Sierra Leone Maritime Administration			Letters has been sent to SLMA and several visits have been made to engage the officials. Followed up visit will be made next week.

Appendix K: Fuel Specification

AmSpec

Certificate of Analysis

Vessel / Object:	HELLAS FOS (9352963)	**Job No:**	155-19-02350
Location:	Corpus Christi, TX / Buckeye Global Marine Terminals - Texas Hub (United States)	**Date Sampled:**	28 Oct 2019
Job Type:	Load	**Date Tested:**	29 Oct 2019
Product Grade:	Normal Butane	**Version:**	1 / 29 Oct 2019 02:45
Client Reference:	Trafigura Trading LLC / 366114 / 2075396		

Sample	Sample ID, Type & Description
155-19-02350-028	HELLAS FOS Composite After Load

Method	Test	Min	Max	Result	Units
ASTM D2598	LP-Gas Vapor Pressure @37.8°C		70	43	psig
ASTM D1837	Volatility Evaporation @95%		36	33.0	°F
ASTM D2163	LPG Composition by GC				
	Propane			1.29	%vol
	Propylene			< 0.01	%vol
	Butane and Heavier			98.61	%vol
	Pentane and Heavier		2.0	1.62	%vol
	Methane			0.02	%vol
	Ethane			0.08	%vol
	Ethylene			< 0.01	%vol
	Cyclopropane			< 0.01	%vol
	Isobutane			18.96	%vol
	n-Butane			78.02	%vol
	Propadiene			< 0.01	%vol
	Acetylene			< 0.01	%vol
	Trans-2-Butene			< 0.01	%vol
	1-Butene			< 0.01	%vol
	Isobutylene			< 0.01	%vol
	Neopentane			0.36	%vol
	cis-2-Butene			< 0.01	%vol
	Isopentane			1.06	%vol
	n-Pentane			0.19	%vol
	1,2-Butadiene			< 0.01	%vol
	1,3-Butadiene			< 0.01	%vol
	Other C5+			< 0.01	%vol
	C6+			< 0.01	%vol
	Olefins			< 0.01	%vol
ASTM D2158	Residues in LPG, (Oil Stain) (Weathering Test)				
	Residue on Evaporation		0.05	< 0.05	ml
	Oil Stain	pass		Pass	
ASTM D2598	Calculation of Certain Physical Properties of LPG from Compositional Analysis				
	Relative Density at 60/60°F or 15.56/15.56°C			0.5795	
	Density at 15°C			0.5796	kg/l
ASTM D1838	Copper Corrosion Rating (1 hour @ 100°F)		1	1	
ASTM D6667-10	Sulfur		140	8.6	ppmw
ASTM D5623#	Hydrogen Sulfide		0	N.D.	ppmw
ASTM D5454*	Moisture Content			30	ppmv
Visual	Water Content			No Free Water	

Notes: #Method Modification: Result reported on a product outside of the method scope
*Method Modification: Result is reported outside (lower/higher) the scope of the method
Analysis performed by non-AmSpec outside laboratory. AmSpec bears no direct responsibility over the result: D6667

Appendix M: EPC Contractor Scope from Power Engineers

Appendix N: Relevant Data Tables

Appendix Q: LRP-ARAP Update

ABBREVIATED RESETTLEMENT ACTION PLAN (ARAP) COMPENSATION MEETING REPORT

Prepared by:

INTEGEMS

Freetown, Sierra Leone

Prepared for:

GLOBELEQ

GLOBELEQ
POWERING AFRICA'S GROWTH

Freetown, Sierra Leone

March 2018

CONFIDENTIAL INFORMATION DISCLAIMER

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Any recommendations, opinions or findings stated in this Report are based on circumstances and facts as they existed at the time INTEGEMS undertook the assignment. Any changes in such circumstances and facts upon which this Report is based may adversely affect any recommendations, opinions or findings contained in this Report.

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This work has been undertaken in accordance with INTEGEMS' Quality Management System.

