# SENTUO OIL REFINERY LIMITED

## ENVIRONMENTAL IMPACT ASSESSMENT

# PROPOSED OIL REFINERY

### AT TEMA, GREATER ACCRA REGION, GHANA

## *MAIN REPORT - DRAFT*


***ENVIRONMENTAL PARTNERSHIP LIMITED***
***P. O. Box KN 41920955***
***Kaneshie, Accra***

***June 2020***

## EXECUTIVE SUMMARY

## INTRODUCTION

Sentuo Oil Refinery Limited (SORL) intends to construct and operate an oil refinery at Tema in the Greater Accra Region of Ghana. The proposed oil refinery project will be located at the Heavy Industrial Area in Tema and SORL has secured Plot No. IND/HI/21/5) from the Tema Development Company (TDC) for the proposed project.

The proposed oil refinery will process 3 million metric tons sour crude oil per year into 1.12 million metric tons of gasoline, 1.23 million metric tons of diesel and various amounts of LPG, benzene, aromatics, xylene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil (SORL, 2019 a, b). It will process light crudes from Saudi Arabia, Kuwait and Nigeria and will be implemented in two phases. The major components for Phase 1 of the refinery are (SORL, 2020):

- 1.5 Million tons per year atmospheric distillation unit;
- 0.8 Million tons per year heavy oil catalytic unit;
- 0.6 Million tons per year diesel hydrogenation unit;
- 0.3 Million tons per year naphtha NMTG unit;
- 0.4 Million tons per year catalytic gasoline selective hydrogenation unit;
- 0.6 Million tons per year sulphuric acid combined plant.

Similar equipment will be installed under Phase 2 and the two phases will be integrated together.

### Project Justification

The justification for the project is firmly rooted in the continuing increasing demand for refined petroleum products to accelerate socio-economic development not only in Ghana but in other West African countries. The Tema Oil Refinery established in 1957 with a 45,000 barrel per day capacity, is still the only major oil refinery in Ghana.

With a current national daily demand of 83,000 barrels, there is clearly the need for a modern refinery to fill this demand gap and also satisfy international markets. Thus, SORL will not only be contributing to improving the supply of oil, fuel and gas in Ghana but is also targeting the export market. This is clearly in line with the policies of the Government of Ghana, which aim to to secure a reliable supply of high-quality energy services for all sectors of the Ghanaian economy and also to become a major exporter of oil and power. SORL's cash flow analysis reveals that the project is profitable in both phases and will yield enough cash to meet its debts servicing obligations.

## POLICY, LEGAL REGULATORY AND INSTITUTIONAL FRAMEWORKS

The national policies relevant to the proposed oil refinery are:

- The Constitution of Ghana, 1992;
- National Environment Policy, 2012;
- National Energy Policy, 2010;

- Local Content Policy in the Oil and Gas Sector, 2010;
- National Land Policy, 1999;
- National Water Policy, 2007.

The relevant legal and regulatory frameworks and guidelines relating to environmental protection and other social aspects of the project include:

i. Environmental Protection Agency (EPA) Act, 1994 (Act 490);
ii. Environmental Assessment Regulations, 1999, (LI 1652);
iii. EPA Fees and Charges (Amendment) Instrument 2015, L.I. 2228;
iv. Relevant EPA Environmental Quality Standards including:
v. National Petroleum Authority Act, 2005, (Act 691);
vi. Petroleum Revenue Management Act, 2011 (Act 815);
vii. Petroleum (Local Content and Local Participation) Regulations, 2013 (L.I. 2204);
viii. Petroleum Commission (Fees and Charges) Regulations, 2015 (L.I. 2221);
ix. Ghana National Fire Service Act, 1997 (Act 537);
x. Fire Precaution (Premises) Regulations, 2003 (L.I. 1724);
xi. Administration of the Lands Act, 1962 (Act 123);
xii. State Lands Act, 1962 (Act 125);
xiii. Labour Act, 2003 (Act 651);
xiv. Water Resources Commission Act, 1996 (Act 522);
xv. Water Use Regulations, 2001 (L.I. 1692);
xvi. Lands Commission Act, 2008 (Act 767);
xvii. The Local Government Act, 1993 (Act 462);
xviii. Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917);
xix. Hazardous, Electronic and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250).

## PROJECT DESCRIPTION

### Location of Project

The proposed oil refinery is to be located in Tema in the Greater Accra Region of Ghana, 30 kilometers east of Accra. It is to be built on Plot No. IND/HI/21/5 at the Tema Heavy Industrial Area, which is one of the core areas of Ghana's industrial activities. This proposed project site lies in the catchment of the Chemu Lagoon, which opens about 1 km southwards into the sea near the Tema Fishing Harbour. VALCO, Tema Oil Refinery and Sentuo Steel are among the key industries in the zone.

### Land Acquisition

SORL has secured 38.59 hectares (95.31 acres) of land, Plot No. IND/HI/21/5) in the Tema Heavy Industrial Area, from the Tema Development Company (TDC) for the construction and operation of the oil refinery. In response to SORL's letter received by TDC on 09 December 2019, TDC, in in a letter with Reference No. IND/HI/21/5 dated 10 December 2019, offered the right-of-entry to

SORL subject to the acceptance of the terms and conditions of the offer and payment of the first year's ground rent.

**Overview of the Proposed Project**

The refinery project will be constructed in two phases, with 1.5 million metric tons crude oil processing capacity for each phase. Phase 1 will cover about 24 ha (60 acres) of land. The total investment in this phase will be $ US 796 million and will involve the construction of a Conversion Refinery to process 1.5 million metric tons of sour crude oil per year into 464,500 metric tons of gasoline oil and 481,800 metric tons of diesel. Other products will include liquified petroleum gas, benzene, aromatics, xylene, toluene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil. The plant in this phase will consume 80 $m^3$ water/h (80 metric tons/h) and 8,200 kW/h of electricity. The project will also transport various types of raw materials and products throughput of about 3 million metric tons /year to and off site.

The first phase of the project will be constructed in two stages. The main components to be built in the first stage are:

- 1.5 million metric tons / year atmospheric distillation unit;
- 800,000 metric tons / year heavy oil catalytic unit;
- 600,000 metric tons / year diesel hydrogenation unit;
- 300,000 metric tons / year naphtha-methanol-to-gasoline (NMTG) combined unit;
- 400,000 metric tons / year catalytic gasoline selective hydrogenation unit; and
- 60,000 metric tons / year sulphur recovery unit.

Phase 2 of the project is expected to be constructed from August 2021 to June 2023 with the same components as for Phase 1.

On completion, the project will be capable of processing 3 million metric tons sour crude oil per year into 1.12 million metric tons of gasoline, 1.23 million metric tons of diesel and various amounts of LPG, benzene, aromatics, xylene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil. It will then become the largest petrochemical production company in Ghana.

Other components of the refinery project include:

- Solid waste, process-water and wastewater treatment facilities;
- Site drainage and stormwater management;
- Administration block;
- Raw materials and product storage tank farms;
- Central laboratory;
- Workshop for repair and maintenance of plant equipment;
- Process and potable water reticulation systems;
- Clinic/first aid post;

Activities under the proposed project will be undertaken under pre-construction, construction, operations and decommissioning and closure phases.

## Pre-Construction Phase Activities

The major pre-construction activities cover feasibility studies, land acquisition, project planning and design including consultations with various stakeholders. Other activities include creation of access to the project site and technical surveys for siting the oil refinery and its components, updating engineering and technical designs, and acquisition of required permits and approvals. The activities will also include inspection of the project site by Electricity Company of Ghana (ECG) staff in preparation for the relocation of pylons at the site.

## Construction Phase Activities

***Key Components***

### i. Project Site Preparation and Layout of Facilities

Activities to be carried out under project site preparation include relocation of utility lines (such as electricity pylons) at the site, clearing, levelling, zoning of the site and installation of the various infrastructure and facilities. The principles underlying the layout of the refinery are summarised as follows:

- Recognition of the current codes and regulations on fire prevention, explosion protection, safety and health;
- Coordination of the technological processes with the overall planning of the open area and natural conditions to ensure a reasonable and compact layout that occupies as little land as possible;
- Arrangement of process equipment with similar units grouped together to save land and energy, and shorten the length of the pipelines;
- Reliance, as much as possible, on existing infrastructure and services to minimise duplication of effort;
- Organization of production facilities to shorten transport distances;
- Consideration of the wind direction to reduce environmental pollution;
- Organization of greening activities to enhance the natural landscape.

The front of the plant, the loading and unloading area, and the units with transportation requirements will be arranged near the edge of the plant. Car loading and unloading facilities and motor vehicles which frequently enter and exit will also be garaged on the edge of the plant site, which leads directly to the road outside the plant.

### ii. Installation of Processing Plant

The key components of the processing plant to be constructed are:

- Crude oil desalting unit;
- Sour crude oil atmospheric distillation unit;
- Heavy oil Catalytic cracking unit;
- Diesel hydrotreating unit;
- Naphtha NMTG combined reforming unit;
- Catalytic gasoline selective hydrogenation unit;
- Sulfuric acid combined unit.

The plan is to install a set of primary (atmospheric and vacuum) distillation plants for distilling 1.5 million tons crude oil per year each in Phases 1 and 2 (combined capacity of 3.0 million tons crude oil per year) into various cuts, and auxiliary units for further refining these cuts into finished and blending products of high market value.

**Sub-Components**

The sub-project components for the construction phase are:

- Crude oil tank farm and pump shed one;
- Light oil tank farm and pump shed one;
- Light oil tank farm and pump shed two;
- Spherical tank farm and pump shed;
- Heavy oil tank farm and pump shed;
- Waste water tank farm and pump shed;
- Car loading facilities;
- Flare facility;
- Plant-wide process and thermal network;
- Fire and Fresh Water Pressurization Station;
- Circulating water field;
- Rainwater monitoring and lifting pump station / accident reservoir;
- Fire control and water supply and drainage pipe network;
- Bubble stand;
- Sewage treatment plant;
- Fire station;
- Plant-wide power, lighting, grounding and telecommunications;
- Main Substation;
- Area transformer substation;
- Steam system;
- Demineralized water, deoxygenated water, condensed water systems;
- Compressed air station;
- Nitrogen storage;
- Whole plant process and heat pipe network.

**i. Storage Tank Farms**

Tanks farms will be constructed for the storage and discharge of raw materials, intermediate and finished products and waste water. Dykes/bunds will be constructed around each farm to contain accidental spills from any tank in the farm. The storage tanks will be of various capacities and types. For example, floating-roof type tanks will be constructed for the storage of crude oil, methanol, gasoline and diesel; dome type tanks for storage of fuel and asphalt; and spherical tanks for storage of acrylic and liquified gas.

**ii. Loading and Unloading Facilities**

Crude oil and other raw materials will be transported directly to the refinery and offloaded to storage tanks by use of pumps. Refined products will be loaded into tankers by pumping from storage tanks through tube cranes.

### iii. Sewage Treatment Plant

A new sewage treatment plant will be built with a capacity of 150 $m^3$/h, which is adequate for the amount of oily sulfur and domestic wastewater to be produced by the refinery of 39 $m^3$/h on the average and up to a maximum of 135 $m^3$/h. The sewage treatment technology plan will be a biochemical treatment process mainly based on homogeneous regulation-oil water separation-oil isolation-two stage air flotation. New sludge treatment facilities will also be built where the sludge generated during the sewage treatment process will be centrally and uniformly treated to the required standard and disposed of as directed by the local competent authority.

### iv. Electrical Power System

The total calculated load of the first phase of the project is about 12,834 kW, of which 10 kV load is 7,974 kW and 380 V low-voltage load is about 4,860 kW. The project will co-ordinate with the Tema branch of the Electricity Company of Ghana to provide two reliable 35 kV dual power sources for the plant area, and also install a 35 kV general substation and a 10 kV regional substation in the plant area. Each system will be single-bus section wiring mode. A bus link will be set between the two sections. Loads with special power supply requirements will be powered by an emergency power system. Emergency power will be supplied by UPS (or EPS).

### v. Telecommunication System

The telecommunications system to be installed in this project includes an administrative telephone system, dispatch telephone system, wireless intercom telephone system, PA system, automatic fire alarm system, industrial television monitoring system, and integrated wiring and telecommunication network. Fire-fighting telecommunication lines will mainly be laid in the ground and other telecommunication lines laid in the form of cable bridges or buried.

### vi. High Temperature Components

The high temperature components to be constructed are:

- *Steam system;*
- *Demineralized water, deoxygenated water, condensed water systems;*
- *Compressed air station;*
- *Nitrogen storage;*
- *Whole plant process and heat pipe network.*

### vii. Access and Refinery Roads

The roads in the refinery area will be arranged in a circle, and the road width, turning radius and clearance height will be such as to meet the traffic requirements of fire fighting vehicles. A fire path inside the plant area will also be constructed to meet fire protection needs.

### viii. Greening

The greening of the plant area will, among others, be based on adapting to local conditions, ensuring safety, beautifying the environment and saving land. According to the general layout plan, production characteristics, pipe network layout, fire safety, environmental characteristics, and local soil and climatic conditions, plant habits and other factors, a reasonable choice of green plants with anti-pollution, purification, noise reduction or dust retention ability will be made for the greening areas of the refinery site. The greening form to be adopted will ensure blending with

the surrounding environment, buildings and other structures for a multi-level three-dimensional greening layout.

***Ancillary Components***

The ancillary components to be constructed/installed in the construction phase are:

- Administrative block;
- Central control room;
- Area Cabinet Room;
- Central Laboratory;
- Repair and Maintenance workshop;
- On-site Clinic/First Aid unit.

**Operations Phase**

***Key Project Components***

The refinery processes typical of the proposed SORL's refinery for both phases of the project summarized below (SORL, 2019a, 2020):

- ***Fractionation(distillation)*** for separation of crude oil in atmospheric and vacuum distillation towers into groups of hydrocarbon compounds of differing boiling-point ranges called "fractions" or "cuts";
- ***Conversion Processes*** to change the size and/or structure of hydrocarbon molecules from the distillation processes through:
    - Decomposition by thermal and catalytic cracking;
    - Unification through alkylation and polymerization; and
    - Alteration with isomerization and catalytic reforming;
- ***Treatment Processes (including desalting)*** to prepare hydrocarbon streams for additional processing into finished products. Treatment includes removal or separation of aromatics and naphthenes, impurities and undesirable contaminants. It also involves chemical or physical separation e.g. dissolving, absorption, or precipitation using a variety and combination of processes including desalting, drying, hydrodesulphurizing, solvent refining, sweetening, solvent extraction, and solvent dewaxing;
- ***Formulating and Blending*** in order to mix and combine hydrocarbon fractions, additives, and other components to produce finished products with specific performance properties;
- ***Other Refining Operations*** include:
    - Light-ends recovery;
    - Sour-water stripping;
    - Solid waste, process-water and wastewater treatment;
    - Cooling, storage and handling and product movement;
    - Hydrogen production;
    - Acid and tail-gas treatment; and
    - Sulphur recovery.

The principles for selection of the process technology include (SORL, 2019b, 2020) the following:

- The production technology is mature, advanced and reliable;

- The technological process scheme has certain adaptability to the variation of the raw material properties;
- The process plan saves investment and land occupation as much as possible, reduces energy consumption and ensures safety and environmental protection that can meet the requirements of relevant laws and regulations;
- The process technology and equipment of the plant are localized, and the equipment manufacturing is based in China.

The key components of the operations phase of the project are:

- Crude oil desalting;
- Sour crude oil atmospheric distillation;
- Heavy oil Catalytic cracking;
- Diesel hydrotreating;
- Naphtha NMTG combined reforming;
- Catalytic gasoline selective hydrogenation;
- Sulphur recovery as sulphuric acid.

***Ancillary Components***

**i. Solid Waste Management**

The solid wastes generated from the refinery operations are mainly waste catalysts, waste adsorbents produced by various units, a small amount of tank bottom mud generated during the maintenance of the tank area, and sludge from the sewage treatment plant.

Solid waste will be disposed of by recycling, comprehensive utilization, landfill and incineration according to the nature of the waste to be discharged. All waste catalysts containing precious metals and waste catalysts that must be recovered in connection with patents will be returned to the manufacturers. Wastes with recycling value, such as unqualified polymers will be downgraded for sale.

**ii. Wastewater Management**

Wastewater will be divided into sulphur-containing water, oil-containing water and domestic wastewater, which will enter different systems. Sulphur-containing waste water will undergo sour water stripping first before entering the sewage water treatment plant; oily water and domestic sewage will be sent directly to the waste water treatment plant, and most of the effluent reused.

When a fire occurs in the refinery, the wastewater for firefighting will be drained to the 13,000 $m^3$ accident pool and later pumped to the sewage treatment plant for treatment and discharge.

iii. **Stormwater Management of Refinery Area**

Stormwater in the refinery plant area will be treated as oily water. It will, therefore, be collected and undergo sour water stripping before passing on to the wastewater treatment plant. Effluent from the wastewater treatment plant will be recycled as much as possible and any excess discharged to the environment through storm drains constructed at the site.

Stormwater from other areas including from outside the project site will be drained through the drainage system provided for the purpose and discharged into the outlet of the lagoon to avoid problems with flooding in the area, including the Heavy Industrial Area.

iv. **Venting and Flaring**

Venting and flaring will be used as part of routine operational and measures to safely dispose of vapours and other gases emitted by the process plant under normal production, accidents, shutdowns and emergency situations for personnel safety and to protect equipment. Gaseous emissions generated in the operation of the refinery mainly comes from the combustion of flue gas of heating furnaces, sulfuric acid tail gas, and hydrocarbon gases emitted by the plant. The new flare system takes into account the flare gas emitted by all process units and auxiliary facilities under various conditions. There will be a separate flare system for acid gas vented from the sulphur recovery plant. A flare management plan will be used to monitor both pollutant concentrations at the ground level and the total quantity of pollutants released annually and to control flare volumes. The refinery emissions include Particulate Matter < 10µ;

- Particulate Matter <2.5µ;
- Nitrogen oxides;
- Sulphur dioxide;
- Carbon monoxide;
- Carbon dioxide
- Volatile organic compounds;
- Benzene;

v. **Chemicals and Chemical Storage**

A variety of chemicals, additives and catalysts will be used during the refinery operations and dedicated on-site chemical storage facilities will be provided for them. Some of the types of chemicals required for normal refinery operations are (NFLRP, 2007):

- Alumina Absorbents;
- Ammonium Polysulphide;
- Antifoam;
- Antioxidant;
- Biocide;
- Boiler Feed Water Treating Chemicals;
- Caustic 50 Baume;
- Cooling Water Treatment Chemicals;
- Corrosion Inhibitor;
- Demulsifier;
- Refinery Distillate and Gasoline Additives;
- Filming Amine;
- Glycol;
- Hydrogen Sulphide Scavengers (MDEA);
- Methanol;
- Neutralizing Amine;
- Organic Chloride;
- Refinery Gasoline Additives;

- Scale Inhibitor;
- Sodium Hypochlorite;
- Wastewater Treatment Chemicals;
- Soda Ash;
- Activated Carbon.

Chemicals will be handled in accordance with recommended practices and stored in an approved storage area that has been designed for containment and segregation to avoid chemical interactions

**vi. Operation of Clinic/First Aid Post**

A clinic and first aid post will be located near the front area of the plant, close to the edge that leads to the main road outside the plant. A competent medical institution will be contracted to operate the clinic to support emergencies and occupational health and safety processes.

***Manpower Requirements***

The refinery project will employ a total of 369 people, 11 of whom will be engaged in direct operations while 14 will perform support services.

***Project Implementation***

The preparation of the feasibility study report shall be completed in March 2020.
The approval shall be completed by the end of May 2020.
Detailed design will be launched in May 2020.
The general construction of the project will be completed by the end of October 2021.

**Decommissioning and Closure Phase**

The service life of the structural design will be up to 50 years (SORL, 2020). However, in the event of the closure of the plant before or after 50 years, the procedures to be followed shall be according to an already developed and EPA-approved Rehabilitation and Decommissioning Plan. During this phase, the refinery will cease functioning and all structures, plants, machinery and equipment will be dismantled. In addition, all destroyed vegetative areas will be restored appropriately.

## CONSIDERATION OF ALTERNATIVES

**Location / Siting of Mine Facilities**

The Sentuo Oil Refinery is to be built on Plot No. IND/HI/21/5 at the Tema Heavy Industrial Area. The project fits into the zoning purposes of the area since refinery operations are considered as heavy industrial activities. The Tema Heavy Industrial Area is one of the core areas of Ghana's industrial activities and serves as the location for various industries including aluminium smelting, cement production, steel works, ceramics and food processing. The area is also home to Tema Oil Refinery (TOR), which was established in 1963 and could share some of its facilities such as those used for transportation of raw and refined materials with the new oil refinery.