Signed by

Julius Mattai

Managing Director

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Approved by:	Julius Mattai
Date:	21 March 2018

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LIST OF ACCRONYMS AND ABBREVIATIONS

ARAP	Abbreviated Resettlement Action Plan
CECA–SL	Copperbelt Energy Corporation Africa – Sierra Leone
CARL–SL	Centre for Accountability and the Rule of Law – Sierra Leone
CSOs	Civil Society Organizations
EPA–SL	Environment Protection Agency – Sierra Leone
ESHIA	Environmental, Social and Health Impact Assessment
HFO	Heavy Fuel Oil
INTEGEMS	Integrated Geo-information and Environmental Management Services
MAFFS	Minister of Agriculture Forestry and Food Security
MDAs	Ministries, Departments and Agencies
MLCPE	Ministry of Lands, Country Planning and the Environment
MLGRD	Ministry of Local Government and Rural Development
MoE	Ministry of Energy
MP	Member of Parliament
PAPs	Project Affected Persons
SLRA	Sierra Leone Roads Authority
SLTU	Sierra Leone Teacher's Union
UK	United Kingdom

1 INTRODUCTION

1.1 Project Background

Copperbelt Energy Corporation Africa–Sierra Leone (CECA–SL) Generation Ltd has proposed the development of a Heavy Fuel Oil (HFO) Power Generation Plant on a site in Kissy Dockyard, Freetown, Sierra Leone[1]. CECA-SL Power Generation Ltd contracted Integrated Geo-information and Environmental Management Services (INTEGEMS) to provide general support service to GLOBELEQ in connection with the Livelihood Restoration Plan (LRP) components of the Environmental and Social Impact Assessment (ESIA) that was conducted by Jacobs Consultancy and INTEGEMS in 2013-2016.

The objective of the Livelihood Restoration Plan is to restore and improve the livelihoods of project affected persons by providing compensation at full replacement cost including strategies in terms of skill trainings which would improve future income, ensuring they are implemented with appropriate disclosure of information, consultation and the informed participation of those affected. This involves disclosure to key stakeholders and subsequent feedback and inputs.

1.2 Summary of the Abbreviated Resettlement Action Plan (ARAP)

The ARAP was prepared in accordance with the World Bank Safeguard Policy; Social and Environmental Assessment and Management Systems (PS1); Land Acquisition and Involuntary Resettlement (PS5) Community Health, Safety and Security (PS4) and the national laws and legislative framework of Sierra Leone: The Constitution of Sierra Leone, 1991; Environment Protection Act (EPA) 2008/2010; and the National Land Policy 2015.

As required by these policies, an Abbreviated Resettlement Action Plan (ARAP) was prepared through a consultative process with the Project Affected Persons (PAPs) and their representatives, Ministry of Agriculture Forestry and Food Security (MAFFS) and Local authorities in the community.

The ARAP provides the profiles of 13 PAPs who were engaged in artisanal garden farming as a source of livelihood in the Project site. All PAPs were informed about the project and the need to relocate their activities from the site. Their resettlement preference was to be paid cash compensation and alternative livelihood options including skills training for the loss of their crops. The key social impacts identified were loss of livelihood and income.

Persons who were farming within the Project site boundaries as at the date of the survey were deemed eligible for compensation. There have been consultations and meetings held with the PAPs and key stakeholders. During the consultations, several issues/concerns were raised by the PAPs, including provision of employment opportunities to the local people and long period taken between valuation of crops and compensation exercise. The cut-off date was agreed upon but there were few delays in implementation schedule.

The ARAP preparation followed the following key stages:

- Identification of project impacts and affected persons;
- Review of legal framework for land acquisition and compensation;
- Consultations and engagements of PAPs;
- Documentation of assets of PAPs;
- Valuation of crops;
- An Entitlement Matrix was drawn and cut-off date determined;
- Institutional responsibilities for implementation and grievance redress; and
- Arrangements for monitoring and implementation.

[1] Since 2017, the Project title changed from HFO Power Generation Plant to Salone Power Plant.

1.3 Objective of the ARAP Compensation

The objective of the ARAP compensation is to restore and improve the livelihoods of the artisanal garden farmers who are the PAPs by providing payment at full replacement cost of their crops including alternative livelihood strategies in terms of skill trainings which would improve future income. This was implemented with appropriate disclosure of information, consultation and the informed participation of the PAPs.

1.4 Facilitation of the ARAP Compensation

GLOBELEQ in coordination with INTEGEMS organised and facilitated the ARAP Compensation Workshop, which was held at the Sierra Leone Teacher's Union (SLTU), Hotel 5 – 10, Kissy Dockyard, Freetown, on Tuesday 13 February 2018. GLOBELEQ was responsible for organising (i.e. publicity, invitation of stakeholders, venue hire, catering/hospitality, etc.) the Compensation Workshop while INTEGEMS provided both administrative and technical assistance and facilitation of the compensation payment processes.

The compensation packages were prepared and agreed in consultation with 13 PAPs (eight within the Project site and five outside of the Project site). Inherently, an ARAP formulation prompts engagement in a consultative process with all the relevant parties involved so that the PAPs' entitlements are professionally, fairly and transparently disbursed in accordance with the necessary regulatory and statutory requirements of the Government of Sierra Leone and the World Bank IFC Performance Standards. The compensation package is a result of a consultative process amongst the Ministries, Departments and Agencies (MDAs) and stakeholders in Quarry & Kissy Dockyard communities and the PAPs who were farming in and around the Project site. Stakeholder consultations were undertaken towards development of the ARAP.

2 PROCEEDINGS OF THE COMPENSATION WORKSHOP

2.1 Introduction

2.1.1 Introduction- Julius Mattai – Managing Director/Principal Consultant INTEGEMS

The Workshop started with a welcome greeting by Julius Mattai followed by Muslim and Christian prayers and an introduction of all attendees/stakeholder present. After the introductions, Julius explained the objectives and purpose of the Workshop. He thanked all the stakeholders present particularly the MDAs, civil society organizations (CSOs) and community heads for their continued support and assistance.

He thanked the PAPs for their patience and understanding throughout the compensation process. Afterwards, he briefly explained the ARAP process and the need for the compensation, particularly highlighting the key steps involved in the process and meetings and engagements that have been conducted to ensure that the PAPs have a full understanding of the ARAP process. He emphasised on the need for PAPs to properly manage their compensation benefits.

He concluded by saying that the main purpose of the meeting was to sign the necessary compensation documents by the PAPs before compensation protocols and payments are completed.

2.2 Statements

2.2.1 Statement from GLOBELEQ - Catherine Minya, ESG Associate

In her opening statement Catherine said her Company always (GLOBELEQ) values and considers the community as their major stakeholders. She also added that as a Company bringing development to the community is as important and essential as having and maintaining a good relationship. Catherine also reiterated the compensation process, adding that GLOBELEQ has ensured that the process is transparent and in compliance with the requisite national and international standards and practices. She further mentioned that the compensation rates paid are higher than the national rates recommended by MAFFS.

2.2.2 Statement from Ministries, Departments & Agencies (MDAs)

2.2.2.1 Environmental Protection Agency – Sierra Leone (EPA – SL)

Joseph S Turay – Assistant Field Operator

Mr Turay in his introduction started by apologizing for the absence of the EPA-SL Chairperson and continued that the compensation payment process is something the Government is always happy to hear about. He also pointed out that the EPA-SL oversees the environmental laws investors must abide to. He said they are here to witness a compliance which means GLOBELEQ as a Company is doing everything within the laws of Sierra Leone, one of which is any company that wants to bring development in the country must think about the community people and must not disturb their livelihood. He continued by saying GLOBELEQ wants to bring electricity in the country and in doing so they have disturbed the livelihood of 13 women who used to survive from their gardens located in and around the Project site and because of this disturbance, they are here to compensate them. This means the farmers will forego their gardens and in return will receive cash and in-kind compensation.

He also said he is happy to hear about the in-kind compensation which is a training course that will allow the PAPs to bring income to sustain their families instead of going back to do their gardens.

He stressed that this is why the Government does not joke with the livelihood of its people and give EPA–SL the mandate that any development of such nature should go with a report that covers this particular section. He stressed that the EPA – SL is at the Workshop to ensure GLOBELEQ complies with the environmental laws and regulations of Sierra Leone but the competent authority for crop compensation is the MAFFS. He pointed out that GLOBELEQ should ensure that the compensation process is transparent and the rightful beneficiaries are receiving the compensation as most compensation doesn’t benefit the actual beneficiaries.

He expressed his satisfaction that the compensation process will be recorded for future reference should there be any disagreement by the PAPs. He appealed to everybody to say what is on their minds as this will be documented after which the Government will accept that GLOBELEQ has complied with the requisite laws and regulations of Sierra Leone. He emphasized that the EPA-SL will be monitoring the project to ensure that what is in the compensation documents is what GLOBELEQ is doing because the compensation will be disbursed to the PAPs in two and three years period depending on the location of their gardens.

He concluded by pleading with the PAPs that they should ensure they understand the compensation documents before signing them because they don’t want to have grievances or complaints in the future from the PAPs that they don’t understand the documents they signed. He told the PAPs that their signatures mean that they have agreed to the compensation package given to them.