In addition to the above, the industrial city of Tema is served by a deep-water harbour that is currently nearing completion of a $1.5 billion Port Expansion Project that will treble the Tema Port's current traffic and enhance the port's competitiveness as a leading maritime hub in West Africa. Clearly, this development will facilitate the import of crude oil and export of refined petroleum products for the Sentuo Oil Refinery. The Tema Harbour also possesses a mixed crude oil pipeline that SORL intends to use in transporting crude oil from vessels to the SORL project site. Besides, Tema and its Heavy Industrial Area are served by a good network of roads that provide easy access to and from the proposed refinery site in addition to the availability of electricity and water supply and other social services.

The Government of Ghana has been working on a Western Region oil and gas hub proposal to turn the country into the West Africa's petroleum hub by 2030. The Hub project will include refineries, petrochemical plants, power plants, light industry, waste and water treatment facilities, storage facilities, and business and residential centres. However, the location has yet to be developed with the requisite amenities and facilities as obtainable in the Tema Heavy Industrial Area for the smooth take-off of the SORL project.

Also, other nearby locations such as the industrial area in the Kpone Katamanso Municipality have comparatively less facilities such as water and road networks. The same applies to other potential areas in the Greater Accra and other regions. The location of the proposed oil refinery such areas will require more investment in upgrading them.

**Technology for Oil Refinery**

The main refinery process technologies applicable to the SORL project include:

- Atmospheric distillation of crude oil, patented by the Tianjin University;
- Heavy oil catalytic complex, patented by Sinopec Luoyang Design Institute;
- Residue hydrogenation, patented by Sinopec Fushun Research Institute;
- Diesel hydrogenation modification, patented by Sinopec Fushun Research Institute;
- Catalytic gasoline hydrogenation, patented by China Petroleum Research Institute;
- Naphtha reforming, patented by Beijing Institute of Petrochemical Science
- Sulphur recovery, patented by Nanhua Group Research Institute

The various technologies assembled for the SORL project have been selected on the bases that the technologies are mature, advanced and reliable. In addition, the choice of process technologies is based on the fact that the technologies are adaptable to various grades and qualities of crude oil, saves investment and land occupation, and reduces energy consumption. Moreover, the selection of the process technologies is based on the need to protect the environment, ensure safety, and meet relevant laws and regulations.

**No Action Alternative**

For the purposes of this report the No-Action alternative means that the Sentuo Oil Refinery will not be established. In this alternative, no direct socio-economic advantages are anticipated.

The key potential disadvantages associated with this alternative include:

- Loss of the opportunity of development of the Ghanaian economy, especially the ability to satisfy the increasing demand for petroleum products;
- Loss of employment opportunities;
- Loss of revenue streams to the government in the form of taxes;
- Loss of opportunity for private investment within the country, which is a key initiative of the Government of Ghana.

## BASELINE INFORMATION

### Topography, Geology and Soils

The topography of the Tema/ Kpone area is generally flat and forms part of Ghana's coastal plains. The land rises gently towards the north, where the principal stream in the area takes its source. The mean height above sea level in Tema is about 15 m. It ranges from 0 m in the south, along the coast to 53 m above sea level in the Kpone Katamanso Municipality. Likewise, the proposed project area is generally low lying and fairly flat. The almost flat nature of the area has made it flood prone and therefore demands a high cost for construction of drainage

Geologically, the Tema/Kpone area is underlain by metamorphic rocks of Acidic Dahomeyan origin, with muscovite-biotite gneiss, quartz-feldspar gneiss, augen gneiss with minor amphibolites as the main rock components. These rocks decompose to become varying overburden thickness of permeable calcareous shale and clays. Depending upon its location, the underlying rocks may contain either biotite or muscovite minerals

The soils of the project area are called Tropical Black Clays (Earths) which are typical of the coastal savanna zone that stretches along the coast of Ghana up to a few kilometers inland. They are developed over the basic gneiss in a generally gentle topography and comprise of very dark brown to black clays. These soils, apart from their black colour, also crack deep and wide during the dry season. Most profiles contain calcium carbonate concretions scattered in the subsoil.

### Climate

The proposed site for the SORL oil refinery lies in the coastal savannah zone of Ghana and therefore experiences a dry equatorial climate with bimodal rainfall. Records from the Ghana Meteorological Agency for the last 30 years (1989-2019) indicate that the onset of the major rainfall season is in March and peaks in June with a break between July and August. The minor rainfall starts from September with the highest amount of rainfall registered in October. The annual average rainfall for the period was 694.1 mm with monthly average temperatures between 25.2$^{o}$ C in August and 28.8$^{o}$ C in February.

The proposed project area experiences sunshine throughout the year with an annual average ranging between 5.6hrs in August to 8.4hrs in November for the 30 years of data on sunshine. The average monthly wind flow ranges from 4.0 m/s in December to 5.5 m/s in September. The wind

direction fluctuates mostly between S and SW with the NE (Harmattan) winds occurring briefly from middle of December through January to the early parts of February.

***Air Quality and Noise***

Air quality measurements in the project area revealed that Total Particulate Matter concentration range of 71.10 to 118.40 μg/m³ was below the EPA/Ghana Standards Authority (GSA) standard value of 150μg/m³ for a 24hour averaging time. The levels of the noxious gases, Sulphur dioxide ($SO_2$) and Nitrogen dioxide ($NO_2$) were also within the EPA maximum permissible levels of 520 $\mu gm^{-3}$ and 250 $\mu gm^{-3}$. Integrated Noise Levels (Leq) within and outside the proposed project site ranged from 64.3dB (A) to 78.5 dB (A), also below the relevant EPA and Department of Factories Inspectorate Standards.

**Hydrology**

The SORL refinery will be located on a piece of land, which is part of the catchment of the Chemu Lagoon. The lagoon drains a total area of 26 $km^2$ which stretches from the north-eastern end of the Accra-Tema motorway and the residential areas lying to the west and north of the lagoon. The riverine section of the lagoon flows in an approximately north to south direction before emptying into the Chemu Lagoon itself. The lagoon opens into the sea through a lined trapezoidal channel. Industrial liquid waste and water from the eastern part of the Tema New Town (Manhean) Township converge into a major drain ending up in the lagoon. These pollutants have destroyed the aquatic life of the lagoon. The lagoon has also lost part of its storage capacity due to siltation.

Analysis of the physico-chemical characteristics of surface waters from the proposed project area showed low oxygen levels and high biochemical oxygen demand and nutrient levels. In line with these unsatisfactory, bacteriological analyses of the surface waters indicated excessive occurrence of faecal coliforms and *E. coli* in all of the surface waters, which makes them unfit, not only for direct human consumption but also for primary contact activities such as swimming

**Hydrogeology**

From a study of the hydrogeologic conditions in the entire Accra Plains area based mainly on data obtained from the few production and test wells drilled by the CSIR Water Research Institute, there is limited potential for the transmission and storage of groundwater in the underlying rocks. This is mainly due to the generally impermeable nature of the overburden and the absence of interconnected fractures and joints in the bedrock itself. Additionally, rainfall in the area being low, most of it also results in high run-off over the impermeable surface into gullies and streams that discharge into nearby lagoons.

It is possible to design a well field on the flood plain to tap shallow groundwater. Nonetheless, it is highly suspected that the general quality of the water will be brackish because of tidal flows and evaporative effects on the lagoon waters. Also, this source of water is most likely to be polluted by all kinds of contaminants, especially toxic waste, discharged into the riverine section and into the main body of the Chemu Lagoon.

## Flora and Fauna

The vegetation types in and around the Chemu Lagoon catchment have been greatly disturbed in step with the industrialization of the Tema area. The sand dune has also been heavily mined for sand leaving the area with little vegetation. The present vegetative cover in the project area reflects a diminishing presence of shrubs and a domination of grasses, mainly *Typha* and *Cyperus* sp. This trend is attributed to the expansion of estate and industrial development as well as illegal stone quarrying and sand wining.

The drastic changes and or destruction of the faunal habitats that have taken place in the project area due to anthropogenic activities have led to decreases in both diversity and populations of the original faunal species in the project area. There does not appear to be any fishes, crabs or mud skippers in the main Chemu Lagoon. Animal fauna that occur in the catchment include mammals such as giant rats and squirrels, which are increasingly rarely seen or hunted. However, many avian species including resident and important paleoarctic migrants are common in the area.

## Socio-economic Conditions

### i. Tema Metropolitan Area

The Tema metropolis is entirely urban. Data available from the 2010 Population and Housing Census (PHC) shows that the metropolis has a total population of 292,773 of which 47.8% is male and 52.2% female. In terms of age distribution, the population is mostly comprised of adults (15-64 years of age) who represent 66.7% of the population, whereas children (0-14 years of age) represent 29.4%.

In terms of the distribution of the employed population among various occupations, 31.5% were found to be in service and sales, 20.2% in craft and related occupation, 10.4% in elementary occupations and 9.8% were professionals. The lowest proportion of the employed population were in skilled agriculture, forestry and fishery occupation (4.2%), and clerical support occupation (4.4%). In terms of the sectors that employs the private informal sector is the largest employer with 65.4%, followed by the private formal sector (23.6%) and then public sector (9.3%).

Tema Metropolitan Assembly in collaboration with stakeholders has constructed and operationalized a total number of 51 health facilities in the Metropolis. These facilities comprise both public and private and are spread across the entire Metropolis based on their functions and the range of services they provide. According to the TMA, malaria and upper respiratory tract infections are the most prevalent diseases.

Tema is privileged to have access to all levels of education in the metropolis. The Metropolis has both tertiary and pre-tertiary institutions which can be found in both the public and private sectors. Out of 474 schools in the Metropolis, private institutions constitute 67% while public schools constitute 33%. There are four private universities in the Metropolis. Also, the Metropolis has satellite campuses for three other universities, namely, Presbyterian University, Ghana Institute of Management and Public Administration (GIMPA) and Kwame Nkrumah University of Science and Technology.

### ii. Kpone Katamanso Municipal Area

According to the 2010 PHC, the Kpone Katamanso Municipal Area (KKMA) has a population of 109,864 comprising 48.7% male and 51.3% female. In terms of age distribution, the 0-4 years age group was the highest proportion (13.5%) followed by the 5-9 age group (11.0%). Although majority of the people are in the industrial and the service sectors, agriculture employs about 13.5 percent of the population. KKMA is also noted for fishing, which plays a vital role in the economic development of the Municipality and is predominant in the Kpone area, close to the sea.

The Municipality has access to both private and public health facilities, which number 41 in total (as of 2017) - 26 public and 15 private facilities. In terms of incidence of diseases in the KKMA, malaria was the most recorded case at the Out-Patient Departments of health facilities in the municipality from 2014 to 2016; however, from 2016, upper respiratory tract infections have been the most recorded cases.

The Kpone Katamanso Municipality has 456 educational institutions, out of which 89 are public and 367 private institutions. Furthermore, the Municipality has one private university, (the Valley View University) at Oyibi; three (3) private SHS and one (1) public SHS. The total enrolment in public schools in the Municipality as at April of 2017 was 22,220 pupils. The gross enrolment of boys and girls over the years have increased due to government policies such as Free Compulsory Universal Basic Education (FCUBE), Ghana School Feeding, and Free Uniforms. Available records on enrolment show that girls enrol (36,142 [51%]) more than boys (35,167 [49%]).

Since March 2020, the COVID-19 pandemic has become a leading health issue of concern all over the world, including Ghana, with infections and deaths recorded in both the Tema Metropolis and the Kpone Katamanso Municipality. Indications are that all countries will have to learn to live with the virus infection just like other new diseases like Ebola and Severe Acute Respiratory Syndrome.

## PUBLIC PARTICIPATION/STAKEHOLDER ENGAGEMENT

At the beginning of the impact assessment process, it is mandatory to consult key stakeholders to seek their concerns and appreciation of the project. Consequently, an EPL team consulted with stakeholders within the proposed area for the oil refinery project at the Tema Heavy Industrial Area as well as with traditional authorities and relevant government and interested private institutions. The consultations took place between 10 February and 11 March 2020 during which the following were consulted:

- Management Team of Sentuo Oil Refinery Ltd. (SORL);
- Tema Mantse and elders;
- Volta Aluminium Company Ltd. (VALCO);
- Golden Exotic Ltd.;
- Macro Fertil Ghana;
- Space in Ghana;
- Ghana Police Service, Tema;
- Ghana Fire Service, Tema
- Environmental Protection Agency, Tema;
- Electricity Company of Ghana, Tema;

- SONAPACK Ghana Ltd.;
- Slaughter House, Tema Heavy Industrial Area;
- Wan Heng Ghana Ltd.;
- Ghana Water Company Ltd., Tema;
- Ghana Ports and Harbours Authority;
- Ministry of Energy, Accra;
- Petroleum Commission, Accra;
- National Petroleum Authority, Accra;
- Water Resources Commission, Accra;
- Tema Metropolitan Authority;
- Ghana Water Company Ltd., Tema;
- Tema Veterinary Services;
- Kpone Katamanso Municipal Assembly;
- Volta Aluminium Company Ltd.

Below is presented a summary of the concerns and appreciation for the proposed refinery project. The concerns are presented based on their ranking according to how many times they were raised or came up for discussion during the consultations:

i. SORL to strengthen communication on project details – 11;
ii. Possible flooding of project area and maintenance of buffer zone - 7
iii. Potential negative impacts on the adjacent Tema New Town -7;
iv. Potential negative impacts of refinery on public health in the industrial area - 7;
v. Increased congestion in proposed project area - 7;
vi. Consideration for another location for the proposed refinery – 6;
vii. Acquisition of permits and approvals – 5;
viii. Location of pipelines and other facilities in the proposed project area - 5;
ix. Potential negative impacts of refinery on nearby food and packaging industries - 4;
x. Proposed project area is a wetland – 4;
xi. Issues on and dissatisfaction with land ownership – 2;
xii. Local youth employment – 2;
xiii. Safety of buildings in the proposed project area – 1;
xiv. Incorporation of water storage facilities into project design - 1

The need for SORL to strengthen communication on the project ranked the highest as it was raised eleven (11) times by various stakeholders. The possibility of flooding of the proposed project site and adjacent areas was the second highest (7) with the same ranking as concerns on the potential negative impacts on the adjacent Tema New Town as well as potential negative impacts on public health and increased congestion in the proposed project area. Other key concerns were on consideration for another location for the project (6), acquisition of permits and approvals (5) and location of pipelines and other facilities in the proposed project area (5). In spite of its low ranking, the issue on land ownership is also considered important.

The Kpone Katamanso Municipal Assembly noted that the project will provide jobs to residents of the municipality and provide revenue to the Assembly as well.

VALCO also indicated that, under its envisaged Integrated Aluminium Project, the presence of an oil refinery could be beneficial since the refinery could serve as a source of pitch and coke, which are used in processing of aluminium

## IDENTIFICATION AND EVALUATION OF IMPACTS

The significance of the various impacts has been assessed separately for the Pre-Construction, Construction, Operation and Decommissioning and Closure phases.

### Pre-construction Phase

The following potential impacts were assessed to be significant in the pre-construction phase:

- Potential Impacts on Drainage
- Potential Impacts on Erosion
- Potential Impacts on Employment and Improvement in Economy
- Potential Impacts on Occupational and Public Health and Safety
- Potential Impacts on Land Use
- Potential Impacts of Regulatory Requirements
- Potential Impacts on Relevant Stakeholders (Social Conflicts)

### Construction Phase

The potential negative impacts of major significance during the construction phase are impacts on air quality, dust and vehicular emissions, noise and vibration, drainage (flooding), soils and erosion, surface water and groundwater quality, waste disposal/management, occupational and public health and safety, land use and regulatory requirements.

Other negative impacts of moderate significance for which mitigation measures will also be required include loss of vegetation and displacement of fauna and local traffic congestion during construction of roads, site preparation and mobilization of equipment, as well as social conflicts and delays in construction schedules due to inadequate consultations with relevant stakeholders. A positive impact will be socio-economic impact at the local level.

### Operations Phase

The potential negative impacts of major significance during the operations phase are:

- Potential Impacts on Ambient Air Quality
- Potential Impacts of Noise
- Potential impacts on Drainage
- Potential Impacts on Soils and Erosion
- Potential Impacts on Surface Water and Groundwater Quality
- Potential Impacts of Waste Disposal/Management
- Potential Impacts on Flora and Fauna
- Potential Impacts on Employment and Improvement in Economy
- Potential Impacts on Occupational and Public Health and Safety
- Potential Impacts of Resource Use (Water and Electricity)
- Potential Impacts of Regulatory Requirements;

- Potential Impacts on Relevant Stakeholders.

In the operations phase the project will have significant positive impacts on the national, regional, municipality and local economies. However, there is likely to be significant negative social impacts at the metropolitan, municipality and local levels.

**Decommissioning and Closure Phase**
The following potential impacts were assessed to be significant in the decommissioning and closure phase:

- Potential Impacts on Ambient Air Quality
- Potential Impacts of Noise
- Potential impacts on Drainage
- Potential Impacts on Soils and Erosion
- Potential Impacts on Surface Water and Groundwater Quality
- Potential Impacts of Waste Disposal/Management
- Potential Impacts on Flora and Fauna
- Potential Impacts on Employment and state of Economy
- Potential Impacts on Occupational and Public Health and Safety
- Potential Impacts of Regulatory Requirements;
- Potential Impacts on Relevant Stakeholders.

## MITIGATION OF POTENTIAL IMPACTS

From the identification and evaluation of impacts, mitigation measures are proposed for the potential significant negative impacts in each phase of the proposed oil refinery project.

### Pre-construction Phase

***Drainage***
In view of the importance of flood control in the project area and the serious concerns expressed by some of the adjoining land owners on the need for an adequate drainage system for the area, SORL shall produce drainage designs that would show that the design and the system to be constructed can indeed evacuate the volumes of water that drain the area during the rainy season. Construction of the drainage system will only proceed when these designs are certified by the relevant authorities (TMA, KKMA) as being adequate

Also, SORL shall ensure that only limited land clearing takes place to minimise exposure of soils to erosion. Use of heavy machinery shall also be avoided. In addition, drains/sewers that go through the project site shall not be blocked or otherwise disturbed, ensuring that they remain functional to avoid flooding situations.

***Erosion***
To mitigate the negative impacts on erosion, SORL will adopt a system of cutting inroads to the project site and trenching for temporary drainage channels that respect the natural land contours. The control of soil erosion during the phase will involve the following two basic approaches:

- Reducing runoff amount;
- Reducing runoff velocity.

***Occupational and Public Health and Safety***
To ensure the health and safety of technical teams conducting surveys during the pre-construction phase, SORL shall insist on the mandatory use of appropriate personal and protective equipment such as safety boots and gloves by all team members. Also, in order to cope with, and help control the spread of the COVID-19 pandemic, SORL shall insist on the observance of all recommended protocols by teams during field inspections and surveys as well as during consultations.

***Acquisition of Permits/Regulatory Requirements***
SORL, aware of the need to develop the oil refinery project in a systematic and timely manner, shall in the pre-construction phase:

- Be guided by all the relevant government policies such as the National Energy Policy and the Local Content Policy;
- Satisfy all the relevant regulatory frameworks such as for land acquisition (State Lands Act, 1962 (Act 125), planning and design (Environmental Assessment Regulations, 1999 (L.I. 1652); National Petroleum Act, 2005 (Act 691); and the GHPA Law, PNDC 160);
- Apply for and obtain all the relevant permits including those pertaining to the Local Government Act, 1993, (Act 462), Ghana National Fire Service Act, 1997 (Act 537) and the Water Use Regulations, 2001 (L.I. 1692);
- Ensure local content and local participation, with respect to employment of workers and general procurement according to the Petroleum (Exploration and Production) Act, 2016 (Act 919), Petroleum (Local Content and Local Participation) Regulations, 2013. Labour Act 651, 2003 and Labour Regulations, 2007 (L.I. 1833);

Also, aware that the process technology and equipment for the oil refinery were sourced from China, SORL shall ensure that during the updating of technical designs, the implementation codes for design and operation of the oil refinery will be aligned to available Ghana standards such as those of EPA and NPA.

***Relevant Stakeholders***
As a general mitigation measure to address the concerns raised on inadequate information sharing, SORL shall develop and make operational its Communication Plan on all phases of the project. SORL shall designate a Public Relations Officer to be responsible for implementing the Communications Plan and consulting with all relevant local and administrative stakeholders. Subsequently, SORL in partnership with TDC shall hold discussions with the Tema Mantse to find an amicable solution to the issue of the dissatisfaction of the traditional ruler with TDC for allocating the proposed project site to SORL.

**Construction Phase**

***Air Quality***
To maintain ambient baseline levels of suspended particulate matter and emissions such as CO, $SO_2$ and $NO_2$ as well as to mitigate the impacts of dust, SORL shall:

- Ensure that site preparation and clearing are not conducted in the peak of the dry season;

- Maintain all its work equipment at optimal operating conditions, according to the manufacturers' specifications;
- Minimize dust generation by using covers for sand heaps and / or control systems such as dust suppression by dowsing with water.

***Noise***

To mitigate the negative impacts of increased noise levels arising from the various construction activities, SORL shall:

- Use construction vehicles and equipment with low noise and vibration capacity;
- Use well maintained equipment and screen or muffle noisy systems;
- Ensure that all personnel wear appropriate Personal Protection Equipment (PPE) such as ear plugs in areas of high noise;

***Drainage***

To mitigate the impact of construction activities on flooding in the project site and its environs, SORL shall:

- Ensure that drains passing through the site from the Heavy Industrial Area are not blocked or destroyed. If these drains will be affected by construction activities, they shall be properly relocated in consultation with Tema Municipal Assembly and the neighbouring businesses.
- Design and construct adequate drainage systems in the project site for post-construction stormwater and treated waste water discharges;
- Avoid or cover exposed surfaces from land clearing and excavations that will generate loose sediment to be carried by surface runoff to cause sedimentation of drains and the lagoon.

***Surface Water Quality***

To minimise water pollution, SORL shall institute the following mitigation measures:

- Schedule site clearing and road construction activities to avoid heavy rainfall periods to the extent that is practical;
- Avoid or cover exposed surfaces from land clearing and excavations to prevent loose sediment from being transported by surface runoff into surface waters;
- Use impervious surfaces for refuelling and other fluid transfer areas to prevent their discharge into surface waters;
- Train workers on the correct transfer, handling of fuels, chemicals and response to spills;
- Provide portable spill containment and clean-up equipment on site and training in the equipment deployment.

***Waste Disposal / Management***

All the waste streams shall be properly assessed and managed to ensure that they do not pose health and safety hazards and also pollute surface waters. In particular, SORL shall:

- Provide waste bins with covers at vantage points at the project site for collection of solid waste;
- Contract a Waste Management company in collaboration with TMA and KKMA, to collect solid waste from the project site for final disposal in a landfill;

- Provide sanitary facilities at the temporary work camp and around the project site for workers to prevent open defecation;
- Prohibit dumping or storage of litter/debris, tools and equipment on the sides of public or private roads;
- Use impervious surfaces at refuelling and other fluid transfer areas at plant site;
- Train workers on the correct transfer, handling of fuels and response to spills;
- Provide portable spill containment and clean-up equipment on site and training in the equipment deployment.
- Ensure personnel working at site are trained in the handling and management of wastes.

***Flora***

To mitigate the negative impacts on flora during construction, SORL shall institute the following measures:

- Minimise earth movements at the construction sites;
- Minimise disturbance of vegetation and where necessary, restore with native vegetation after construction;
- Use impervious surfaces at refuelling and other fluid transfer areas at construction sites;
- Train workers on the correct transfer, handling of fuels and chemicals;
- Provide portable spill containment and clean-up equipment on site and training in the deployment of the equipment;

***Occupational Health and Safety***

SORL has commissioned Luoyang Ruize Petrochemical Engineering Co. of Henan, China to design, construct and supervise the construction and commissioning of the proposed oil refinery (SORL 2020). During this phase, the Contractor will adopt construction methods that ensure the greening of the oil refinery plant area. Generally, The Contractor shall be responsible for ensuring the health and safety of all persons involved in the works, whether directly or indirectly, by providing a safe working environment, suitable protective equipment and effective training, among other measures required by statutory regulations. Also, in order to cope with, and help control the spread of the COVID-19 pandemic, the Contractor shall observe all recommended protocols during the construction phase. In practice, the Contractor shall implement construction principles that adapt to local conditions, ensure safety and protect the environment.

Specifically, the Contractor in consultation with SORL shall:

- Appoint an Environmental Health and Safety (EHS) Officer;
- Provide Personal Protective Equipment (PPE) and training on safety procedures;
- Provide First Aid posts and display safety / precautionary measures at selected points on the project site to guide movement and activities of workers and visitors;
- Train selected workers as first aid givers and provide adequate first aid kits at the construction areas to treat minor ailments and cuts. However, major cases will be referred to the Tema General Hospital;
- Train drivers at the site to understand road traffic regulations;
- Enforce speed limits of 50 km/hr. in built-up areas and 10-30 km/hr. at the project site;
- Ensure that movement of heavy-duty trucks and equipment to site or storage areas are carried out in phases and regulated to control the number of trucks and reduce the risk of accidents;

- Ensure that all equipment to be used are in good condition and undergo scheduled regular maintenance to minimise of accidents.

***Public Health and Safety***

The Contractor in consultation with SORL shall:

- Analyse traffic flows and prepare a management plan to ensure that transport of equipment is carried out during low peak periods and to minimise congestion at the construction site;
- Institute adequate traffic management measures to caution the public and to create safety awareness;
- Observe all recommended protocols to control the spread of the COVID-19 pandemic.
- Engage flagmen to man all major intersections to assist with passage of trucks conveying materials and equipment to and from the construction site and storage areas;
- Maintain security personnel who are trained to respect the human rights of the public at the construction site;
- Provide workers and security personnel toilet facilities during the construction period;
- Use indicator linings / reflective warning notices or wire mesh to prevent falls into uncovered trenches or deep excavations;
- Ensure that all the drivers to be engaged possess the requisite qualifications;
- Enclose the project site and strictly control admission of job seekers to discourage idling and irresponsible behaviour.

***Land Use***

To mitigate the negative impacts on land use during construction, SORL shall:

- Rationalize the movement of construction vehicles efficiently to minimise congestion in the project area including use of alternative routes;
- Ensure the regular maintenance of vehicle engines and construction equipment to reduce emissions
- Spray the road construction sites with water to reduce the amount of dust in the air;
- Enforce mitigation measures already proposed for waste management in this phase;

***Regulatory Requirements***

To ensure that construction activities for the oil refinery infrastructure are implemented as scheduled, SORL shall:

- Be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652, National Petroleum Act, 2005 (Act 691), GHPA Law, PNDC 160 , the Labour Act 651, 2003 and Labour Regulations, 2007 (L.I. 1833);
- Apply for and obtain all the relevant permits including those pertaining to the Local Government Act, 1993, (Act 462), Ghana National Fire Service Act, 1997 (Act 537) and the Water Use Regulations, 2001 (L.I. 1692);
- Ensure local content and local participation, with respect to employment of workers and general procurement according to the Petroleum (Exploration and Production) Act, 2016 (Act 919), Petroleum (Local Content and Local Participation) Regulations, 2013. Labour Act 651, 2003 and Labour Regulations, 2007 (L.I. 1833);

***Relevant Stakeholders***
To minimise social conflicts and delays in construction schedules, SORL shall consult with all relevant local and administrative stakeholders with respect to all construction-related activities that may directly or indirectly affect the general public, especially, nearby residents and businesses.

**Operations Phase**

***Ambient Air Quality***
In addition to mitigation measures proposed for the construction phase, other specific general air quality control measures to be instituted by SORL include:

- *Venting and flaring*

Venting and flaring will be used as part of routine operational measures to safely dispose of vapours emitted by the process plant under normal production, accidents, shutdown and emergency situations. A flare management plan will be used to monitor both pollutant concentrations at the ground level and the total quantity of pollutants released annually and to control flare volumes;

- *Emission control of combustion of flue gases from heating furnaces*

In order to reduce the emission of nitrogen oxides from flue gas combustion, low nitrogen burners will be used in the heating furnace;

- *Control of exhaust gas emissions*

The hydrocarbon gas released from the safety valves of each unit will be discharged into the flare system; the gas discharged during accidents and the purge gas that is produced when the system is first started and stopped will also be discharged into the flare system;

- *Control of fugitive emissions*

For fugitive gas emissions control, Vapour Recovery Units, would be used as much as possible instead of open venting or flaring. To reduce the fugitive emissions of hydrocarbon gases, light oil products will be stored in floating roof tanks, and liquefied petroleum gas in spherical tanks;

- *Minimization of SOx emissions*

This will be done through desulphurization of fuels, or by directing the use of high-sulphur fuels to units equipped with SOx emission controls;

- *Treatment of hydrogen sulphide gas*

The gas discharged from each unit will be desulphurized by a gas desulphurization unit, and the purified dry gas used as refinery fuel gas. The hydrogen sulphide will be sent to a sulphuric acid unit to produce sulphuric acid. To prevent fugitive hydrogen sulphide from being directly discharged into the environment, an acid gas flare system will be used;

- *Control of Greenhouse Gas (GHG) emissions*

Aggregate GHG emissions (e.g., $CO_2$, $CH_4$) shall be quantified annually in accordance with internationally recognized methodologies. Appropriate fuel gas systems and flares, and power/waste heat recovery units will be used to minimize GHG emissions. The overall objective would be to reduce GHG emissions and evaluate cost-effective options for reducing emissions that are technically feasible (IFC, 2016);

- *Control of particulate emissions*

High-efficiency air pollution control devices (e.g., bag filters, electrostatic precipitators, scrubbers, third-stage cyclones) will be installed on potentially large sources of particulate matter emissions such as the FCCU regeneration unit. These technologies along with NOx and

SOx emissions control technologies (e.g., wet gas scrubbers) will be employed to additionally control $PM_{2.5}$. A combination of these techniques is expected to achieve >99 percent abatement of particulate matter. Measures to control particulates may also contribute to control of metal emissions from the refinery (IFC, 2016).

***Noise***

Mitigation measures to be instituted by SORL for noise in the operations phase include:

- Use of low-noise equipment, such as low-noise pumps and air-cooler fans;
- Use of sound absorption processing indoors as needed for large compressors, fans and other high-noise equipment;
- Installation of mufflers at steam vents, air vents and induced draft fan inlets;
- Use of low-noise burners for heating furnaces;
- Greening of the plant boundary in such a way as to reduce the impact of noise.

***Drainage***

Stormwater from the refinery plant area and outside the project site, will be drained through the drainage system provided for the purpose and discharged into the outlet of the lagoon to avoid problems with flooding in the area, including the Heavy Industrial Area. The drains will be frequently monitored and maintained to ensure their functionality throughout the life of the refinery.

***Erosion and Soils***

In the operations phase, SORL shall minimise the occurrence of exposed surfaces through greening of the general refinery area, in collaboration with the Department of Parks and Gardens. The greening style will ensure blending with the surrounding environment, buildings and other structures to maintain the aesthetic value of the project area.

***Surface Water and Groundwater Quality***

In addition to mitigation measures for impacts on surface water quality described for the construction phase, the following measures for the operations phase shall be implemented.

- No solid wastes shall be disposed of in the lagoon or project area;
- All water to be discharged into the lagoon from the refinery area shall first be treated to EPA acceptable quality levels in the waste water treatment plant;
- Hydrocarbon and hazardous chemical spillages will be contained, collected and handled according to EPA and industry standard procedures and no spills shall be discharged into the lagoon;
- No spills shall be allowed to infiltrate the soil.

***Waste Disposal / Management***

In addition to those outlined in the construction phase, further measures to mitigate the potential negative impacts of the management of waste generated during operations of the refinery will be implemented as follows:

- Solid waste shall be disposed of by recycling, comprehensive utilization, landfill and incineration according to the nature of the waste to be discharged. All waste catalysts containing precious metals and waste catalysts that must be recovered in connection with patents will be returned to the manufacturers. Wastes with recycling value, such as

unqualified polymers will be downgraded for sale. Qualified, EPA-approved companies will be contracted and entrusted to dispose of hazardous solid wastes such as waste catalysts without recovery value through, for example, safe landfill or incineration.

- The project shall basically follow the principle of pollution minimisation, decontamination and diversion, and classification treatment for the various types of waste water generated during the production process as well as re-use;
- Wastewater shall be divided into sulphur-containing water, oil-containing water and domestic wastewater, which will enter different systems. Sulphur-containing waste water (process water) will undergo sour water stripping and be reused as the first option or sent to the sewage water treatment plant; oily water and domestic sewage will be sent directly to the wastewater treatment plant, and most of the effluent reused;
- Due to its hazardous nature, the following process wastewater management practices shall further be implemented:
    - Prevention and control of accidental releases of liquids through regular inspections and maintenance of storage and conveyance systems, including stuffing boxes on pumps and valves and other potential leakage points, as well as the implementation of spill response plans;
    - Provision of sufficient capacity for storing process fluids to enable maximum recovery into the process and, as a consequence, avoiding large discharges of process liquids into the oily wastewater drainage system;
    - Design and construction of wastewater and hazardous materials storage containment basins with suitably impervious surfaces to prevent infiltration of contaminated water into soil and groundwater;
    - Segregation of process wastewater from storm water and segregation of wastewater and hazardous materials containment basins; and
    - Implementation of good housekeeping practices, including conducting product transfer activities over paved areas and prompt collection of small spills.
- When a fire occurs in the refinery, the wastewater for firefighting will be drained to the 13,000 $m^3$ accident pool using a pipeline for storage. After the fire is extinguished, the waste water in the pool will be pumped to the sewage treatment plant for treatment and discharge;
- Stormwater in the refinery plant area will be collected and discharged to the wastewater treatment plant. Effluent from the wastewater treatment plant will be recycled as much as possible and any excess discharged to the environment through storm drains constructed at the site.

***Storage and Use of Chemical***

GHM will carry out the following mitigation measures against accidental spills and discharges of chemicals in the mine:

- Safe shipments of sodium cyanide in dedicated "ISO-tanktainers" toughened against accidental damage;
- Storing cyanide reagent within bunded areas at the mineral processing plant;
- Storing other reagents on pallets, with integrated spill containment at the existing warehouse or in bunded areas of the mineral processing plant;
- Separating all non-compatible chemicals during storage;

- Making available a list of all chemicals and their properties to all the relevant departments of the mine;
- Operating the processing plant using the best available technology and practices to promote efficiency and prevent major accidents.

***Flora***

In the operations phase, although the expected loss of vegetation will be insignificant, the degrading vegetation of the project area will need to be augmented and maintained. SORL shall therefore:

- In collaboration with the Department of Parks and Gardens, landscape the project site and its adjoining areas and maintain a policy of minimum disturbance of vegetation.

***Employment and Improvement in Economy***

The possibility that the operations phase could negatively impact the local and national economies through gaseous emissions that could contaminate products in warehouses nearby needs addressing. Hence, SORL shall:

- Ensure that minimal gaseous emissions take place by following the measures proposed above to control the negative impacts of gaseous emissions;
- Monitor the air quality in order to prevent gaseous emission going above permissible levels;

***Occupational Health and Safety***

SORL shall carry out the following measures for mitigation of the potential negative impacts on occupational health and safety.

SORL shall:

- Develop an Occupational Health and Safety Plan, including requirements for PPE, task risk assessment, mandatory training, audit and monitoring and incident reporting;
- Develop Emergency Response Plans for the different operations;
- Ensure that the workers are provided with adequate PPE including overalls, earplugs, anticorrosive gloves as their particular operations would require;
- Observe all recommended protocols to control the spread of the COVID-19 pandemic.
- Provide non-conductive hand tools rated for the voltage at which live electrical works are performed;
- Place precautionary / warning signs at vantage points around the project site;
- Undertake risk assessments to indicate the avoidance / elimination of hazards associated with manual handling of chemicals;
- Ensure that workers handling fuels, chemicals, machinery and equipment are well trained on the dangers the handlings;
- Issue permits to cover work system of high temperature, risky electrical and works at heights;
- Ensure that all staff working on live equipment or lines are without conductive apparel (watches, bracelets, rings, key chains, necklaces, cloth with conductive thread, etc.);
- Provide barricades and signage for all live electrical equipment;
- Set up flammable / toxic gas alarms to indicate accumulation / dangers in the installation areas, tank and oil loading / unloading operation areas;

In general, good housekeeping practices will be an integral part of the refinery operations to maintain a well laid out working space and avert accidents.

Further to the above, other specific mitigation measures have been proposed for:

*Prevention / Control of asphyxiating conditions and inhalation hazards;*
*Noise;*
*Prevention and Control of Fires and Explosions;*
*Heat;*
*Hazardous chemicals;*
*Solid Waste and Wastewater Management;*
*Operation of Clinic/First Aid Post.*

***Public Health and Safety***

In order to prevent other enterprises and residents around the project site from being affected by atmospheric pollutants due to the refinery operations, the local wind direction, wind speed, dominant wind frequency and topographical factors have been fully considered in the general laying out plan of the project site. In addition, mitigation measures for air quality and noise for the physical environment shall also be applied for public health and safety in the operations

***Resource Use (Water and Electricity)***

SORL shall supplement its water supply from GWCL from other sources such as an on-site desalination plant. Also, its electricity supply from ECG shall also be supplemented from on-site diesel generators. The aim of these measures is to not deprive other users of adequate access to these resources. This is especially important for treated water supply from the GWCL since its quantity is currently not enough to meet demand in the Tema Municipality and rationing is being implemented to manage the situation.

***Regulatory Requirements***

SORL shall operate the oil refinery taking into consideration the current regulatory requirements in Ghana. Thus, SORL shall:

- Be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652 and the National Petroleum Act, 2005 (Act 691);
- Ensure local content and local participation with respect to employment of workers and general procurement (Petroleum Local Content and Participation Regulations, 2013);
- Comply with those regulations for employment, (Labour Act 651, 2003) and Labour Regulations, 2007 (L.I. 1833), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), and water use (Water Use Regulations, 2001 (L.I. 1692). Others are the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) and the EPA Environmental Quality Standards for noise, air quality and effluent discharges.

***Relevant Stakeholders***

During the operations phase, SORL shall, using its Communication Plan:

- Maintain cordial relationships with the Tema Mantse who is responsible for the Tema New Town community;
- Consult with all relevant local and administrative stakeholders;

***Ambient Air Quality***
To control gaseous emissions from vehicles and operations of machinery as well as dust emissions, SORL and its contractors shall:

- Use water bowsers to dampen dusty roads to ensure dust suppression;
- Impose vehicle speed limitation on all unpaved roads and tracks;
- Ensure strict compliance with the maintenance schedule of all vehicles and equipment;
- Comply with the EPA Air Quality Standards;

***Noise***
To protect personnel from being exposed to noise levels above 85dBA, SORL and its contractors shall:

- Ensure that all personnel use the appropriate personal protection equipment;
- Comply with EPA Ambient Noise Standards;

***Drainage***
SORL shall apply the same mitigation measures as for the operations phase as the impacts here are similar to those for drainage in that phase.

***Surface Water Quality***
These impacts will occur under similar conditions as for pollution of surface water in the construction phase. SORL shall therefore use the same mitigation measures as for the construction phase.

***Waste Disposal / Management***
To ensure safe disposal of waste during the decommissioning and closure phase, SORL and its contractors shall:

- Provide sanitary facilities at the decommissioning sites for workers to prevent open defecation;
- Prohibit dumping or storage of litter/debris, tools and equipment on the sides of access or side roads;
- Use impervious surfaces at refuelling and other fluid transfer areas at decommissioning sites;
- Train workers on the correct transfer, handling of fuels, chemicals and response to spills;
- Provide portable spill containment and clean-up equipment on site and training in the deployment of the equipment;
- Ensure personnel working at site are trained in the handling and management of wastes.

***Flora***
To mitigate the potential negative impacts on flora, SORL shall mandate each contractor to ensure proper handling of waste. For example, each contractor shall:

- Prohibit dumping or storage of litter/debris, tools and equipment on the sides of access or internal roads;
- Provide portable spill containment and clean-up equipment on site;
- Ensure personnel working at site are trained in the handling and management of wastes.

***Occupational and Public Health and Safety***
To mitigate the potential negative impacts on the health of workers and the general public, SORL shall mandate each contractor to apply preventive measures including:

- Using water bowsers to dampen dusty roads and exposed surfaces on site to ensure dust suppression;
- Complying with vehicle speed limits on all unpaved roads and tracks;
- Ensuring strict compliance with the maintenance schedule of all vehicles and equipment;
- Complying with the EPA Air Quality Standards;
- Procuring firefighting equipment and training workers on their use;
- Providing Personal Protective Equipment and training on safety procedures to workers;
- Observe all recommended protocols to control the spread of the COVID-19 pandemic.

***Regulatory Requirements***
SORL shall require all contractors to conduct the decommissioning and closure phase activities taking into consideration the relevant regulatory requirements such as those for employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537) and the EPA Environmental Quality Standards for noise, air quality and effluent discharges.

## PROVISIONAL ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS

SORL's Provisional Environmental Management Plan (PEMP) is part of this EIS to control and direct activities during the first 18 months of development and operation of the proposed refinery project. To comply with Regulation 24(2) of the Environmental Assessment Regulations, 1999 (L.I. 1652), SORL will prepare an EMP that updates the Provisional EMP and addresses activities to be carried out in the subsequent three years of operation. The EMP will be updated every three years throughout the life of the refinery project.

The provisional environmental monitoring plan is designed as a strategy for collecting the necessary data on implementation of mitigation measures to assess their effectiveness in managing the identified potential impacts of the refinery activities. Relevant records will be kept to ensure compliance with mitigation measures recommended in the EIA. The records will also be used to prepare various post-EIS reports as required by EPA.

## CONCLUSION

In line with Ghana's Environmental Assessment Regulations, 1999 (L.I. 1652), SORL has conducted an Environmental Impact Assessment to obtain an environmental permit to implement the project. Based on the details of project activities and concerns and issues raised during consultations with various stakeholders, in addition to the current environmental and socio-economic baseline information on the project location and its area of influence, potential impacts have been identified.