2.2.2.2 Ministry of Agriculture, Forestry and Food Security (MAFFS)

Joseph K Tondoneh – Agriculture Officer

Mr Tondoneh started by acknowledging that this is a special day for MAFFS but before going further, he brought special greetings from the MAFFS Minister and Directors to the PAPs/farmers because if the MAFFS is progressing today is as a result of them. He said the crops they are farming is very important to the Ministry and it is contributing to the livelihood development of people in the community.

He stressed on the contribution from the MDAs to the development of the country as they all have their mandate and that this project falls under the mandate of the Ministry of Energy (MoE) to produce electricity in the country. He continued by saying that if for any reason the project is disturbing the livelihood of the farmers, they must create a balance so that everybody will be happy and EPA–SL has been very effective in creating this balance among the MDAs and commended them for their support in ensuring that any company that wants to bring development must meet the environmental standards of the country.

Mr Joseph also said that one of their major activities in such a project is to make sure that the farmers are compensated accordingly, which means every compensation must meet the national laws and standards and also benefit the people directly affected. He also said that GLOBELEQ contacted them to do the crop assessment which was very good and they didn't do it on annual basis because the crops are all year round crops which means they can be harvested twice per month if they have a suitable environment. He also said they are happy as a Ministry that GLOBELEQ have decided to add on to the compensation amount provided to them by the ministry to meet the international standard.

He concluded by advising the PAPs not to forget their farming skills even though they yearn for training to improve their livelihood but if for any reason they have access to farmland, let them don't abandoned their farming skills as farming is very important to the country.

2.2.2.3 Ministry of Local Government & Rural Development (MLGRD)

Michael A Samai – Acting Director for Rural Development

Mr Samai in his introduction said as a Ministry they are happy for the invitation from GLOBELEQ to witness the compensation process and continued that this is the kind of example the President and his Government want to see in the country.

He said every development must benefit the local communities and it is people and as government representative, they must ensure that the people affected by the project receive their rightful compensation as that is the only thing that will make them happy. He expressed his satisfaction to see other MDAs, local stakeholders and PAPs in this important stage of the project.

He concluded by suggesting that if the PAPs are facing problems or challenges relating to the compensation, they should bring them up as all the relevant stakeholders of the project are here to solve any grievance or complaint.

2.2.2.4 Ministry of Lands, Country Planning & the Environment (MLCPE)

A B Magid-Sesay

Mr Magid-Sesay said he is very happy and satisfied with the process because it is transparent and as an MLCPE Representative, they are pleased with the compensation operation and this is what the government is always trying to achieve for its people.

2.2.3 Representative from Centre for Accountability & Rule of Law (CARL)

Dr Gassan Abess – Human Right, Research and Criminal Justice Advisor

Dr Abess said they are Independent Observers of the compensation payment process to make sure that it is transparent because human rights and livelihood must be protected as it is a right-based problem. He also said he is satisfied from what he has observed so far because the process is transparent and open and the beneficiaries seem to understand and appreciate the process.

2.2.4 Statement from Local Stakeholders

Abdul Salam Kanu – Former Member of Parliament

In his opening statement, Mr Kanu thanked the EPA–SL for implementing the environmental laws of Sierra Leone and making sure that all developmental projects must adhere to the environmental standards set by the Government. Mr Salam said in his tenure, he ensured that all companies within his Constituency did everything required and in the process his people were satisfied and he thanked them for giving him their support. He also spoke about the delays in commencing the project; adding that he is very pleased with GLOBELEQ's effort and patience.

Mr Salam expressed his satisfaction with the PAPs for their courage and patience adding that the long awaited compensation package is finally here. In his concluding statement he expressed his sincere gratitude and appreciation to all the local chiefs for their continual support during the challenging phases of the project and also commended INTEGEMS for their relentless support throughout the project as they showed professionalism and integrity.

Adama Wara Kamara – Community Head

Adama opened her statement with praises for the project team in their recognition of the community leaders and appealed for that to continue. She also stressed on the need for GLOBELEQ not to forget the siblings of the PAPs who have learnt some skills but unemployed. She pleaded with GLOBELEQ to consider other members of the community when they start recruiting.

Andrew Konteh – Sub Chief and Chairman

Mr Konteh in his first statement said he is grateful to INTEGEMS and Honourable Salam for their support throughout the project. He said he was worried that his house would be destroyed as there were rumours going around about houses that would be destroyed around the project site in order to construct the road leading to the project site. He added that he was only at peace after he spoke to Honourable Salam who assured him that if his house was to be destroyed by the project team a better house will be built for him.

In his concluding statement he expressed his sincere thanks and appreciation to Harold Kallon (GLOBELEQ's Project Coordinator) for confirming that no houses will be destroyed by the project and for his continuous support towards the PAPs adding that the PAPs are looking forward to the other compensation packages in the coming years.

Sulaiman Bangura – Acting Community Head

Mr Sulaiman said he was happy to be present and thanked GLOBELEQ for bringing such development to their community and his prayer for them is that God will continue to bless them in everything they are doing.

Abdul Kabia – Local Chief Kissy Dockyard Community

Mr Abdul started by expressing his sincere gratitude to GLOBELEQ and all the stakeholders for their support throughout the project. He then pleaded with GLOBELEQ to consider the youths in the community during their recruitment process. In his final words, he thanked the PAPs for their patience and courage throughout the project.

Alimamay Kamara – Local Chief Quarry Community

Mr Alimamy in his opening statement thank Honourable Salam for all he has done for the community adding that God will bless him for his transparency during his tenure as an MP. He then appealed to the gardeners not to forget their farming skills and encourage others to be involved in farming activities as it has a lot of benefits. He concluded by pleading with GLOBELEQ to consider the community people when they start their recruitment process.

2.2.5 Statement from Project Affected Persons (PAPs)

Kaday Koroma

Kaday said she has being farming around the project site for the past years but since they are bringing development that will benefit everybody, she is happy. She expressed her appreciation and thanked GLOBELEQ and INTEGEMS for their support as she is satisfied with the compensation process and the package.

Isatu Konteh

Isatu started by thanking everybody that has contributed to the progress of the project, including her colleagues that were working under rain and sun in their gardens to support their families. She also thanked Honourable Salam for supporting them throughout the difficult periods. She said she is happy and appreciate the compensation package and pleaded with GLOBELEQ to consider their children when they are recruiting for staffs as some of them have learnt skills but there is no job opportunity.

Nannah Conteh

Nannah started by saying she is happy as she will finally receive her compensation and said she will not forget what INTEGEMS did for her during the difficult periods. She also said that there was some misinformation going around that the farmers outside the project site will not be compensated but thank God to INTEGEMS staffs that were present during the last meeting to give the correct information that all PAPs will be compensated but not equally.

She concluded by thanking everybody for their support and said she is happy for the compensation package and she is happy and ready to attend the training course.

Warah Conteh

Warah thanked GLOBELEQ for all what they have done for them as they cannot pay them back, especially for the banking and financial management training course provided for them. She hope that the project will be a success to everybody in the community and to GLOBELEQ.

Titty Koroma

Titi said she appreciated everybody that has contributed to the success of this project as she is very happy with the compensation package.

Mammie Smart

Mammie started by saying that she has spent all her life in gardening and that is her only source of livelihood that she used to raise her family. She thanked all the stakeholders, especially Mr Julius Mattai, for his support throughout the difficult period. She said she is very happy and appreciate the compensation package given to her.

Sento Mansaray

Sento said her mother introduced her to farming activity and that is what she has used to raise her family. She thanked everybody for their support and said she is happy with the compensation process.

Tenneh Sesay

Tenneh said she has been doing the gardening work all her life and that is what is up keeping her family unto this moment and she is very happy to receive the compensation package.

Zainab Conteh

Zainab started by saying she is happy that they are here for the compensation process and as the chairlady of the PAPs, she thanked all of the PAPs for their patience and courage during the challenging period. She also thanked INTEGEMS and Honourable Salam for everything they have done for them. She emphasised that Mr Harold Kallon has been very good to them as he is always in constant communication with them. He also encouraged them to be patient that the compensation will be done at the appropriate time. She said they are all happy to finally receive their compensation package, including the training course.

2.3 Signing of Compensation Certificates and Payments

A total of 13 PAPs received compensation in cash for a period of one year. The criteria for the payment was based on statutory market value of crops valuation. Thus, all the PAPs received different amount of compensation. Subsequently, GLOBELEQ will pay cash compensation for additional one year for PAPs outside the project site and two years for those within the project site.