In general, the project will have positive impacts on the local, regional and national economies in the form of improvement in the supply of petroleum products. With a current national daily

demand of 83,000 barrels of crude oil, and production of about 50,000 barrels, the modern refinery will contribute to filling this demand gap and also satisfying international markets. The project will also support employment and generation of income from taxes and levies and business opportunities to contractors and suppliers, among others. In the Greater Accra Region, it will support 350 direct jobs.

However, there are also potential negative impacts that need to be addressed. These include concerns raised during consultations with stakeholders such as the lack of detailed information on the project, possible flooding of the project area because it is part of a wetland, impacts on public health in the industrial area and Tema New Town and increased congestion in the project area. Measures have been proposed to mitigate the potential negative impacts including the use of a Communication Plan to increase public awareness of the project and development of an Emergency Preparedness Plan to safeguard both occupational and public health. Other mitigation measures have also been included in the project design to control gaseous emissions, risk of fire and explosions as well as control flooding using up-to-date engineering designs backed by good environmental practices. For example, SORL, aware that the project area is part of a wetland that is susceptible to flooding during the rainy season, intends to design and put in place an adequate drainage system that can cater for the water that runs through the entire project area to avoid problems with flooding.

Overall, the proposed oil refinery project, represents for Ghana, a very important development opportunity because it is in line with the policies of the Government of Ghana, which aim to secure a reliable supply of high quality energy services for all sectors of the Ghanaian economy and also to become a major exporter of oil and power. Counting on SORL's appropriate implementation of the Provisional Environmental Management Plan, it can be concluded that the benefits of the project will far outweigh the identified potential adverse impacts.

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## ACRONYMS AND ABBREVIATION

| | |
|---|---|
| ADU | Atmospheric Distillation Unit |
| BOD | Biochemical Oxygen Demand |
| bpsd | Barrels per stream day |
| CCU | Catalytic Cracking Unit |
| COD | Chemical Oxygen Demand |
| CSIR | Council for Scientific and Industrial Research |
| CSR | Corporate Social Responsibility |
| DCMP | Decommissioning and Closure Management Plan |
| DCS | Distributed Control System |
| DO | Dissolved Oxygen |
| ECG | Electricity Company of Ghana |
| ECOWAS | Economic Community of West African States |
| EIA | Environmental Impact Assessment |
| EHS | Environment, Health and Safety |
| EIS | Environmental Impact Statement |
| EMA | Environmental Management Associates |
| EMP | Environmental Monitoring Programme |
| EPA | Environmental Protection Agency |
| EPL | Environmental Partnership Limited |
| ERP | Emergency Response Plan |
| FCC | Fluid Catalytic Cracking |
| GEL | Golden Exotic Limited |
| Gmet | Ghana Meteorological Authority |
| GNFS | Ghana National Fire Service |
| GNPC | Ghana National Petroleum Corporation |
| GPHA | Ghana Ports and Harbours Authority |
| GSS | Ghana Statistical Services |
| GWCL | Ghana Water Company Limited |
| HSSE | Health Safety Security and Environment |
| IFC | International Finance Corporation |
| KKMA | Kpone Katamanso Municipal Assembly |
| L.I. | Legislative Instrument |
| LNG | Liquefied Natural Gas |
| LPG | Liquefied Petroleum Gas |
| MoEn | Ministry of Energy |
| MTBE | Methyl Tetra Butyl Ether |
| NEPAD | New partnership for Africa's Development |
| NFLRP | New Foundland and Labrador Refinery Project |
| NMTG | Naphtha-methanol-to-gasoline |
| NPA | National Petroleum Authority |
| PEMP | Provisional Environmental Management Plan |
| PHC | Population and Health Census |
| PNDC | Provisional National Defence Council Law |

| | |
|---|---|
| PPE | Personal Protective Equipment |
| SORL | Sentuo Oil Refinery Limited |
| TDC | Tema Development Company |
| TMA | Tema Metropolitan Assembly |
| ToR | Terms of Reference |
| TOR | Tema Oil Refinery |
| UNEP | United Nations Environmental Programme |
| VALCO | Volta Aluminium Company |
| VDU | Vacuum Distillation Unit |
| WHO | World Health Organization |
| WRC | Water Resources Commission |

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# CHAPTER 1 INTRODUCTION

## 1.1 Background to Project

Sentuo Oil Refinery Limited (SORL) was incorporated in Ghana on 18 November 2018 under the Company Registration Number CS329482018 and certified to commence business on 28 November 2018 (Appendices 1-1.1 and 1-1.2). SORL intends to construct and operate an oil refinery at Tema in the Greater Accra Region of Ghana (Figure 1-1.1).


Source: [www.nationsonline.org](http://www.nationsonline.org)

**Figure 1-1.1 Location of Proposed Project Area**

The oil refinery project will be located at the Heavy Industrial Area in Tema (Plate 1-1.1) and SORL secured Plot No. IND/HI/21/5) from the Tema Development Company (TDC) on 19 December 2019 as per the correspondence attached (Appendix 1-1.3).


**Plate 1-1.1 Proposed Site for Oil Refinery at Tema Heavy Industrial Area**

The proposed oil refinery will process 3 million metric tons sour crude oil per year into 1.12 million metric tons of gasoline, 1.23 million metric tons of diesel and various amounts of LPG, benzene, aromatics, xylene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil (SORL, 2019 a, b).

It will process light crudes from Saudi Arabia, Kuwait and Nigeria and will be implemented in two phases. The major components for Phase 1 of the refinery are (SORL, 2020):

- 1.5 Million tons per year atmospheric distillation unit;
- 0.8 Million tons per year heavy oil catalytic unit;
- 0.6 Million tons per year diesel hydrogenation unit;
- 0.3 Million tons per year naphtha NMTG device;
- 0.4 Million tons per year catalytic gasoline selective hydrogenation unit;
- 0.6 Million tons per year sulphuric acid combined plant.

Similar equipment will be installed under Phase 2 and the two phases will be integrated together.

As indicated in Appendix 1-1.4, SORL has initiated the process to secure an Environmental Permit for the project by registering the proposed undertaking on 05 December 2019 with the Ghana Environmental Protection Agency (EPA). SORL has subsequently commissioned Environmental Partnership Limited (EPL) to carry out the EIA.

## 1.2 Project Justification

The justification by SORL to establish the oil refinery is firmly rooted in the continuing increasing demand for refined petroleum products to accelerate socio-economic development not only in Ghana but in neighbouring West African countries (SORL, 2019a). The Tema Oil Refinery (TOR), established in 1957 with a 45,000 barrel per day capacity, is still the only

major oil refinery in Ghana. Platon Gas Oil Limited, the first private functional oil refinery in Ghana, established in 2014, has a maximum capacity of about 6,000 barrels per day (SORL, 2019a).

With a current national daily demand of 83,000 barrels, there is clearly the need for a modern refinery to fill this demand gap and also satisfy international markets. SORL, with its strategic objective to improve the supply of oil, fuel and gas in Ghana, has therefore decided to construct and operate an oil refinery in Tema to process crude oil into various products. This is clearly in line with the policies of the Government of Ghana, which aim to develop an Energy Economy to secure a reliable supply of high quality energy services for all sectors of the Ghanaian economy and also to become a major exporter of oil and power (MoEn, 2010). SORL's assessment indicates an economically viable investment with projections of a profit of US$73,560,060 in the first year of operations, rising to US$156,712,619 after the Phase 2 is operational (SORL, 2020). The cash flow analysis reveals that the project will yield enough cash to meet its debts servicing obligations.

The proposed project will have a number of socio-economic effects at the national, regional and local levels. At the national level for example, the refinery operation will contribute directly to government income tax. In the Greater Accra Region, it will support 350 direct jobs.

## 1.3 Objectives of the Environmental Impact Assessment

According to Ghana's Environmental Assessment Regulations, (L.I. 1652, 1999), an Environmental Impact Assessment (EIA) is mandatory for this proposed activity. EIA is a systematic process to identify, predict and evaluate the environmental and social impacts of proposed activities or projects (UNEP, 2002). It analyses the positive and negative impacts of a planned activity to provide information that allows for introduction of environmental protection and social-economic considerations into the execution of the activity.

The general objectives of an EIA are therefore to:

- Provide information for decision making by regulators, the public and host communities on the environmental and social consequences of proposed actions;
- Promote sustainable environmental and socio-economic development through the identification of appropriate enhancement and mitigation measures;

The immediate objectives of the EIA study are to:

- Predict the consequences of all phases of the development of the oil refinery at Tema from the environmental, social, economic and cultural perspectives;
- Identify appropriate measures for mitigating the potential negative impacts of the project;
- Provide avenues for the involvement of the public, government and private sector in the assessment and review of the impact of the proposed project activities;
- Facilitate informed decision-making, including setting the environmental and social terms and conditions for implementing the project.
- Improve the environmental and social designs of the proposed project;
- Ensure that resources are used appropriately and effectively;
- Meet the requirements of the Ghana EPA for the issuance of an Environmental Permit for SORL to commence the oil refinery project.

The long-term objectives of the EIA study are to:

- Protect human health and safety;
- Avoid irreversible changes and serious damage to the environment;
- Safeguard valued resources and the natural ecosystems;
- Support the goals of environmental management and sustainable development.

## 1.4 Approach and Methods for the Environmental Impact Assessment

As indicated in Section 1.1 above, SORL has initiated the process of securing an Environmental Permit for the project by registering the proposed project on 05 December 2019 with the EPA. To obtain an Environmental Permit, SORL has followed the EPA Guidelines for Large Scale and Significantly Impacting Undertakings. The highlights are:

### *1.4.1 Scoping and Terms of Reference for EIA*

The next step in the conduct of the EIA is for SORL to undertake a scoping exercise which involves extensive consultations with interested and/or affected parties. According to the Environmental Assessment Regulations, 1999 (L.I. 1652), an EIA begins with a scoping exercise the report of which shall set out the scope or extent of the EIA and shall include a draft Terms of Reference (ToR) indicating the essential issues to be addressed.

The Consultant, EPL, identified various categories of stakeholders and held discussions with them during field visits and office consultations in February and March 2020. Stakeholders consulted included the Tema Metropolitan Assembly, Kpone Katamanso Municipal Assembly, Ministry of Energy, National Petroleum Authority and private organizations. The experiences of these stakeholders thus formed the bases of concerns and appreciations of the oil refinery project. Meetings were also held with the management of SORL. In addition, the Consultant provided the stakeholders with letters (Appendix 1-1.6) stating the purpose of the project and requesting for comments with respect to their concerns and appreciation for the oil refinery project.

SORL presented a draft Scoping Report with the ToR for the EIA study to the EPA under its letter EP/EA/01/19 and dated 16 April 2020. Comments received from EPA on the draft report referenced CF.: 7316/05 and dated 21 May 2020 are presented in Appendix 1-1.7. Chapter 6 of this Environmental Impact Statement (EIS) presents details of the scoping exercise.

### *1.4.2 Environmental Impact Assessment Study*

The Consultant conducted the EIA study on behalf of SORL further to the approval of the Scoping Report by EPA. The EIA followed the requirements of the EPA as follows:

**i. Literature Review**

The Consultant assembled and analysed data and information on the relevant environmental and socio-economic characteristics of the project area with the objective of describing the area as it is currently and as it would be expected to develop if the project were not to proceed. Data and information were obtained from SORL and from such sources as the Council for Scientific and Industrial Research (CSIR), Environmental Protection Agency, Tema Metropolitan Assembly, Kpone Katamanso Municipal Assembly, Ministry of Energy, National Petroleum Authority and international agencies including the IFC. The Consultant also undertook field

trips to the project area for validation of the literature and further collection of baseline data and information.

**ii. Expert Studies**

The field visits during stakeholder consultations and for data collection between February and May 2020 provided the opportunity for the Consultant to get acquainted with the project site and its area of influence and make observations and measurements on the natural and socio-economic resources of the project area. The Consultant therefore conducted baseline studies, which included the following:

- Climate and air quality;
- Noise levels;
- Water resources;
- Fauna and Flora;
- Socio-economic status;

### *1.4.3 Layout of the Environmental Impact Statement*

As presented in the Terms of Reference of the scoping report (Chapter 6) approved by the EPA, the Environmental Impact Statement has the following layout:

i. Executive Summary;
ii. Introduction;
iii. Policy, Legal and Regulatory Frameworks;
iv. Description of the Proposed Project;
v. Consideration of Alternatives;
vi. Existing Baseline Conditions;
vii. Public Participation;
viii. Identification and Evaluation of Potential Impacts;
ix. Mitigation of Potential Impacts;
x. Provisional Environmental Management and Monitoring Plan;
xi. Decommissioning and Closure;
xii. Conclusions
xiii. List of References
xiv. Appendices

# CHAPTER 2 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORKS

This section presents overviews of the policy, legal and regulatory and institutional frameworks relevant to the proposed project by Sentuo Oil Refinery Limited (SORL) at the Tema Heavy Industrial Area.

## 2.1 National Policy Frameworks

The key national policies relevant to the proposed oil refinery are:

- The Constitution of Ghana, 1992;
- National Environment Policy, 2012;
- National Energy Policy, 2010;
- Local Content Policy in the Oil and Gas Sector, 2010;
- National Land Policy, 1999;
- National Water Policy, 2007.

These are summarized below.

### i. The 1992 Constitution of Ghana

The 1992 Constitution provides a broad policy basis for the protection of the environment in Ghana. In Chapter 6, under the Directive Principles of State Policy, the Constitution places a responsibility on every Ghanaian and the government to protect and safeguard the environment for posterity. It also requires the government to take the relevant steps, in collaboration with appropriate agencies, to protect and defend the national environment for future generations. Article 36 (9) of the Constitution states that "*The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek cooperation with other states and bodies for purposes of protecting the wider international environment for mankind".* Article 41 (k) states that *"The exercise and enjoyment of rights and freedoms is inseparable from the performance of duties and obligations, and accordingly, it shall be the duty of every citizen to protect and safeguard* the environment".

### ii. National Environment Policy

The basis of the Environmental Policy of Ghana is grounded in Article 36(9) of the 1992 Constitution, as stated above. The National Environment Policy was launched in 2012 to replace the 1995 policy, with the vision to manage the environment in a sustainable manner to benefit Ghanaian society. Its ultimate aim is to improve the surroundings, living conditions and the quality of life of the entire citizenry, both present and future. It seeks to promote sustainable development through ensuring a balance between economic development and natural resource conservation. The policy thus makes establishing a high quality natural environment a key element supporting the country's economic and social development. The proposed oil refinery project will thus take all the appropriate steps to safeguard the natural environment of the project area during all the different phases, pre-construction, construction, operations, decommissioning and closure.

### iii. National Energy Policy

The National Energy Policy is intended to guide the development and management of Ghana's energy sector, especially the emerging oil and gas sector. The policy creates a conducive environment for increased investment in the energy sector in Ghana to create jobs, national

value added and export revenues. The proposed oil refinery project is line with the policy's call for investment in the energy sector to create jobs, national value added and export revenues. SORL shall adhere to the guidelines for the development and management of the energy sector in Ghana.

**iv. Local Content Policy**

The Local Content Policy outlines strategies on how the Government intends to develop the oil and gas industry with optimal local content and local participation by enhancing national development, creating jobs and effectively managing the potential revenue from oil and gas production and processing, in addition to ensuring security for oil and gas installations in the industry as a whole. The Policy is geared towards a progressive and comprehensive integration of Ghanaians into all aspects of the oil and gas industry to ensure the benefits of the industry are maximised for Ghanaians through education, skills and expertise development, the transfer of technology and active research and development activities. A key aspect of the Policy is that it targets a minimum of 90 per cent local participation in all aspects of the oil and gas value-chain by 2020. The legislation requires that an oil and gas company such as SORL must obtain 60 to 90 % of its goods and services from domestic sources within 10 years of its operation in the Ghana.

**v. National Land Policy**

The National Land Policy provides the framework for the sound management and utilization of the country's land and other natural resources in order to enhance the conservation of environmental quality, preserve options for the present and future generations and secure human sustenance. One key aspect of the objectives of the Policy is to protect the rights of landowners and their descendants from becoming landless or tenants on their own lands. Among the guiding principles of the Ghana Land Policy Subsection (3.1), are (i) the principle of optimum usage for all types of land, including human settlements, industry and commerce, agriculture, forestry and mining, the protection of water bodies and the environment in the long term national interest; (ii) the principle of government facilitating equitable and reasonable access to land within the context of national land use planning and the (iii) the principle of fair access to land and security of tenure.

The implementation of the project satisfies the policy principles stated in subsection 3.1 (i and ii) which call for the optimum usage for land by embarking on industrial development such as an oil refinery and government represented by TDC facilitating access to the land within the context of national land use planning.

**vi. National Water Policy**

The National Water Policy of Ghana, approved in June 2007, is intended to provide a framework for the sustainable development of Ghana's water resources. The overall goal of the policy is to "*achieve sustainable development, management and use of Ghana's water resources to improve health and livelihoods, reduce vulnerability while assuring good governance for present and future generations*". The policy objectives are to: i) ensure availability of water for hydropower generation, various industrial and commercial uses, mining operations, water transport and recreational purposes; and ii) ensure adequate protection of water sources in mining and other industrial areas. The policy recognises the various cross-sectoral issues related to water-use and the links to other relevant sectoral policies such as those on sanitation, agriculture, transport and energy. The oil refinery project will be implemented taking into account the objectives of the water policy. The project will recycle

water and treat process water and wastewater and these practices will contribute to ensuring adequate protection of water sources and availability of water for the industrial use.

## 2.2 Legal and Regulatory Frameworks

From legal and regulatory perspectives, there are a myriad of laws and regulations in Ghana that address protection of the environment and society. It is important for the SORL to be aware of and operate within the pertinent laws and legislation applicable to the energy sector.

This section presents an overview of the key legislation and relevant frameworks that relate to environmental protection and other social aspects of the oil refinery project.

i. Environmental Protection Agency Act, 1994 (Act 490);
ii. Environmental Assessment Regulations, 1999, (L.I. 1652);
iii. EPA Fees and Charges (Amendment) Instrument 2015, L.I. 2228;
iv. Relevant EPA Environmental Quality Standards include:

- Environmental Quality Standards for Ambient Air on maximum permissible levels of a variety of air pollutants;
- Environmental Quality Standards for Ambient Noise on the maximum permissible noise levels; and
- Sector Specific Effluent Quality Standards for Discharges into Natural Water Bodies.

v. National Petroleum Authority Act, 2005, (Act 691);
vi. Petroleum Revenue Management Act, 2011 (Act 815);
vii. Petroleum Revenue Management (Amendment) Act, 2015 (Act 893);
viii. Petroleum (Local Content and Local Participation) Regulations, 2013 (L.I. 2204);
ix. Petroleum Commission (Fees and Charges) Regulations, 2015 (L.I. 2221);
x. Ghana National Fire Service Act, 1997 (Act 537);
xi. Fire Precaution (Premises) Regulations, 2003 (L.I. 1724);
xii. Administration of the Lands Act, 1962 (Act 123);
xiii. State Lands Act, 1962 (Act 125);
xiv. Labour Act, 2003 (Act 651);
xv. Water Resources Commission Act, 1996 (Act 522);
xvi. Water Use Regulations, 2001 (L.I. 1692);
xvii. Lands Commission Act, 2008 (Act 767);
xviii. The Local Government Act, 1993 (Act 462);
xix. Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917);
xx. Hazardous, Electronic and Other Waste (Classification) Control and Management Regulations, 2016 (L.I. 2250).

Details of the most relevant legal and regulatory frameworks are provided below:

**i. Environmental Protection Act**

The Environmental Protection Act, 1994 (Act 490) established the authority, responsibility, structure and funding of the EPA. The Agency is empowered under Act 490 to "*require any person responsible for any undertaking which in the opinion of the Agency has or is likely to have adverse effect on the environment to submit to the Agency in respect of the undertaking an environmental impact assessment containing such information within such period as shall be specified in the notice*". The EIA process is legislated through the Environmental Assessment Regulations, 1999 (L.I. 1652).

**ii. Environmental Assessment Regulations**

The Environmental Assessment Regulations, 1999 (L.I. 1652) were established in 1999 pursuant to the EPA Act, 1994 (Act 490) and amended in 2002. Primarily, the Regulations require that before the commencement of any activity which relates to the environment, such an activity or undertaking be registered by the EPA and an Environment Permit issued in respect of the undertaking, based on the Ghana Environmental Impact Assessment Procedures. Thus, activities such as those of an oil refinery, which have the potential of adversely affecting the environment must first be subject to an Environmental Impact Assessment before the Environmental Permit is granted. The Environmental Assessment Regulations, also provide for the submission of environmental management plans and annual environmental reports to the EPA.

This Environmental Impact Statement for SORL has been prepared in compliance with the above requirements. The proposed oil refinery project will be planned, designed, developed and operated with due cognisance to the Environmental Permit requirements of the EPA. Among others, SORL is also required to present the Environmental Permit from EPA to the National Petroleum Authority to obtain a permit for the construction of the oil refinery.

**iii. Relevant EPA Environmental Standards**

- Environmental Impact Assessment Procedures (1995) on the procedures to be adhered to when undertaking an EIA;
- Environmental Quality Standards for Ambient Air on maximum permissible levels of a variety of air pollutants;
- Environmental Quality Standards for Ambient Noise on the maximum permissible noise levels;
- Sector Specific Effluent Quality Standards for Discharges into natural water bodies.

The proposed oil refinery will discharge gaseous, liquid and solid wastes that shall comply with the above standards.

**iv. National Petroleum Authority Act**

The National Petroleum Authority Act, 2005 (Act 691) established the National Petroleum Authority (NPA) to regulate, oversee and monitor activities in the downstream sector of the petroleum industry, including importation of crude oil and establishment of oil refineries. The NPA is also empowered by the Act to establish a unified petroleum price fund taking cognisance of the prescribed petroleum pricing formula; and to provide for related purposes.

The objectives and functions of the NPA are: i) to monitor and regulate petroleum prices in accordance with the prescribed pricing formula, ii) to grant licenses to service providers and marketing companies, iii) to protect the interests of consumers and maintain the highest standards of petroleum products offered to them. Its notice, NPA.N.017, provides the requirements for a permit (Appendix 2-2.1) to construct a petroleum refinery such as that proposed by SORL. The company shall therefore apply to the NPA for the relevant licences to establish, construct and operate an oil refinery.

**v. Petroleum (Local Content and Local Participation) Regulations**

The Petroleum (Local Content and Local Participation) Regulations, 2013 is in several sections that cover specific issues. Sections 1 to 4 elaborate the general provisions, covering: purpose and scope of the petroleum policy, Ghanaian content obligation on companies carrying out

petroleum activity and prioritization the interests of Ghanaians. Regulation 1(h) states "*to provide for the submission of the local content plan and related sub-plans by contractors, subcontractors, licensees and any other allied entity involved in the petroleum industry including:*

*(i) Provision of goods and services;*

*(ii) Transfer to the Corporation or the Commission and Ghanaians of advanced technology and skills related to petroleum activities;*

*(iii) Recruitment and training programme".*

Regulation 3 states that *"a contractor, subcontractor, licensee, the Corporation or other allied entity carrying out a petroleum activity shall ensure that local content is a component of the petroleum activities engaged in by that contractor, subcontractor, and licensee, the Corporation or other allied entity"*.

Regulations 6 and 17-34 cover local content plans and require entities operating in petroleum activity to submit both long-term and annual local content plans as well as sub-plans detailing how they intend to achieve local content goals. The proposed oil refinery is owned by the Sentuo Group Limited, a private enterprise that has operated in Ghana since 2010 (SORL, 2020) and has therefore gained experience in application of the above regulations. SORL shall operate within the requirements of the above regulations in all the different activity phases of the oil refinery.

**vi. Ghana National Fire Service Act**

The Ghana National Fire Service Act 1997 (Act 537) established the Ghana National Fire Service with an objective of prevention and management of undesired fires and other related matters. Among others, the Service is expected to organise public fire education programmes to create and sustain awareness of the hazards of fire; heighten the role of the individual in the prevention of fires; provide technical advice for building plans in respect of machinery and structural layouts to facilitate escape from fire, rescue operations and fire management; and offer rescue and evacuation services as well as train and organize fire volunteer squads at community level.

**vii. Fire Precaution (Premises) Regulations**

The Ghana National Fire Service Act, 1997 (Act 537) states that a fire certificate will be required for premises used as a public place or place of work. This requirement is reinforced by the Fire Precaution (Premises) Regulations, 2003 (L.I. 1724). It is incumbent on any project developer to ensure that adequate measures are introduced to minimise or prevent fire outbreaks and a fire permit is obtained for development prior to the commencement of works. SORL shall apply for a fire certificate and other related permits before commencement of construction works.

**viii. State Lands Act**

The State Lands Act, 1962 (Act 125) was enacted to provide for the acquisition of land for national and other purposes connected therewith. The Act vests the authority to acquire land for public interest in the President of the Republic. It also gives responsibility for registering a claim on the affected persons or group of persons. In addition, it provides some details to be considered when computing compensation such as definitions for i) cost of disturbance, ii) market value, replacement value, etc. SORL acquired the land for the proposed project from the appropriate government body, Tema Development Company, which has oversight responsibility for the Acquired Area in the Tema metropolis.

**ix. Lands Commission Act**

The Lands Commission Act 2008, (Act 767) accentuated the establishment of the Lands Commission through Articles 258 to 265 of the 1992 Constitution. The Act provides the legal basis for four land sector agencies to merge as Divisions. These are the Land Valuation Division, Land Registration Division, Survey and Mapping Division and the Public and Vested Land Management Division. The Commission achieves its mandate through the promotion of judicious use of land in accordance with sustainable land management principles and maintenance of sound ecosystems. Other land management institutions under the control of the Commission include the Office of the Administrator of Stool Land.

The proposed project requires registration of the land acquired, an activity that falls under the Lands Commission. The Project will also be implemented in line with the objectives of the Commission for sustainable development of land.

**x. Local Government Act**

The Local Government Act, 1993 (Act 462) gives responsibility to District Assemblies to exact and enforce bye-laws and implement government policy at the local level. This Act establishes and regulates the local government system and gives authority to the Regional Coordinating Council and the District Assembly to exercise political and administrative power in the regions and districts, provide guidance, give direction to, and supervise all other administrative authorities in the regions and districts. The District Planning Authority established under the Act is mandated to: i) initiate and prepare district development plans and settlement structure plans; ii) integrate and ensure compatibilities among sector and spatial policies, plans, programmes and projects of the district; iii) synthesize the policy proposals on development planning in the district into a comprehensive framework for the economic, social and spatial development of settlement, and so on. The proposed oil refinery project is situated within the Tema Metropolitan Area and the Kpone Katamanso Municipality and the respective Assemblies shall be fully engaged in its implementation.

**xi. Water Resources Commission Act**

The Water Resources Commission (WRC) was established under the WRC Act, 1996 (Act 522) with a mandate to regulate and manage Ghana's water resources as well as stream government policies in the water resources sector. Among others, WRC has the power to grant water rights. Section 13 of the Act prohibits the use of water (divert, dam, store, abstract or use water resources or construct or maintain any works for the use of water resources) without authority and Section 16 empowers the Commission to grant Water Rights (water use permits) to prospective users. The Act states under Section 24 that any person who pollutes or fouls a water resource beyond the level that the EPA may prescribe, commits an offence and is liable on conviction to a fine or a term of imprisonment or both.

The source of production and domestic water for the proposed project will be the Ghana Water Company Ltd. The design consumption of fresh water for the project is estimated as 9,600 tons/day (SORL, 2020).

**xii. Water Use Regulations**

The Water Use Regulations, 2001 (L.I. 1692) of the WRC aim to regulate and monitor the use of water resources. Under the WRC Act, 1996 (Act 522), the Commission also has the power to enter upon any land to inspect works constructed or under construction there and to ascertain the amount of water abstracted or capable of being abstracted by means of the works. The

Water Use Regulations enjoins all persons to obtain Water Use Permits from the Water Resources Commission for commercial water use. The Commission is also mandated to request for evidence that an EIA or an environmental management plan has been approved by the EPA before issuance of the Water Use Permit. In the event of water abstraction such as from a borehole, SORL shall apply for the necessary permit from WRC.

**xiii. Labour Act**

The Labour Act, 2003 (Act 651) prohibits discrimination based on sex, ethnicity, race, colour and religion, and provides protection for workers in Ghana. Section 118(1) of the Act stipulates that it is the duty of an employer to ensure that every worker employed works under satisfactory, safe and healthy conditions. Thus, the employer is expected "to provide and maintain at the workplace, plant and system of work that are safe and without risk to health and take steps to prevent contamination of the workplaces by, and protect the workers from, toxic gases, noxious substances, vapours, dust, fumes, mists and other substances or materials likely to cause risk to safety or health". A worker is required to report situations that he or she believes may pose an imminent and serious danger to his or her life, safety or health.

The proposed oil refinery is owned by the Sentuo Group Limited, a private enterprise that has operated in Ghana since 2010 (SORL, 2020) and has therefore gained experience in application of the Labour Act. SORL shall thus ensure that its human resource policies and terms of employment are in line with Act 651 and put in place measures to ensure the safety and well-being of its workers.

**xiv. Workmen's Compensation Law**

The Workmen's Compensation Law, 1987 (PNDCL 187) holds employers responsible for the payment of compensation to workmen for personal injuries caused by accidents arising out and in the course of their employment. Regulations passed under the law extend the requirements for the payment of compensation to incapacity or death arising from occupational diseases. The Law is applicable to the proposed project and the safety of all the oil refinery workers shall be the responsibility of the SORL.

**xv. Hazardous and Electronic Waste Control and Management Act**

The Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) provides for the control, management and disposal of hazardous, electrical and electronic waste and related purposes. Under the Act, a person shall not deposit hazardous waste or other wastes on any land in the country or in the territorial waters of the country. The Act also states that a person involved in the management of hazardous wastes or other wastes shall: i) Take the steps that are necessary to prevent pollution from hazardous wastes and other wastes arising from the management, and ii) Where pollution occurs, minimize the consequences of the pollution on human health and the environment. The Act will guide the project on hazardous and electronic waste management and disposal during project implementation

## 2.3 Institutional Frameworks

### *2.3.1 Relevant Ministries*

**i. Ministry of Environment, Science, Technology and Innovation**

The mission of the Ministry of Environment, Science Technology and Innovation is to establish a strong national scientific and technological base for accelerated sustainable development of the country to enhance the quality of life for all. This mission is to be achieved through the

formulation of sound policies regulatory frameworks to promote the use of appropriate environmentally friendly, scientific and technological practices and techniques. Three agencies under the ministry play key roles in ensuring sustainable exploitation and use of the oil and gas resources to enhance national development. These are the Land Use and Spatial Planning Authority (previously Town and Country Planning Department), the Council for Scientific and Industrial Research (CSIR) and the Environmental Protection Agency. EPA's role is particularly important given that the exploitation of oil and gas resources is often fraught with environmental challenges.

**ii. Ministry of Energy**

A number of Ministries, Departments and Agencies are mandated to act as well as ensure that the petroleum policies are implemented. The most important one is the Ministry of Energy whose mandate is to ensure efficient and sustainable generation and provision of sufficient, secure and reliable energy for domestic use and for export. The ministry also seeks to encourage the participation of the private sector in the development of energy infrastructure and secure future energy supply. The ministry has oversight responsibility over several agencies including Ghana National Petroleum Corporation, Ghana National Gas Company, National Petroleum Authority, Bulk Oil Storage and Transportation Company Ltd., Tema Oil Refinery, Volta River Authority, Electricity Company of Ghana, Volta Aluminium Company, Energy Commission and Petroleum Commission.

### *2.3.2 Major Institutions*

**i. Ghana National Petroleum Corporation**

The most important public institution whose activities are entirely related to oil and gas is the Ghana National Petroleum Corporation (GNPC), which was established as a body Corporate under Ghana's Provisional National Defence Council (PNDC) Law 64 of 1983. Its main mandate is to undertake the exploration, development, production and disposal of petroleum. GNPC plays policy roles by providing technical advice to the Ministry of Energy and other national oil and gas institutions for policy making, implementation, monitoring and review. Significantly, until the establishment of the Petroleum Commission, the GNPC played a dual role as both a major player with a purely commercial interest and a regulator in the oil and gas industry. However, the regulatory role of GNPC has been ceded to the Petroleum Commission.

**ii. National Petroleum Authority**

The National Petroleum Authority (NPA) was established after calls by the general public for efficiency, growth and stakeholder satisfaction in the industry. The authority was set up under the National Petroleum Authority Act, 2005 (Act 691) to regulate, oversee and monitor the downstream sector of the petroleum industry to ensure efficiency, growth and stakeholder satisfaction. The objectives and functions of the NPA are: i) to monitor and regulate petroleum prices in accordance with the prescribed formula, ii) to grant licenses to service providers and marketing companies, iii) to protect consumers' interests and maintain the highest standards of petroleum products offered to them. The NPA requires that the design parameters of an oil refinery shall, among others, generally follow the specification codes outlined in the current edition of National Fire Protection Association Standards No. 59A.

**iii. Bulk Oil Storage and Transportation Company Limited**

The regulation of downstream operations in the petroleum subsector is a shared responsibility between the Energy Commission, the National Petroleum Authority and the Bulk Oil Storage and Transportation Company Limited (BOST), which was incorporated in 1993 as a private

limited liability company with the Government of Ghana as the sole shareholder. Its mandate is to: i) develop a network of storage tanks, pipelines and other bulk transportation infrastructure throughout the country, ii) rent or lease out part of the storage facilities to enable it generate income, iii) keep Strategic Reserve Stocks for Ghana, iv) own, manage and develop a national network of oil pipelines and storage depots, v) manage the "Zonalization" policy of the National Petroleum Authority, and vi) develop the Natural Gas Infrastructure throughout the country.

Thus, BOST holds the Natural Gas Transmission Utility License granted by the Ghana Energy Commission to:

- Monitor and control the operations of the national interconnected network for the transmission of natural gas in areas within the country, and to ensure the safe, reliable and economic transportation of natural gas facilities connected to the transmission system
- Provide transmission interconnection services without discrimination to other licensees in the natural gas industry; and
- Provide transmission interconnection services to operators of natural gas networks in ECOWAS member states.

**iv. Ghana Chamber of Oil & Gas**

The Ghana Chamber of Oil & Gas was incorporated in 2009 with the aim to help develop the nascent industry in an "environmentally responsible, transparent and safe manner for the mutual benefit of members and the people of Ghana". It describes itself as "a voluntary, non-profit, private sector association whose member companies are engaged in various sectors of the oil and gas industry in Ghana. The Chamber has 4 levels of membership: Major Members comprise of "licensed operators upstream and mid-stream"; Associate Members include "technical and consulting service providers"; Buy-Side members comprise "Offtakers", and Affiliate Members include "other service providers with a demonstrated relationship to the industry (Banks, Insurance companies, etc." Like other business associations in Ghana, the Chamber represents the interests of its member and facilitates the resolution of industry issues in ways that will lead to the industry's growth while addressing government requirements and the needs of communities.

**v. Ghana Ports and Harbours Authority**

The Ghana Ports and Harbours Authority (GPHA) is a Statutory Corporation established under PNDC Law 160 of 1986 to build, plan, develop, manage, maintain, operate and control all ports in Ghana. The Authority manages and operates the sea ports of Ghana and various business units in collaboration with a number of private service providers in the areas of vessel handling, stevedoring, transfer, storage, receipt and delivery of containerized and general cargo. Others are safety, security and conservancy services. In its operations related to the use of the Tema Port, such as reception of crude oil and other raw materials and export of finished products, SORL shall consult with GPHA and apply for the necessary permits as well as use of GPHA's facilities.

**vi. Public Utilities Regulatory Commission**

The Public Utilities Regulatory Commission (PURC) and Energy Commission are statutory bodies responsible for regulating the provision of electricity utility services. The PURC's functions include determining tariffs, monitoring performance standards and promoting competition among service providers both in electricity and water. The Energy Commission, on the other hand, is responsible for monitoring the application of the petroleum pricing

formula to ensure its full and timely implementation. It should be noted that the PURC is an independent entity and not an energy sector agency. However, PURC performs a critical function for the energy sector; hence SORL will work closely with it.

## 2.4 International Conventions and Requirements

The relevant International Conventions include:
Convention on Biological Diversity, 1992;
International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990;
Convention for the Conservation of Migratory Species of Wild Animals, 1983;
United Nation Convention on the Law of the Sea, 1982;
Convention for the Prevention of Marine Pollution from Land-based Sources, 1974;
Convention for Wetlands of International Importance, 1971;
The Paris Agreement, 2015.

The international requirements relevant to the oil refinery project include:

### i. Climate Change

Human contributions of greenhouse gases have modified the atmospheric greenhouse layer, which plays an important role in moderating global temperatures. The Petroleum Refineries Sector is the third largest greenhouse gas emitting industrial sector among stationary sources, behind Power Plants and Petroleum and Natural Gas Systems. (Stern, 2007). Oil refineries contribute to polluting emissions, including of carbon dioxide, one of the most dangerous of the greenhouse gases. The threat of climate change is multidimensional and its impacts transcend national borders. Facing the energy industry today is climate change (CSIS, 2019). The impacts of climate change threaten the energy system in multiple ways. Increasing temperatures will decrease the technical efficiency of thermal and solar power generation and will drive cooling demands that could further stress power grids. Stressed power grids will not only hurt residential and commercial customers but will also affect the supply of power to oil and gas operations such as those of SORL that will rely on grid power. Increased temperatures will also affect operations of the oil refinery, and indeed interfere with land transportation routes for the petroleum products of Sentuo Oil Refinery.

Thus, SORL would not only be required to limit greenhouse gas emissions of its refinery as a climate change mitigation measure but would have to be committed to climate change adaptation by ensuring its physical structures and operations are resilient to envisaged physical impacts of more extreme weather events such as extreme temperatures, windstorms and rainfall.

### ii. Paris Agreement

The Paris Agreement calls for sustainable development by providing opportunities for the Parties to reduce their emissions through economy-wide and sectoral mitigation actions, in accordance with their state of development, their national circumstances, and in full compliance with the principles and provisions of the UN Framework Convention on Climate Change. Without doubt, climate change is a multi-faceted, complex global challenge that will require the cooperation of all countries to effectively implement the Paris Agreement in a manner that is fair, far-reaching and respects human values. Therefore, SORL shall take cognisance of this as well as Ghana's greenhouse gas emissions control commitments to this Agreement, particularly through her Nationally Determined Contributions, and limit greenhouse gas emissions from the refinery. Thus, the technologies to be deployed and

operations of the refinery would have to be state of the art, highly efficient and environmentally friendly.

**iii. United Nations Sustainable Development Goals**

The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. Its 17 Goals build on the successes of the Millennium Development Goals, but include new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The key goals that relate to the oil refinery project are Goal 2 on water, Goal 8 on economic growth and employment, Goals 12 and 13 on responsible consumption and production and climate change, respectively and Goal 16 on peace and justice.

**iv. African Union Agenda 2063**

The African Union Agenda 2063, is Africa's blueprint and master plan for transforming Africa into the global powerhouse of the future. It has a set of 7 Aspirations, which aims that by 2063, Africa shall be a prosperous continent, with the means and resources to drive its own development, with sustainable and long-term stewardship of its resources. This will include among other targets, a Pan-African High Speed Train Network to connect all the major cities/capitals of the continent. To achieve this target, the indicative strategy considered is to implement high capacity oil refinery and oil and gas pipelines.

**v. New Partnership for Africa's Development**

The New Partnership for Africa's Development (NEPAD) was adopted by African Heads of State and Government of the OAU in 2001 and was ratified by the African Union in 2002 to address Africa's development problems within a new paradigm. NEPAD's main objectives are to reduce poverty, put Africa on a sustainable development path, halt the marginalization of Africa, and empower women. NEPAD, being an African Union strategic framework for Pan-African socio-economic development, addresses critical challenges facing the continent: poverty, development and Africa's marginalization internationally and provides unique opportunities for African countries to take full control of their development agenda, to work more closely together, and to cooperate more effectively with international partners.

# CHAPTER 3 DESCRIPTION OF THE PROPOSED PROJECT

## 3.1 Introduction

Sentuo Oil Refinery Limited (SORL) intends to establish a 3.0 million metric tons per year oil refinery in Tema after conducting a comprehensive review and evaluation of the coastal areas of Africa, raw material sources, government support, supporting infrastructure facilities and product demand among other aspects of the project. The refinery will process heavy, medium and light crudes into various products such as Liquified Petroleum Gas (LPG), Kerosene, Gasoline, Diesel, Fuel Oil and Benzene. According to SORL's feasibility and market analysis study, the entire project will be constructed in two phases, with 1.5 million metric tons crude oil processing capacity for each phase. The total construction period is estimated to be four years. The first phase of the project is expected to start in 2020, and the second phase will be implemented immediately after the completion and commissioning of the first phase (SORL, 2019b, 2020).