The compensation certificates were singed individually by the PAPs and their representatives, GLOBELEQ and INTEGEMS in the full presence of the various representatives from the MDAs and NGOs. INTEGEMS signed as a third party and the MDAs were the witnesses to ensure the compensation processes were fair,, transparent and credible.

3 CONCLUSION

In general, the compensation payment process was a success and all the parties involved were happy with the outcome of the operation. PAPs were happy to finally receive their compensation and they thanked everybody that helped them to achieve their long awaited dreams. They prayed that the relationship between them, GLOBELEQ and INTEGEMS will forever be friendly.

The compensation packages will assist the PAPs in their farming activities (outside the Project site) if they so wish to continue and also continue with or start a new business for income generation. Furthermore the ARAP provided a roadmap for the grievance redress mechanism which PAPs should use to get their issues resolved, if any.

4 ANNEXES:

4.1 Agenda

Activity	Owner
Arrival and registration of participants	INTEGEMS
Official Opening – Prayers and welcome 1. Introduction	INTEGEMS
2. Statement from Project Team	GLOBELEQ
3. Representative, Environment Protection Agency- Sierra Leone (EPA-SL) 4. Representative, Ministry of Energy (MoE) 5. Representative, Minister of Agriculture Forestry and Food Security (MAFFS) 6. Representative, Ministry of Local Government and Rural Development (MLGRD) 7. Representative, Ministry of Lands, Country Planning and the Environment (MLCPE) 8. Representative, Centre for Accountability and the Rule of Law (CARL)	MDAs
9. Statement From Local Stakeholders	Community
10. Statement from PAPs	PAPs
11. Compensation Process	INTEGEMS, GLOBELEQ, MDAs and PAPs
12. Closing Remarks	INTEGEMS
13. Vote of Thanks	GLOBELEQ
LUNCH	
14. End of Workshop	

4.2 Attendance List

No	Name	Organization	Email
1	Salamatu Bangura	Community Representative	+232 99 378 951
2	Musu Sesay	Community Representative	+232 76 720 743
3	Manso Kargbo	PAPs Representative	+232 30 328360
4	Sento Mansaray	PAPs	
5	Tenneh Sesay	PAPs	
6	Mammie Smart	PAPs	+232 77 412 841
7	Isatu Conteh	PAPs	+232 77 308 785
8	Bambay Mansaray	PAPs	+232 77 714 419
9	Titty Koroma	PAPs	+232 77 002 584
10	Marie Conteh	PAPs Representative	+232 99 583 421
11	Rugiatu Sesay	PAPs Representative	+232 99 792 992
12	Zainab Conteh	PAPs	+232 30 050 891
13	Abdul Kabba	PAPs Representative	+232 78 529 662
14	Warah Conteh	PAPs	+232 99 841 522
15	Nannah Conteh	PAPs	+232 88 892 614
16	Isatu Konteh	PAPs	+232 99 561 582
17	Kaday Koroma	PAPs	+232 30 068 720
18	Monday Kargbo	PAPs	+232 88 393 327
19	Salllay Conteh	PAPs	+232 99 676 086
20	Alhaji Kamara	Community Head/Chief	
21	Andrew R Konteh	Sub Chief and Chairman	+232 30 537 691
22	Mohamed Koroma	Community Head/Chief	
23	Abdul Kabia	Community Chairman	+232 25 428 554
24	Sullay Bangura	Acting Community Chead/Chief	+232 30 259 353

No	Name	Organization	Email
25	Alpha Rashid Konteh	Community Youth Leader	+232 77 434 458
26	Hassan B Hassan	Assistant Community Head	+232 88 847 720
27	Ajaratu Timbo	Councilor	+232 78 044 191
28	Patrick Sambu	Community Youth PRO	+232 77 547 003
29	Martha Conteh	MAFFS	+232 76 929 497
30	Joseph S Turay	EPA – SL	+232 78 053 178
31	Emmanuel During	EPA – SL	+232 76 619 835
32	Joseph K Tondoneh	MAFFS	+232 78 218 844
33	Dr Gassam Abess	CARL	+232 77 819 225
34	Julius Mattai	INTEGEMS	+232 78 898 260
35	Catherine Minya	GLOBELEQ	+237 67 952 6759
36	Mamoud Mansaray	INTEGEMS	+232 78 354 576
37	Koinguma Baimba	INTEGEMS	+232 76 738127
38	Ibrahim Aziz BANangura	INTEGEMS	+232 76 463 070
39	Joe Patrick Amara	CECA – SL	+232 78 387373
40	Michael A Samai	MLGRD	+232 76 607 437
41	Paul Osman Kabia	United Polio Organization	+232 88 235 575
42	Memunatu Kargbo	Chairlady	+232 30 492 058
43	Joseph Allieu Sesay		+232 30 287 285
44	Hon. Abdul Salam Kanu	Former MP	+232 76 926 888
45	Prince Kunda Kemoi	INTEGEMS	+232 78 607 355
46	Yusif Turay		
47	Adama Warah Kamara	Community Head/Chief	+232 88 788 211
48	Fatmata Kamara	Community Representative	+232 88 916 750
49	Alhassan D kamara	Zion	+232 30 791 255
50	Mariatu Dumbuya	Zion	+232 79 236970
51	A B Magid-Sesay	MLCPE	+232 78 936 520

SALONE POWER PLANT PROJECT

COMPENSATION PROCESS ATTENDANCE LIST

No	Name	Organization	Phone Number	Email	Signature
1	Salamatu Bangura	Community Representative	099 378951		
2	Musu Sesay	Community Representative	076-720743		
3	Manso Kargbo	PAPs Representative	030-328360		MKargbo
4	Sento Mansaray	PAPs			
5	Tenneh Sesay	PAPs			
6	Mammie Smart	PAPs	077412841		
7	Isatu Conteh	PAPs	077308785		
8	Bambay Mansaray	PAPs	099714419		
9	Titty Koroma	PAPs	077002584		
10	Marie Conteh	PAPs Rep	099-58-34-21		KConteh
11	Rugiatu sesay	PAPs Representive	099-792-992		
12	Zainab Conteh	PAPs	030050891		
13	Abdul Kabba	PAPs Representative	078529662		Kabba.
14	Warah Conteh	PAPs	099841522		

13 February 2018

No	Name	Organization	Phone Number	Email	Signature
15	Nannah Conteh	PAPs	088 892614		
16	Isatu Konteh	PAPs	099561582		
17	Kaday Koroma	PAPs	030 068720		
18	Monday Kargbo	PAPs	088393327		
19	Salay Conteh	PAPS	099-676086		
20	chief Pa Mohamed Koroma	Community Head			
21	Ch				
22	chief Alhaji Kamara	Community Head	076 666153		
23	Andrew R. Konteh	Zonal chairman/Sub chief	030537691		
24	Abdul Kabia	Chairman Community	025428554		
25	Pa Sullay Bangura	Acting Community Chief	030 259353		
26	Alpha Rashid Konteh	Dockyard Youth Devt org. (DYDO)	077434458		
27	Pa Hassan. B. Hassan	Assistant Community Chief	088 847720		
28	Ajaratu Timbo	Counsellor.	078044191		
29	Patrick Samber	P.R.O Community	077-547003		
30	Martha Conteh	MAFFS	076929497	keita.marta@yahoo.com	

13 February 2018

No	Name	Organization	Phone Number	Email	Signature
31	Joseph S Turay	EPA-SL	078053178	Sapunkar1@yahoo.com	
32	Emmanuel Dwing	EPA-SL	076-619835	emmandwing@gmail.com	
33	Joseph K. Tondoneh	MAFFS	078288844	JKtondoneh@gmail.com	
34	Dr. Gassan Abess	CARL-SL	079-398771	gassanabess1972@yahoo.com	
35	Abu Bakarr Isangbo	CARL-SL	077 819225	A.Isangbo@yahoo.com	
36	Julius Mattai	INTEGEMS	078898260	jd.mattai@integems.com	
37	MINYA. Catherine	GLOBELEQ	+23767952625	catherine.minya@globeleq.com	
38	Mamoud Mansaray	INTEGEMS	078354576	m.mansaray@integems.com	
39	Koingama Baimba	INTEGEMS	076738127	Ko.baimba@integems.com	
40	Ibrahim Aziz Bangura	INTEGEMS	078-463070	i.bangura@integems.com	
41	Joe Patrick Amara	CECA-SL	078387373	patrick.amara@globeleq.com	
42	Michael A. Samai	MLGRD	076-607437	michaelsamai60@gmail.com	
43	Paul Osman Sinain	United Radio Broadcasters Assn	088235575	Paulosmain@yahoo.com	
44	Memunatu Kargbo	Chair Lady	030492058		
45	Joseph Allieu Sesay	PRO & CDC Sec.	030287285	josephallieusesay@gmail.com	
46	Hon. Abdul Salam Kanu	MP. Con. 101	076926888	a.salam@gmail.com	