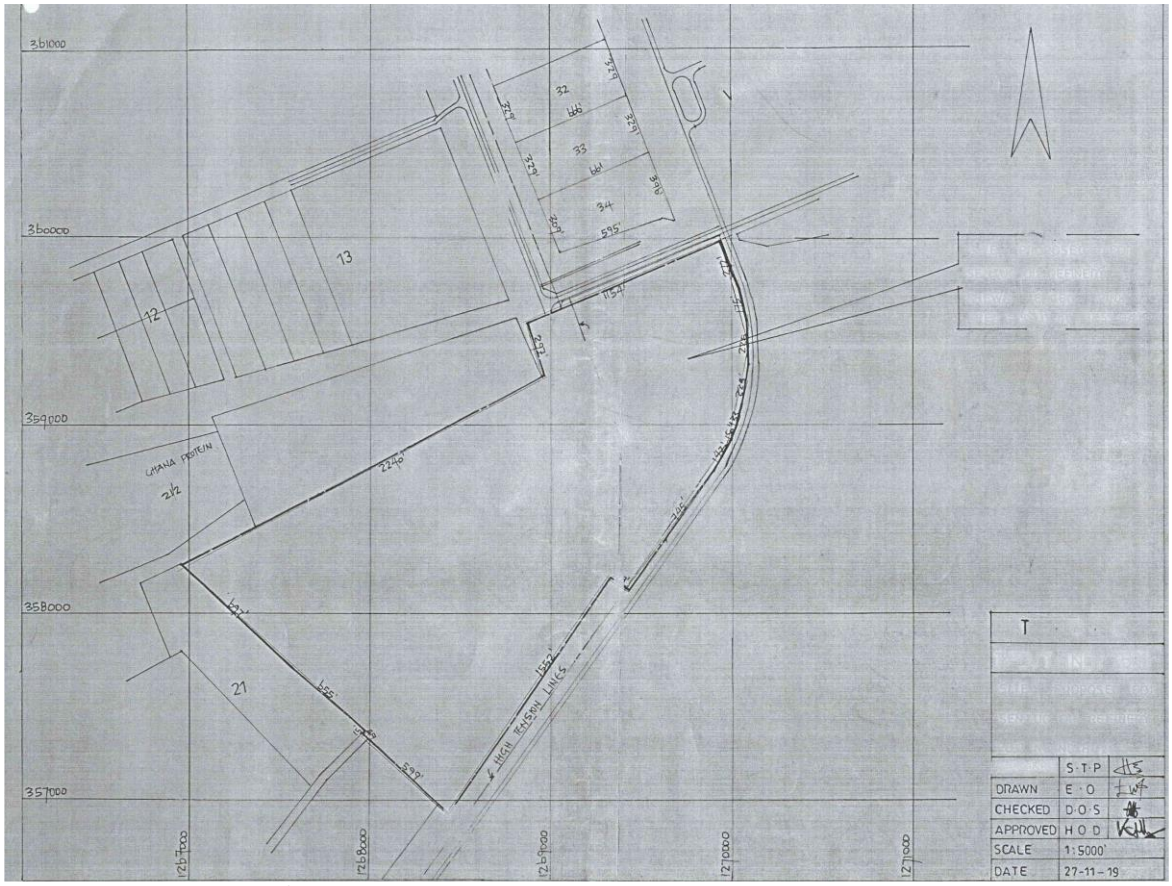
Water will be sourced from Ghana Water Company Ltd (GWCL) and the sea. Electricity will be sourced from the Electricity Company of Ghana (ECG). The plant will have two back-up standby diesel-powered generators that will come on-line automatically in the event of a power failure. Each unit will be capable of independently supporting the plant if required.

SORL intends to import its crude oil from the Middle East where the raw material is extremely rich, reserves and current production levels are high and increased production and export levels of the crude oil are projected for the future. Importation of some crude from Nigeria is also being considered.

## 3.2 Location of Project

The proposed oil refinery is to be located within the Tema Heavy Industrial Area (Figure 3-2.1). The Tema metropolis forms part of the Greater Accra Region and lies about 30 kilometers east of Accra, the capital city of Ghana. The Greenwich Meridian (i.e. Longitude 0º) passes through the metropolis, and it meets the Equator or Latitude 0° in Ghanaian waters off the Gulf of Guinea.

The Sentuo Oil Refinery is to be built on Plot No. IND/HI/21/5 at the Tema Heavy Industrial Area, which is one of the core areas of Ghana's industrial activities. This proposed project site lies entirely in the catchment of the Chemu Lagoon, which opens about 1 km southwards into the sea near the Tema Fishing Harbour. VALCO, Tema Oil Refinery and Sentuo Steel are among the key industries in the zone. There are also industries for the manufacture of cement, food, textiles, leather, basic metal goods and plastic products, among others. Within the immediate vicinity of the proposed project site, to the west, are warehouses that store bananas, cashew and other edibles for export using paper packages produced in the same area. A slaughter house is also located nearby. In the adjacent settlement of Tema New Town to the south east, construction of wooden fish crates, cold stores, and other fish related industrial activities predominate.




**Source: Sentuo Oil Refinery Ltd.**

**Figure 3-2.1 Location of Project Site in Tema Heavy Industrial Area**

## 3.3 Land Acquisition

The Tema Metropolis comprises two distinct planning areas (TMA, 2018). These are the Tema 'Acquisition Area' which is administered by Tema Development Company (TDC) and the 'Non-Acquisition Area', which although owned by the various traditional authorities, is managed by the Tema Metropolitan Assembly (TMA).

The Tema Development Corporation was established in 1952 by an Act of Parliament, with subsequent legislative changes including L.I. 1468 of 1989, to plan, develop and manage the 'Acquisition Area'. The Corporation developed the Land Use Plan for the area in 1960. In March 2016, the government converted the corporation into a limited liability company, Tema Development Company, to enhance its operations. The establishment of TMA by the Local Government Act 1993 (Act 462) has resulted in the overlapping of planning functions of the two institutions.

SORL has secured 38.59 hectares (95.31 acres) of land, Plot No. IND/HI/21/5) in the Tema Heavy Industrial Area (Plate 1-1.1), from TDC for the construction and operation of the oil refinery. In response to SORL's letter received by TDC on 09 December 2019, TDC, in its reply with Reference No. IND/HI/21/5 dated 10 December 2019, offered the right-of-entry to SORL subject to the acceptance of the terms and conditions of the offer and payment of the first year's ground rent (Appendix 1-1.3).

## 3.4 Overview of the Proposed Project

The refinery project will be constructed in two phases, with 1.5 million metric tons crude oil processing capacity for each phase. Phase 1 will cover about 24 ha (60 acres) of land. The total investment in this phase will be $ US 796 million and will involve the construction of a Conversion Refinery to process 1.5 million metric tons of sour crude oil per year into 464,500 metric tons of gasoline oil and 481,800 metric tons of diesel. Other products will include liquified petroleum gas, benzene, aromatics, xylene, toluene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil. The plant in this phase will consume 80 $m^3$ water/h (80 metric tons/h) and 8,200 kW/h of electricity. The project will also transport various types of raw materials and products throughput of about 3 million metric tons /year to and off site.

The composition of SORL's crude oil in Phase 1 will be as follows: Iranian condensate 300,000 metric tons / year, Saudi light crude 600,000 metric tons / year, and Kuwait crude 600,000 metric tons / year. The project intends to use the Tema Port mixed crude oil pipeline to deliver its crude to the project site (SORL, 2019b, 2020). Also, 8,500 metric tons / year of methanol will be imported as additional feedstock for the refinery in Phase 1.

The first phase of the project will be constructed in two stages. The main components to be built in the first stage are:

- 1.5 million metric tons / year atmospheric distillation unit;
- 800,000 metric tons / year heavy oil catalytic unit;
- 600,000 metric tons / year diesel hydrogenation unit;
- 300,000 metric tons / year naphtha-methanol-to-gasoline (NMTG) combined unit;
- 400,000 metric tons / year catalytic gasoline selective hydrogenation unit; and
- 60,000 metric tons / year sulphur recovery unit.

Phase 2 of the project is expected to be constructed from November 2021 to June 2023 with the same components as for Phase 1 and similar products similar to those in Phase 1 will be produced.

On completion, the project will be capable of processing 3 million metric tons sour crude oil per year into 1.12 million metric tons of gasoline, 1.23 million metric tons of diesel and various amounts of LPG, benzene, aromatics, xylene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil. It will then become the largest petrochemical production company in Ghana.

Other components of the refinery project include:

- Solid waste, process-water and wastewater treatment facilities;
- Site drainage and stormwater management;
- Administration block;
- Raw materials and product storage tank farms;
- Central laboratory;
- Workshop for repair and maintenance of plant equipment;
- Process and potable water reticulation systems;
- Clinic/first aid post;

A summary of the proposed project schedule is as follows:

- Current to August 2020. Finanlize refinery design and project costing. Obtain Environmental Permit for the project from the Ghana EPA;
- August 2020 to November 2020. Obtain the necessary permits for construction of the refinery from the NPA, TMA/KKMA, Fire Service and other relevant authorities;
- December 2020- July 2021. Construction and commissioning of Phase 1 of project.
- August 2021 -June 2023 Construction and commissioning of Phase 2 of project

Activities under the proposed project will be undertaken under pre-construction, construction, operations and decommissioning and closure phases. The details of the activities in the different phases are presented below:

## 3.5 Pre-Construction Phase

The major pre-construction activities cover feasibility studies, land acquisition, project planning and design including consultations with various stakeholders. Other activities include creation of access to the project site and technical surveys for siting the oil refinery and its components, updating engineering and technical designs, and acquisition of required permits and approvals. The activities will also include inspection of the project site by Electricity Company of Ghana (ECG) staff in preparation for the relocation of pylons at the site.

With respect to the acquisition of land for the project, SORL has already secured Plot No. IND/HI/21/5 in the Tema Heavy Industrial Area from TDC as detailed in Section 3.2 above. According to SORL (2020), the selection of the site for the project has been influenced by factors such as availability of land, transportation facilities, power, labour and raw materials. The site has been mapped out to cater for both Phase 1 and Phase 2 activities.

Feasibility studies and market demand analysis (SORL, 2019a, 2019b, 2020) have been completed.
Creation of access to the project site has started and staff of ECG have begun conducting site inspections with a focus on relocating the Company's pylons from the project site to areas adjacent to the VALCO Haulage road. In addition, as indicated in Sections 1.3 and 1.4 above, the process of obtaining an Environmental Permit from EPA has started.

However, other activities are yet to be completed. These include technical surveys for siting the oil refinery and its components, updating engineering and technical designs, and acquisition of other permits and approvals from such institutions as the National Petroleum Authority, Tema Metropolitan Authority and or the Kpone Katamanso Municipal Assembly, Ghana Ports and Harbours Authority and the Ghana National Fire Service. Among others, during the updating of technical designs, the implementation codes for design and operation of the oil refinery as defined in the Feasibility Report (SORL 2020) will be aligned to available Ghana standards such as those of EPA and NPA.

## 3.6 Construction Phase

### *3.6.1 Key Project Components*

**i. Project Site Preparation and Layout of Facilities**
Activities to be carried out under project site preparation include relocation of utility lines (such as electricity pylons) at the site, clearing, levelling and zoning of the site for installation of the

various infrastructure and facilities. The principles underlying the layout of the refinery (Figure 3-6.1) are summarised as follows:

- Recognition of the current codes and regulations on fire prevention, explosion protection, safety and health;
- Coordination of the technological processes with the overall planning of the open area and natural conditions to ensure a reasonable and compact layout that occupies as little land as possible;
- Arrangement of process equipment with similar units grouped together to save land and energy, and shorten the length of the pipelines;
- Reliance, as much as possible, on existing infrastructure and services to minimise duplication of effort;
- Organization of production facilities to shorten transport distances;
- Consideration of the wind direction to reduce environmental pollution;
- Organization of greening activities to enhance the natural landscape.

Based on the above principles, the general layout showing the proposed locations of different areas of the oil refinery at the project site (Figure 3-6.1) may be summarised as in Table 3-6.1 below.

**Table 3-6.1 Proposed Locations of Different Areas at Project Site**

| Area of Plant | Location at Project Site |
|---|---|
| Front area of the plant | Southwest corner of project site |
| Public engineering area | Close to the front of the site |
| Installation area | Northwest of the site |
| Flame area | West of the installation area |
| Tank area | South of the site |
| Loading and unloading center | Northeast of the site |
| Rainwater and sewage accident area | West of the installation area |
| Common engineering area | Near the loading center |
| Foam tank station | Non-hazardous area |

**Source: SORL (2020)**

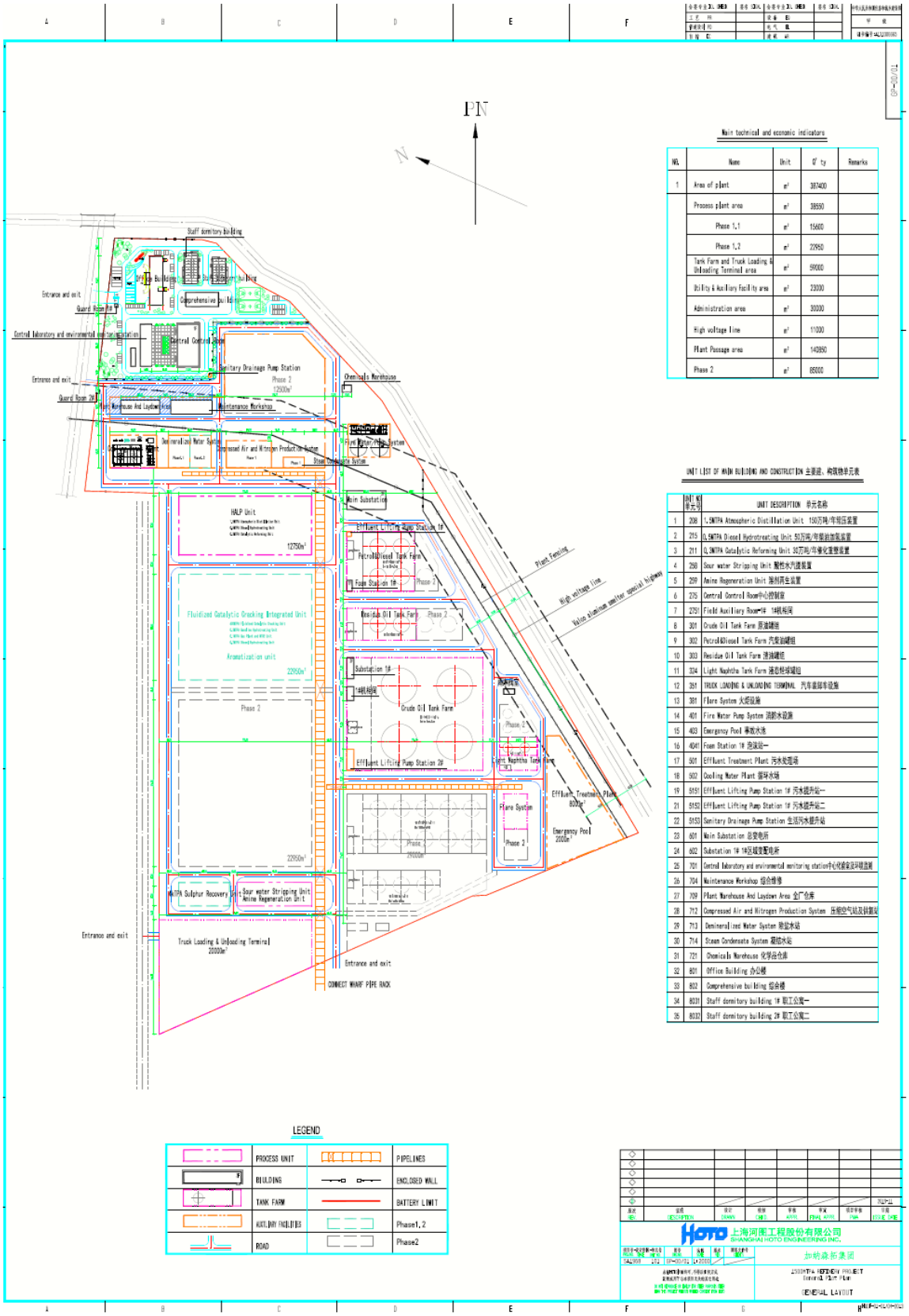
The front of the plant, the loading and unloading area, and the units with transportation requirements will be arranged near the edge of the plant. Car loading and unloading facilities and motor vehicles which frequently enter and exit will also be garaged on the edge of the plant site, which leads directly to the road outside the plant.

The area allocations for the various land uses of the project site are indicated in Table 3-6.2.

**Table 3-6.2 Area Allocations for Various Land Uses**

| Land Use | Area ($10^4$ $m^2$) | Land Use Factor (%) |
|---|---|---|
| Main infrastructure installation area | 7.40 | 19.05 |
| Storage and transportation facilities | 9.28 | 23.88 |
| Auxiliary facilities and sewage treatment plant | 2.15 | 5.53 |
| Roads and other uses (Including front of plant, greening, system corridors and reserved land) | 20.03 | 51.54 |
| Total Area | 38.86 | 100 |

**Source: SORL (2020)**




**Source: SORL (2020)**

**Figure 3-6.1 Proposed Layout of Oil Refinery**

**ii. Processing Plant**

The key components of the processing plant to be constructed are presented in Table 3-6.3.

**Table 3-6.3 Key Components of Processing Plant**

| Component No. | Component Name | Capacity (10,000 tons / year) | |
|---|---|---|---|
| ***1. Processing units*** | | Phase 1 | Phase 2 |
| 1.1 | Crude oil desalting unit | 150 | 150 |
| 1.2 | Sour crude oil atmospheric distillation unit | 150 | 150 |
| 1.3 | Heavy oil Catalytic cracking unit | 80 | 80 |
| 1.4 | Diesel hydrotreating unit | 60 | 60 |
| 1.5 | Naphtha NMTG combined reforming unit | 30 | 30 |
| 1.6 | Catalytic gasoline selective hydrogenation unit | 40 | 40 |
| 1.7 | Sulfuric acid combined unit | 6 | 2 |

**Source: SORL (2020)**

The plan is to install a set of primary (atmospheric and vacuum) distillation plants for distilling 1.5 million tons crude oil per year each in Phases 1 and 2 into various cuts, and auxiliary units for further refining these cuts into finished and blending products of high market value. The various processing units have been grouped according to functionality as in the site layout shown in Figure 3-6.1.

### *3.6.2 Project Sub-components*

The sub-project components for the construction phase are listed in Table 3-6.3. The locations of these components are also shown in the site layout in Figure 3-6.1.

**Table 3-6.3 Project Sub-components – Construction Phase**

| No. | Sub-component |
|---|---|
| ***2. Product storage and transportation facilities*** | |
| 2.1 | Crude oil tank farm and pump shed one |
| 2.2 | Light oil tank farm and pump shed one |
| 2.3 | Light oil tank farm and pump shed two |
| 2.4 | Spherical tank farm and pump shed |
| 2.5 | Heavy oil tank farm and pump shed |
| 2.6 | Waste water tank farm and pump shed |
| 2.7 | Car loading facilities |
| ***3. Water supply, drainage and fire control*** | |
| 3.1 | Fire and Fresh Water Pressurization Station |
| 3.2 | Circulating water field |
| 3.3 | Rainwater monitoring and lifting pump station / accident reservoir |
| 3.4 | Fire control and water supply and drainage pipe network |
| 3.5 | Bubble stand |
| 3.6 | Sewage treatment plant |
| 3.7 | Fire station |
| 3.8 | Flare Facility |
| ***4. Power and telecommunications*** | |

| | |
|---|---|
| 4.1 | Plant-wide power, lighting, grounding and telecommunications |
| 4.2 | Main Substation |
| 4.3 | Area transformer substation |
| ***5 High temperature components and nitrogen supply*** | |
| 5.1 | Steam system |
| 5.2 | Demineralized water, deoxygenated water, condensed water systems |
| 5.3 | Compressed air station |
| 5.4 | Nitrogen storage |
| 5.5 | Whole plant process and heat pipe network |
| 5.6 | Plant wide process and thermal network |

**Source: SORL (2020)**

### i. Storage Tank Farms

Tanks farms will be constructed for the storage and discharge of raw materials, intermediate and finished products and waste water. Dykes/bunds will be constructed around each farm to contain accidental spills from any tank in the farm. Table 3-6.4 lists the raw materials and product tanks to be installed in the construction phase.

**Table 3-6.4 Raw Material and Product Tanks to be Installed**

| No. | Media Name | Processing capacity ($10^3$ tons/ year) | Oil Density | Oil Tank | | Storage Days | | Tank Type |
|---|---|---|---|---|---|---|---|---|
| | | | | Number × Volume | Total Volume | Design | Actual | |
| **1** | **Raw material** | | | | | | | |
| 1 .1 | Crude | 150 | 0.9 | 4 × 30,000 | 120,000 | 15 ~ 20 | 20 | Floating roof |
| 1.2 | Methanol | 1.15 | 0.9 | 4 × 1,000 | 4,000 | 15 ~ 20 | 82 | Floating roof |
| | ***Sub-Total*** | | | ***8 Ge*** | ***124,000*** | | | |
| **2** | **Products** | | | | | | | |
| 2.1 | 92 # gasoline | 46.45 | 0.73 | 4 × 10,000 | 40,000 | 15 ~ 20 | 18 | Floating roof |
| 2.2 | Diesel | 48.18 | 0.83 | 4 × 10,000 | 40,000 | 15 ~ 20 | 20 | Floating roof |
| 2.3. | Fuel oil | 4.74 | 0.9 | 3 × 10,000 | 30,000 | 15 ~ 20 | 174 | Dome |
| 2.4 | Asphalt | 15.12 | 0.95 | 5 × 5.000 | 25,000 | 15 ~ 20 | 47 | Dome |
| 2.5 | Liquefied gas | 9.08 | 0.55 | 3 × 1.000 | 3,000 | 5 ~ 7 | 5 | Spherical tank |
| 2.6 | Acrylic | 3.22 | 0.52 | 2 × 1.000 | 2,000 | 5 ~ 7 | 8 | Spherical tank |
| 2.7 | Benzene | 1.44 | 0.9 | 2 × 500 | 1,000 | 5 ~ 7 | 18 | Floating roof |
| 2.8 | Sulfuric acid | 2.23 | 1.8 | 2 × 500 | 1,000 | 5 ~ 7 | 24 | Dome |
| | ***Sub-Total*** | | | ***24 Ge*** | ***142,000*** | | | |
| | **Total** | | | **32 Ge** | **266,000** | | | |

**Source: SORL (2020)**

The storage media in the tank area are mostly flammable and explosive materials. The selection of materials for tank construction will be based mainly on the tank design pressure, design

temperature, process medium and domestic material production conditions. It is envisaged that tank materials will be sourced locally. For the LPG spherical tank, 15MnNbR will be used. For vault and internal floating roof storage tanks, carbon steel will be used as the main material. The principles for material selection for this project will be as follows:
－20 ℃ ≤T set < 420 ℃, using carbon steel or low alloy steel.