13 February 2018

No	Name	Organization	Phone Number	Email	Signature
47	Prince Kunda Kemoi	INTEGEMS	078607355	pkemoi@integems.com	[illegible]
48	Yusif Turay				
49	chief Adama Warah Kamara	Community chief	088788211		[illegible]
50	Fatmata Kamara	Community Rep	088916750		FA
51	Alhas D Kamara	Zion	030 79 12-55		[illegible]
52	Mariatu Dumbuya	Zion	079236970		[illegible]
53	A. B. Majid-Sesay	MLCPE	078-936520	abmajid2002@gmail.com	[illegible]
54					
55					
56					
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4.3 Compensation Payment Package Table

Name of PAPs	Number of heaps	Crops type	Project Compensation Packages for the first year			
			Cash SLL	In Kind SLL	Selected Training	Total Compensation SLL
Sento Mansaray	6	Potato leaves, Cassava leaves, Green, Sour, and Krain-Krain	6,090,000	967,500	Catering	7,057,500
Tenneh Sesay	6	Potato leaves, Cassava leaves, Sour and Krain-Krain	7,057,500	0	NA	7,057,500
Mammie Smart	7	Corn, Cassava leaves and Green	8,242,500	0	NA	8,242,500
Isatu Conteh	5	Potaote leaf, Cassava leaves, Green, sour and krain-Krain	3,870,000	967,500	Catering	5,887,500
Bambeh Mansaray	6	Potato leaves, Cassava leaf and Krain-Krain	5,040,000	967,500	Catering	6,007,500
Mammie Titty Koroma	8	Potato leaves, Cassava leaves, Green, Sour and Krain-Krain	9,427,500	0	NA	9,427,500
Zainab Conteh	6	Potato leaves, Cassava leaves, Green, Sour and Krain-Krain	6,090,000	967,500	Catering	7,057,500
Warah Conteh	6	Corn, Potato leaves, Cassava leaves, Sour and Krain-Krain	6,090,000	967,500	Catering	7,057,500
Nannah Conteh	3	Potato leaves, Cassava leaves, Green and Krain-Krain	1,525,500	967,500	Catering	2,493,000
Isatu Konteh	2	Potato leaves and Krain-krain	697,500	967,500	Catering	1,665,000
Kaday Koroma	7	Potato leaves, Green and Krain-Krain	5,823,000	967,500	Catering	6,790,500

Monday Kargbo	4	Potato leaves, Lamine, Green and Krain-krain	3,330,000	0	NA	3,330,000
Sallay Conteh	13	Potato leaves, Green and Krain-Krain	10,809,000	0	NA	10,809,000

4.4 Photo Plates

PAPs Receiving their Compensation Certificate

Bambay Mansaray receiving her compensation certificate

Nannah Conteh receiving her compensation certificate

Monday Kargbo receiving her compensation certificate

Salay Conteh receiving her compensation certificate

Kaday Koroma receiving her compensation certificate

Mammie Smart signing her compensation certificate

PAPs Signing Compensation Certificate

Titty Koroma signing her compensation certificate

Isatu Conteh signing her compensation certificate

Zainab Conteh signing her compensation certificate

Warah Conteh signing her compensation certificate

Isatu Konteh signing her compensation certificate

Sento Mansaray signing her compensation certificate

Representatives from MDAs

Tenneh Sesay signing her compensation certificate

Representative from MAFFS

Representative from MLGRD

Representative from MLCPE

Representative from CARL

Representative from EPA-SL

Representatives from the community

Adama Wara Kamara – Community Head	**Former Member of Parliament Abdul Salaam Kanu**
	
Andrew Konteh – Chairman Kissy Dockyard	**Sulaiman Bangura - Acting Chief**
	
Abdul Kabia - Chief Kissy Dockyard	**Alimamay Kamara - Chief Quarry Community**
	

Cross Section of GLOBELEQ & INTEGEMS Staffs and PAPs Representatives

Catherine Minya of GLOBELEQ in her statement

Julius Mattai in his introductory statement

Joe P Amara GLOBELEQ

Cross Section of Stakeholders

Cross Section of Stakeholders

Cross Section of Stakeholders

Appendix R: Mitigation Action Plan

Appendix S: Guidelines and Standards

Appendix T: Questionnaires

Appendix U: References