**ii. Loading and Unloading Facilities**
Crude oil and other raw materials will be transported directly to the refinery and offloaded to storage tanks by use of pumps. Refined products will be loaded into tankers by pumping from storage tanks through tube cranes. The number of cranes to be installed for each product is as indicated in Table 3-6.5.

**Table 3-6.5 Number of Cranes for Loading Products into Tankers**

| No. | Product | Number of Cranes |
|---|---|---|
| 1 | Gasoline | 2 |
| 2 | Diesel | 2 |
| 3 | Fuel oil | 1 |
| 4 | Asphalt | 1 |
| 5 | Liquefied gas | 6 |
| 6 | Acrylic | 3 |
| 7 | Benzene | 1 |
| 8 | Sulfuric acid | 1 |
| **Total** | | **17** |

**iii. Sewage Treatment Plant**
A new sewage treatment plant will be built with a capacity of 150 $m^3$/h, which is adequate for the amount of oily sulfur and domestic wastewater to be produced by the refinery of 39 $m^3$/h on the average and up to a maximum of 135 $m^3$/h. The sewage treatment technology plan will be a biochemical treatment process mainly based on homogeneous regulation-oil water separation-oil isolation-two stage air flotation. New sludge treatment facilities will also be built where the sludge generated during the sewage treatment process will be centrally and uniformly treated to the required standard and disposed of as directed by the local competent authority.

**iv. Water Supply and Drainage System**
A water supply and drainage system will be installed to provide safe and reliable fresh water and circulating cooling water for process units, public works units and auxiliary production facilities to ensure that the waste water discharged from each unit meets the required standards and can be partially reused. The system will also provide the necessary fire protection facilities for the refinery. The source of production and domestic water for the project will be the Ghana Water Company Ltd. in Tema with a design consumption of 9,600 metric tons/day.

**v. Electrical Power System**
The total calculated load of the first phase of the project is about 12,834 kW, of which 10 kV load is 7,974 kW and 380 V low-voltage load is about 4,860 kW. The project will co-ordinate with the Tema branch of the Electricity Company of Ghana to provide two reliable 35 kV dual power sources for the plant area, and also install a 35 kV general substation and a 10 kV regional substation in the plant area. Each system will be single-bus section wiring mode. A bus link will be set between the two sections. When the bus link is disconnected in normal

operation, the two sections of the bus are operated in series. The 35 kV and 10 kV substations will have three-phase three-wire systems, with the neutral points not grounded, or the arc suppression coil grounded; the 0.38 / 0.22 kV power distribution system will be a three-phase five-wire system, and the neutral point will be directly grounded. The 0.38kV power distribution system will be TN-S.

Loads with special power supply requirements will be powered by an emergency power system. Emergency power will be supplied by UPS (or EPS). The DC load will be powered by the DC battery without interrupting the power supply unit. A microcomputer integrated protection monitoring system will be set up in the general substation to monitor remote transmission of data, communicate with the dispatching station and transmit information.

The project grounding, protective grounding, lightning protection grounding, antistatic grounding, and information system grounding will share a common grounding system. The ground electrodes will be 2.5 m long and Φ25 copper-clad steel ground electrode driven vertically into the ground. The top will be 0.7 m from the ground and the distance between the ground electrodes will be 5 m. The underground ground trunk line will use Φ14 copper-clad steel ground wire, with the underground ground branch line using Φ12 copper-clad steel ground wire. The ground wire will be buried to a depth of 0.8 m.

**vi. Telecommunication System**

The telecommunications system to be installed in this project includes an administrative telephone system, dispatch telephone system, wireless intercom telephone system, PA system, automatic fire alarm system, industrial television monitoring system, and integrated wiring and telecommunication network. Fire-fighting telecommunication lines will mainly be laid in the ground and other telecommunication lines laid in the form of cable bridges or buried.

**vii. High Temperature Components**

The high temperature components to be constructed are:

- *Steam system;*
- *Demineralized water, deoxygenated water, condensed water systems;*
- *Compressed air station;*
- *Nitrogen storage;*
- *Whole plant process and heat pipe network.*

**viii. Access and Refinery Roads**

The roads in the refinery area will be arranged in a circle, and the road width, turning radius and clearance height will be such as to meet the traffic requirements of fire fighting vehicles. A fire path inside the plant area will also be constructed to meet fire protection needs.

**ix. Greening**

The greening of the plant area will, among others, be based on adapting to local conditions, ensuring safety, beautifying the environment and saving land. According to the general layout plan, production characteristics, pipe network layout, fire safety, environmental characteristics, and local soil and climatic conditions, plant habits and other factors, a reasonable choice of green plants with anti-pollution, purification, noise reduction or dust retention ability will be made for the greening areas of the refinery site. The greening form to be adopted will ensure blending with the surrounding environment, buildings and other structures for a multi-level three-dimensional greening layout.

In the front of the plant and in auxiliary facilities such as transformer and sewage treatment areas, tall trees will be used. Between the production area and the surrounding roads, lawns and flowers will be used. Lawn greening will be used between fire roads and fire dikes but there will be no greening in the fire dike.

### *3.6.3 Ancillary Components*

The ancillary components to be constructed/installed in the construction phase are listed in Table 3-6.6.

**Table 3-6.6 Ancillary Components - Construction Phase**

| No. | Component Name |
|---|---|
| ***6. Auxiliary Production Facilities*** | |
| 6.1 | Administrative block |
| 6.2 | Central control room |
| 6.3 | Area Cabinet Room |
| 6.4 | Central Laboratory |
| 6.5 | Repair and Maintenance workshop |
| 6.6 | On-site Clinic/First Aid unit |

**Source: SORL (2020)**

**i. Automatic Control and Information Technology Centre**

The automation system to be installed is intended for automation of crude oil atmospheric distillation processes, the heavy oil catalytic unit, diesel hydrogenation, the naphtha NMTG unit, gasoline selective generation unit, sulfuric acid plant and product shipment to customers.

The system is designed to enable the refinery achieve safe, stable, efficient, low-consumption, high-quality, and environmentally friendly production. Considering the relatively centralized layout of the process plant units and the overall design level of the control system, a central control room will be constructed to control, operate and monitor all plant units. This project will use a Distributed Control System (DCS) with high-quality, high-reliable instruments to reduce failures, reduce maintenance workload, and extend production cycles. The system will also be used to establish and process in real-time a database that will be the foundation for further data processing and production information platforms. Explosion-proof instruments will be used as required, and intrinsically safe explosion-proof and flame-proof instruments will be used according to explosion-proof grades and instrument types.

All units of the processing plant to be installed in this project will use mature and reliable DCS. The display operation stations of the processing plant DCS will be all placed in the central control room for centralized operation and management to achieve centralized operation, information centralization, and centralized management, so that the central control room becomes the processing plant's operation centre, information processing centre, and production scheduling management centre and fire control centre

The DCS hardware of each processing unit will be independently set to ensure that units do not interfere with each other during normal production and start-up and shutdown processes, reduce unnecessary shutdowns, and ensure long-term stable production of process units. Due to the use of DCS, not only can all process variables be processed in real time for real-time

control and alarms; various control, display and alarm screens can also be generated and various production, management and alarm reports can be printed. The DCS's rich calculation functions can also be used for complex process calculations.

**ii. Central Laboratory and Environmental Monitoring Station**

The central laboratory is an auxiliary production facility to be used for the quality control analysis of the intermediate products and the quality analysis of the ex-factory products as well as the water quality analysis of the circulating water field and demineralized water station.

The laboratory will be housed in a 4-storey building to be constructed and will have engineering facilities such as water supply and drainage, ventilation, compressed air purification, power distribution, telecommunications, LIMS systems, and fire protection. It will also have chromatography, and electrochemical analysis instrument rooms and equipped with nitrogen, oxygen, hydrogen, acetylene, helium, argon and other pipeline facilities. Chromatography, catalyst micro-reactivity, instrument analysis, liquefied gas analysis and gas cylinder rooms will all be equipped with flammable and explosive gas alarm devices; while the benzene analysis room will have a toxic gas monitor.

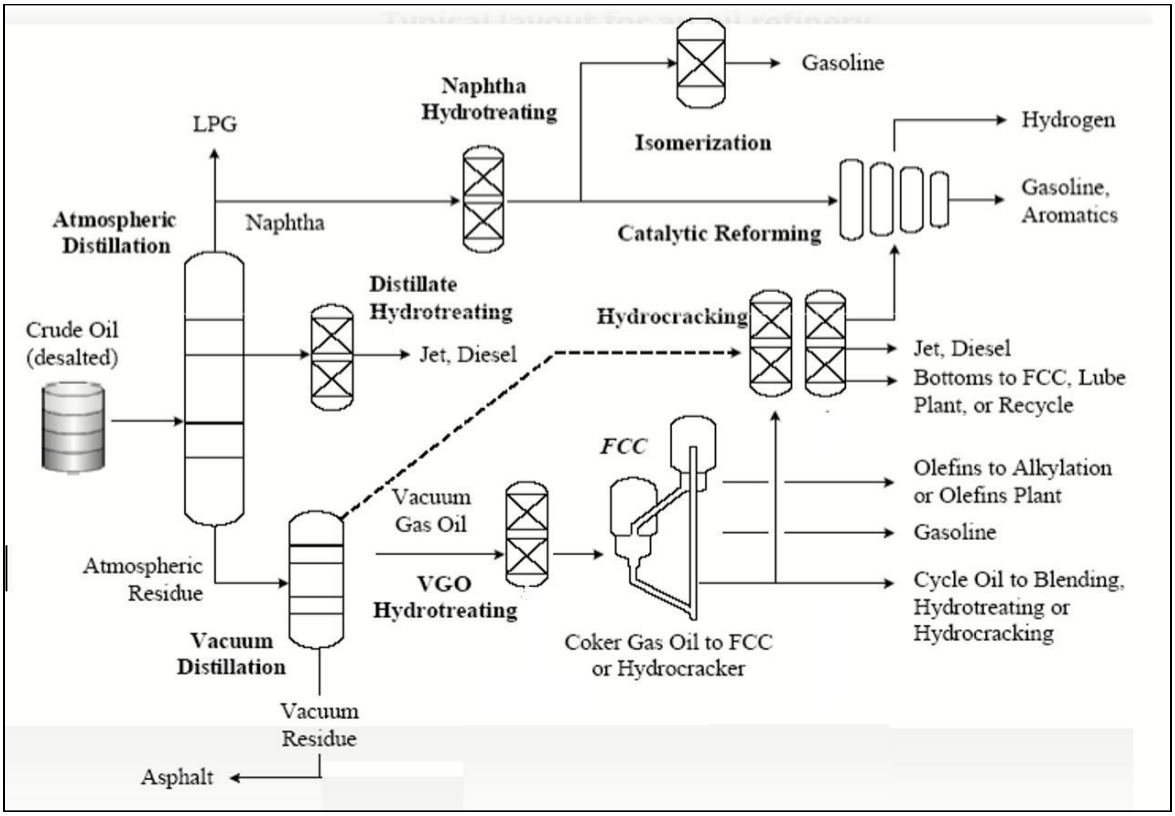
The environmental monitoring station to be installed on the roof-top of the 4-storey building will serve as the environmental monitoring facility of the project. It will be designed as a Grade A station with 17 environmental monitoring instruments and other pieces of equipment.

## 3.7 Operations Phase

### *3.7.1 Key Project Components*

The refinery processes typical of the proposed SORL's refinery are illustrated in Figure 3-7.1 for both phases of the project and summarized below (SORL, 2019a, 2020):

- ***Fractionation(distillation)*** for separation of crude oil in atmospheric and vacuum distillation towers into groups of hydrocarbon compounds of differing boiling-point ranges called "fractions" or "cuts";
- ***Conversion Processes*** to change the size and/or structure of hydrocarbon molecules from the distillation processes through:
    - Decomposition by thermal and catalytic cracking;
    - Unification through alkylation and polymerization; and
    - Alteration with isomerization and catalytic reforming;
- ***Treatment Processes (including desalting)*** to prepare hydrocarbon streams for additional processing into finished products. Treatment includes removal or separation of aromatics and naphthenes, impurities and undesirable contaminants. It also involves chemical or physical separation e.g. dissolving, absorption, or precipitation using a variety and combination of processes including desalting, drying, hydrodesulphurizing, solvent refining, sweetening, solvent extraction, and solvent dewaxing;




**Source: SORL (2020)**

**Figure 3-7.1 Refinery Processes Typical of the Proposed SORL Refinery**

- ***Formulating and Blending*** in order to mix and combine hydrocarbon fractions, additives, and other components to produce finished products with specific performance properties;
- ***Other Refining Operations*** include:
  - Light-ends recovery;
  - Sour-water stripping;
  - Solid waste, process-water and wastewater treatment;
  - Cooling, storage and handling and product movement;
  - Hydrogen production;
  - Acid and tail-gas treatment; and
  - Sulphur recovery.

The principles for selection of the process technology include (SORL, 2019b, 2020) the following:

- The production technology is mature, advanced and reliable;
- The technological process scheme has certain adaptability to the variation of the raw material properties;
- The process plan saves investment and land occupation as much as possible, reduces energy consumption and ensures safety and environmental protection that can meet the requirements of relevant laws and regulations;
- The process technology and equipment of the plant are localized, and the equipment manufacturing is based in China.

The key components of the operations phase of the project are presented in Table 3-7.1 and described below.

**Table 3-7.1 Key Components of Operations Phase**

| Component No. | Component Name | Capacity (10,000 tons / year) | |
|---|---|---|---|
| | | Phase 1 | Phase 2 |
| 1 | Crude Oil Desalting | 150 | 150 |
| 2 | Sour crude oil atmospheric distillation | 150 | 150 |
| 3 | Heavy oil Catalytic cracking t | 80 | 80 |
| 4 | Diesel hydrotreatment | 60 | 60 |
| 5 | Naphtha NMTG combined reforming | 30 | 30 |
| 6 | Catalytic gasoline selective hydrogenation t | 40 | 40 |
| 7 | Sulphur recovery | 6 | 2 |

**Source: SORL (2020)**

**i. Crude Oil Desalting**

A detailed feasibility study has been carried out for the following crude oils:

- 100% Saudi Light Crude
- 100% Kuwaiti Light Crude
- A mixture of Saudi Light and Kuwaiti Light Crude

The design is for a refinery on-stream time of 8,400 hours annually and operating flexibility of 60 to 110%. Crude oil will first be desalted by removing potentially corrosive salts to protect downstream process units of the refinery. It will then be preheated at atmospheric pressure and at about 135$^{o}$C in a gas or oil furnace before being fed to the distillation unit.

**ii. Crude Oil Atmospheric Distillation**

Pre-heated desalted crude feedstock is first delivered at pressures slightly above atmospheric to the Atmospheric Distillation Unit (ADU) operated at atmospheric pressure (Figure 3-7.1). The refining process then starts with the separation of feedstock into various fractions or cuts according to their boiling point ranges in the atmospheric tower or column. The lighter hydrocarbons, with lower boiling points, rise as vapours to the top of the tower which is cooled to 40°C by heat exchange with crude oil, air cooler and aftercooler, whereas heavier hydrocarbons with higher boiling points collect as liquids at the bottom of the tower.

The main products from the ADU can be broadly divided into gas (sent to the gas separation-MTBE-alkylation unit), straight run light naphtha (sent to a gasoline blending unit), straight run heavy naphtha (sent to a Naphtha NMTG combined unit), straight run kerosene (sent to a distillate blending unit), straight run middle distillate (sent to a catalytic cracking unit, CCU), straight run gas oil (sent to a CCU), and residue (sent to a Vacuum Distillation Unit, VDU, or to a residue blending unit).

The material balance of the ADU is presented in Table 3-7.2.

**Table 3-7.2 Material Balance of the ADU**

| Description | | Yield (% wt) | Flow rate | |
|---|---|---|---|---|
| | | | Kg/h | MT p.a. |
| **Raw material** | Crude | 100.00 | 78,571.43 | 1,500,000 |
| | ***Total*** | ***10.000*** | ***78,571.43*** | ***1,500,000*** |
| **Products** | Gas + loss | 0.67 | 1,196.43 | 10,050 |
| | Naphtha | 21.00 | 37,500.00 | 315,000 |
| | Diesel | 27.23 | 48,625.00 | 408,450 |
| | Atmospheric residue | 37.34 | 66,500.00 | 558,600 |
| | Wax oil | 2.28 | 4,071.43 | 34,200 |
| | Asphalt | 10.08 | 18,000.00 | 151,200 |
| | Loss | 1.50 | 2,678.57 | 22,500 |
| | ***Total*** | ***100.00*** | ***178,571.43*** | ***1,500,000*** |

**Source: SORL (2020)**

Utilities and other consumables used in the ADU are summarized in Table 3-7.3.

**Table 3-7.3 Utilities and Other Consumables used in the ADU**

| No. | Consumable | Unit | Consumption |
|---|---|---|---|
| 1 | Fuel (standard oil) | kg/h | 1,500 |
| 2 | Electricity | KWH/h | 900 |
| 3 | 1.0MPa steam | t/h | 4.5 |
| 4 | Fresh water | t/h | 3 (intermittent) |
| 5 | Recycled water | t/h | 165/450 |
| 6 | Purified air | $m^3n/min$ | 2 |
| 7 | Non-purified air | $m^3n/min$ | 10 (intermittent) |
| 8 | Demineralized water | t/h | 2.0 / 16 (max.) |
| 9 | Oily waste water | t/h | 3 (intermittent) |
| 10 | Sulphur-containing waste water | t/h | 3.3 |

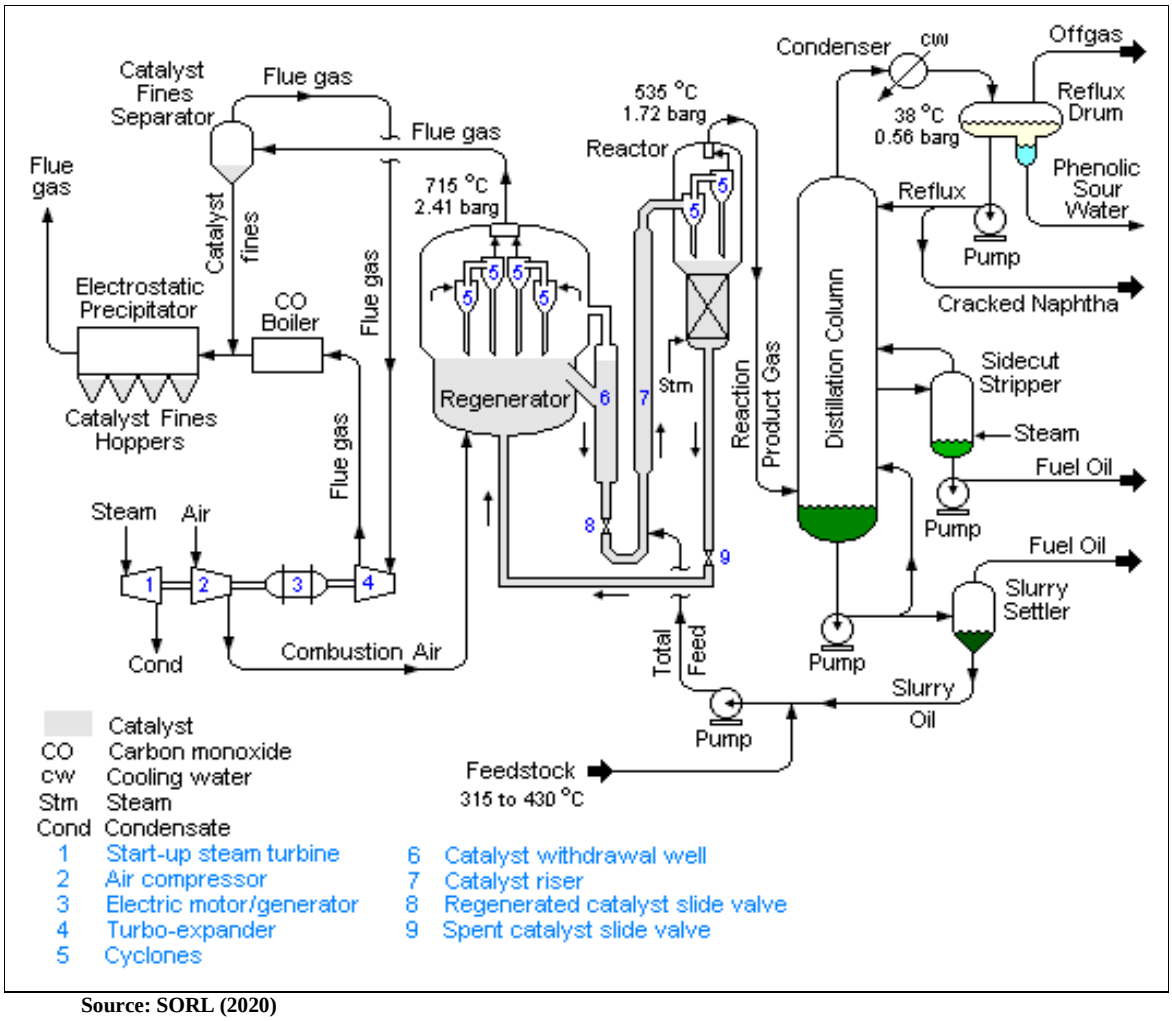
**Source: SORL (2020)**

### iii. Heavy Oil Catalytic Cracking Unit

Catalytic cracking using both heat and catalyst will be employed in a Fluid Catalytic Cracking unit (FCC, Figure 3-7.2) for the conversion process to upgrade heavy hydrocarbons from the atmospheric and vacuum distillation units into more valuable lower-boiling hydrocarbons such as gasoline, diesel oil, light fuel oils and olefin-rich gases. Catalytic cracking yields higher quantities of these fuels as compared to thermal cracking and is a better-controlled process. In addition, gasolines obtained by catalytic cracking contain less sulphur. Typical feedstocks of an FCC include Vacuum Gas Oil, Atmospheric Gas Oil, Atmospheric Residue and Vacuum Residue.

The key components of the fluid catalytic cracking unit are the reactor and regenerator (Figure 3-7.2). Preheated high-boiling petroleum feedstock (at about 315 to 430 °C) consisting of long-chain hydrocarbon molecules is combined with recycle slurry oil from the bottom of the distillation column and injected into the catalyst riser of the FCC unit where it is vaporised and cracked into smaller molecules of vapour by contact and mixing with the very hot powdered catalyst from the regenerator. The cracked product vapours pass on into the reactor where they are separated from the spent catalyst. The separated hydrocarbons then flow into a distillation

column for separation into various cuts. The spent catalyst flows through a steam stripping section to remove any hydrocarbon vapours before being returned to the catalyst regenerator.




**Source: SORL (2020)**

**Figure 3-7.2 Schematic Flow Diagram of a Fluid Catalytic Cracking Unit**

The material balance of the Heavy Oil Catalytic Cracking process is given in Table 3-7.4.

**Table 3-7.4 Material Balance of the Heavy Oil Catalytic Cracking Process**

| **Description** | | **Yield (% wt)** | **Flow Rate** | |
|---|---|---|---|---|
| | | | **Kg/h** | **MT p.a.** |
| **Raw material** | Slag | 98.92 | 7,5571.43 | 634,800 |
| | Methanol | 1.08 | 824.15 | 6,923 |
| | ***Total*** | ***100*** | ***7,6395.58*** | ***641,723*** |
| **Product** | $H_2S$ | 0.7 | 531.25 | 4,463 |
| | Dry gas | 9.87 | 7,541.29 | 63,347 |
| | Liquefied gas | 8.98 | 6,857.29 | 57,601 |
| | Propylene | 5.38 | 4,111.09 | 34,533 |
| | MTBE | 2.52 | 1,923.02 | 16,153 |
| | Gasoline | 33.63 | 25,694.29 | 215,832 |

| | | | | |
|---|---|---|---|---|
| | Diesel | 17.61 | 13,451.71 | 112,994 |
| | Heavy fuel oil | 7.91 | 6,045.71 | 50,784 |
| | Coke | 12.91 | 9,862.07 | 82,841 |
| | Loss | 0.49 | 377.86 | 3,174 |
| | ***Total*** | ***100*** | ***76,395.58*** | ***641,723*** |

**Source: SORL (2020)**

Utilities and other consumables used in the FCC unit are summarized in Table 3-7.5.

**Table 3-7.5 Utilities and Other Consumables Used in the FCC Unit**

| No. | Consumable | | Unit | Consumption | Note |
|---|---|---|---|---|---|
| 1 | Fresh water | | t/h | 7.2/80 | Normal (continuous) / maximum (intermittent) |
| 2 | Recycled water | | t/h | 2,353 | Continuous |
| 3 | Demineralized water | | t/h | 88.2 / 95* | Continuous / maximum |
| 4 | Electricity | 380/220V | kW | 1,824 | Continuous |
| | | 10,000V | kW | 2,213 | Continuous |
| 5 | Steam | 1.0MPa | t/h | 43.5 | Continuous |
| | | 3.5MPa | t/h | -54.5 | Continuous |
| 6 | Purified compressed air | | $m^3_n$/min | 50.23 | Normal / maximum |
| 7 | Non-purified compressed air | | $m^3_n$/min | 30 | Normal / maximum |
| 8 | Nitrogen | | $m^3_n$/min | 1.13 / 4.7 | Continuous / maximum |
| 9 | Fuel gas | | $Nm^3$/h | 660 | Continuous |

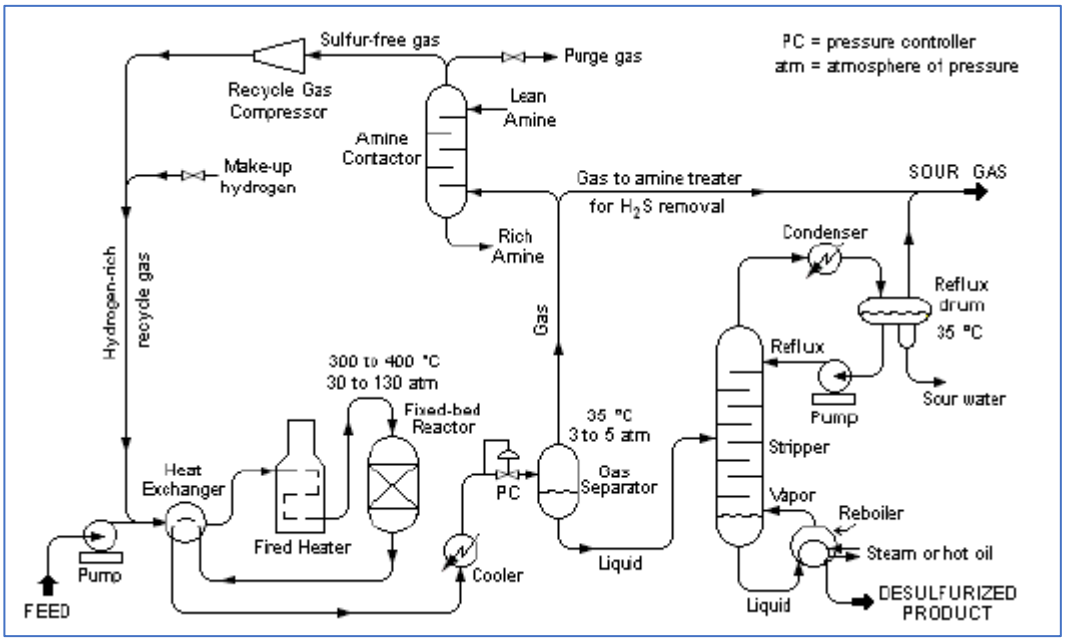
**Source: SORL (2020).**

Note: "-" represents output (produced in the process) and "*" represents discontinuity

### iv. Diesel Hydrotreating

Hydrogen will be used in the hydrotreating unit (Figure 3-7.3) of the plant to desulphurize straight-run diesel and catalytic diesel to yield Ultra-low Sulphur Diesel (ULSD) blending components for vehicles and desulphurize naphtha, LPG and acid gas (Table 3-7.6). The design capacity of the unit is $60\times10^4$ metric tons p.a., the operating flexibility is 60% -120%, and the annual operating time is 8,400h.

Straight-run diesel and catalytic diesel from the upstream units are filtered through the raw material filter to remove impurities above 15 μm and then flow into the raw material buffer tank as feed. The liquid feed is pumped up to the required elevated pressure and is joined by a stream of hydrogen-rich recycle gas (Figure 3-7.3). The resulting liquid-gas mixture is preheated by flowing through a heat exchanger. The preheated feed then flows through a fired heater where the feed mixture is totally vaporized and heated to the required elevated temperature before entering the reactor and flowing through a fixed bed of catalyst where the hydrodesulfurization reaction takes place. The hot reaction products are partially cooled by flowing through the heat exchanger where the reactor feed was preheated and then flows through a water-cooled heat exchanger before it flows through the pressure controller (PC) and undergoes a pressure reduction down to about 3 to 5 atmospheres. The resulting mixture of liquid and gas enters the gas separator vessel at about 35 °C and 3 to 5 atmospheres of absolute pressure.




**Source: SORL (2020)**

**Figure 3-7.3 Schematic Flow Diagram of Diesel Hydrotreating Unit**

The liquid from the gas separator vessel is routed through a reboiled stripper distillation tower. The bottoms product from the stripper is the final desulphurized liquid product from the hydrotreating unit. Most of the hydrogen-rich gas from the gas separator vessel is recycle gas, which is routed through an amine contactor for removal of the reaction product $H_2S$ that it contains. (http://www.oilfieldwiki.com/wiki/Hydrodesulfurization#Process_description)

The hydrotreating process material balance is shown in Table 3-7.7.

**Table 3-7.7 Hydrotreating Process Material Balance**

| Description | | kg/h | Wt (%) | $10^4$ metric tons p.a. |
|---|---|---|---|---|
| | | Early stage | Early stage | Early stage |
| Feedstock | Unrefined diesel | 61,190.48 | 98.66 | 51.4 |
| | Hydrogen | 833.33 | 1.34 | 0.7 |
| | ***Total*** | ***62,023.81*** | ***100*** | ***52.1*** |
| Products | Refined diesel | 5,7071.43 | 92.02 | 47.94 |
| | Naphtha | 1,547.62 | 2.50 | 1.3 |
| | LPG | 1,500.00 | 2.42 | 1.26 |
| | Acid gas | 1,273.81 | 2.05 | 1.07 |
| | Loss | 630.95 | 1.02 | 0.53 |
| | ***Total*** | ***6,2023.81*** | ***100*** | ***52.1*** |

**Source: SORL (2020)**

Utilities and other consumables used in the hydrotreating unit are summarized in Table 3-7.8.

**Table 3-7.8 Utilities and Other Consumables used in Hydrotreating Unit**

| No. | Consumable | Unit | Consumption | Note |
|---|---|---|---|---|
| 1 | Fuel gas | t/h | 0.44 | |
| 2 | Recycled water | t/h | 120 | |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Demineralized water | | t/h | 2 / 5 | Continuous / intermittent |
| 4 | Electricity | 380V | KWH | 650 | |
| | | 220V | KWH | 10 | |
| 5 | Purified air | | $Nm^3/h$ | 55 | |
| 6 | Nitrogen | | $Nm^3/h$ | (5,000) | Intermittent, start purge, pressure test |
| 7 | 1.0MPa Steam | | t/h | (3) | Intermittent, start purge |

**Source: SORL (2020)**

**v. Naphtha NMTG Reforming**

In this unit, low octane rating heavy straight-run (HSR) naphtha is converted into high octane gasoline blending components, benzene, refined naphtha and liquefied petroleum gas. The processes in the Naphtha NMTG combined unit consists of pre-hydrogenation, reforming reaction, post-fractionation and benzene extraction. The capacity of the unit will be 300,000 metric tons p.a. for each of the 2 phases.

*Pre-hydrogenation*

The purpose of pre-hydrogenation is to refine and fractionate the feedstock (HSR naphtha ~ 165 ° C fraction) and to prepare feedstock for catalytic reforming. The feedstock is subjected to full-fraction hydrogenation to remove sulphur, nitrogen, arsenic, lead, copper and other impurities that are toxic to the reforming catalyst. The pre-hydrogenated oil passes through a desulphurization tower to remove trace sulphur and water in the oil. The bottom oil enters the naphtha fractionation tower to cut light naphtha below C5 and refined naphtha above C6. Refined naphtha serves as feed for the reforming unit.

The pre-hydrogenation uses a one-pass process, and the hydrogen gas separated from the pre-hydrogenation high-pressure separator is discharged through a pressure-controlled fuel gas pipe network.

The process adopts a newly developed high-efficiency, high-space-speed hydrogenation catalyst from China. The space velocity is increased from the conventional volumetric space velocity of 2h-1 to 4h-1, which greatly reduces the investment cost of pre-hydrogenation equipment and catalysts.

*Reforming*

The main purpose of catalytic reforming is to increase the octane number of the naphtha feedstock to a level that makes the reformate product suitable as a gasoline blend stock.

The reforming section uses segmented hydrogen mixing and fixed-bed semi-recycling process technology and is equipped with four reactors. The first and second reactors are naphthenic dehydrogenation zones, at high space velocity, low hydrogen oil ratio and lower temperature operation; the third and fourth reactors are alkane dehydrocyclization zones, operating at low space velocity, high hydrogen-to-oil ratio and higher temperatures. This process can improve catalyst utilization, increase gasoline yield and hydrogen yield, and reduce energy consumption among other favourable aspects. The reforming catalyst is regenerated outside the unit.

In order to reduce the pressure-drop of the hydrogen-producing system and increase the heat exchange depth to facilitate energy conservation, the reforming feed heat exchanger and the two-stage hydrogen-mixing heat exchanger use pure counter current vertical heat exchangers. In addition, the reforming heating furnace uses an advanced and mature "four-in-one" high-efficiency heating furnace, whose overall furnace efficiency can reach more than 90%.

*Post fractionation*

The purpose of post-fractionation is to separate the reformed oil into aromatics extraction raw materials and high-octane gasoline blending components. The post-fractionation part of the reforming unit is equipped with a de-pentane tower and a de-hexane tower. The C6 fraction and gasoline blending components are fractionated by rectification. The stable gasoline from the reformer first enters a de-octane overhead heat exchanger, so that the stabilized gasoline is fed into the de-pentane tower at 125 ° C as a hot feed. Similarly, the bottom content of the de-pentane tower is also in the form of hot feed and discharges into the de-hexane tower. The stabilized gasoline exits the de-pentane tower and joins the gasoline blending streams of the refinery. The extracted fractions cut off from the top of the de-hexane column enter the feed buffer tank of the aromatics extraction distillation column as the raw materials for extractive distillation to produce benzene and other products.

*Benzene extraction*

Benzene is separated from C6 distillate by extractive distillation in the aromatics extraction unit using sulfolane solvent. The unit consists of distillation, solvent recovery and evaporation towers. The extractive distillation tower uses a vertical reboiler. The solvent recovery tower and benzene evaporation tower use an insert reboiler. In order to prevent the sulfolane solvent from decomposing at high temperature, medium pressure steam to reduce the temperature to 2.2MPa saturated steam is used as the heat source of the reboiler at the top of the tower, and the condensate recycled. Benzene is recovered from the top of the solvent recovery tower, heated in a white clay tank heater to remove trace acidic substances and then sent into the benzene evaporation tower. The refined benzene is extracted from the benzene evaporation tower, cooled, pumped into the benzene inspection tank and then sent out of the tank as benzene product.

The process material balance for Naphtha NMTG combined unit is shown in Table 3-6.9.

**Table 3-6.9 Process Material Balance for Naphtha NMTG Combined Unit**

| **Description** | | **Yield** | | |
|---|---|---|---|---|
| | | Wt (%) | kg/h | Metric tons p.a. |
| Feedstock | Hydrogen | 0.15 | 59.52 | 500 |
| | Naphtha | 96.01 | 39,285.71 | 330,000 |
| | Diesel hydrogenated naphtha | 3.84 | 1,571.43 | 13,200 |
| | ***Total*** | ***100*** | ***40,916.67*** | ***343,700*** |
| Products | Gas | 12.77 | 5,226.19 | 43,900 |
| | LPG | 7.42 | 3,035.71 | 25,500 |
| | Light naphtha | 10.91 | 4,464.29 | 37,500 |
| | Benzene | 4.36 | 1,785.71 | 15,000 |
| | Reformed gasoline | 64.53 | 26,404.76 | 221,800 |
| | ***Total*** | ***100*** | ***40,916.67*** | ***343,700*** |

Source: SORL (2020).

Utilities and other consumables used in the NMTG unit are summarized in Table 3-7.10.

**Table 3-7.10 Utilities and Other Consumables used in Naphtha NMTG Combined Unit**

| **No.** | **Consumable** | **Unit** | **Consumption** | **Note** |
|---|---|---|---|---|
| 1 | Fuel gas | t/h | 2,521 | Based on low calorific value 41,868KJ / Kg |
| 2 | Recycled water | t/h | 691 | |

| | | | | |
|---|---|---|---|---|
| 3 | Electricity | kW | 3,557 | |
| 4 | 2.5MPa steam | t/h | 4.8 | |
| 5 | 1.0MPa steam | t/h | 500 / (3,000) | Liquefied gas vaporizer and heat tracing |
| 6 | Condensate | t/h | -5.3 | Output |
| 7 | Purified compressed air | $m^3_n/h$ | 240 | |
| 8 | Non-purified compressed air | $m^3_n/h$ | 300 | Intermittent amount for continuous 8 hours |
| 9 | Nitrogen | $Nm^3/h$ | 90 / (300) | Intermittent amount for continuous 8 hours |
| 10 | Deoxygenated water | t/h | 0.5 | |
| 11 | Desalinated water | t/h | 3 / (10) | |
| 12 | Fresh water | t/h | (37) | |

**Source: SORL (2020)**

## vi. Catalytic Gasoline Selective Hydrogenation

The catalytic gasoline selective hydrogenation unit will be used to produce gasoline components with sulphur content of less than 10 μg/g in order to increase gasoline production and increase the octane number of etherified gasoline. The raw materials of this unit will be hydrogen, methanol and catalytic gasoline. Full-distillate gasoline can be divided into two components: light gasoline and heavy gasoline. Light gasoline has a high olefin content and heavy gasoline has high sulphur content and low olefin content. In the distillation process in the catalytic unit, the light gasoline cutting point will be adjusted so that its sulphur content will be less than 10 ppm. This will make desulphurization of the light gasoline unnecessary. Thus, selective hydrogenation will apply to the heavy gasoline in order to remove sulphur as hydrogen sulphide while avoiding olefin saturation to maintain required octane number. The light gasoline etherification section will be set to increase gasoline production and increase the octane number of etherified gasoline.

The process material balance for the Catalytic Gasoline Selective Hydrogenation is shown in Table 3-7.11.

**Table 3-7.11 Process Material Balance for Catalytic Gasoline Selective Hydrogenation**

| **Description** | | **Yield** | | |
|---|---|---|---|---|
| | | Wt (%) | kg/h | Metric tons p.a. |
| Feedstock | Catalytic gasoline | 100 | 24,000 | 201,600 |
| | New hydrogen | 0.2 | 48 | 403 |
| | Methanol | 2.48 | 595 | 4,998 |
| | ***Total*** | ***102.68*** | ***24,643*** | ***207,001*** |
| Products | Hydrogen sulphide | 0.25 | 60 | 504 |
| | Gas | 2.28 | 548 | 4,603 |
| | Refined gasoline | 99.11 | 23,786 | 199,802 |
| | Loss | 1.01 | 250 | 2,100 |
| | ***Total*** | ***102.65*** | ***24,643*** | ***207,010*** |

**Source: SORL (2020)**

Table 3-7.12 shows the utilities and other consumables used in the Catalytic Gasoline Selective Hydrogenation.

**Table 3-7.12 Utilities and Other Consumables Used in Catalytic Gasoline Selective Hydrogenation**

| No. | Consumable | Unit | Consumption | Note |
|---|---|---|---|---|
| 1 | Fuel gas | Kg/h | 100 | 40℃, 0.4 MPa |
| 2 | Circulating cold water | t/h | 120 | 31℃, 0.5 MPa |
| 3 | Electricity | kW | 320/350/30 | 6000/380 / 220v, without interruption |
| 4 | 3.5MPa steam | t/h | 13 | 425℃, 3.5MPa |
| 5 | 1.0MPa steam | t/h | （3） | Intermittent |
| 6 | Demineralized water | t/h | （50） | Intermittent |
| 7 | Deoxygenated water | t/h | 2.6 | 104℃, 5.0Mpa |
| 8 | Purified air | $Nm^3/h$ | 120 | Normal temperature, 0.5 MPa |
| 9 | Nitrogen | $Nm^3/h$ | 30 | Normal temperature, 0.6 MPa |
| 10 | Fresh water | t/h | （50） | Intermittent |
| 11 | Condensate | t/h | -13.6 | 160℃, 1.0MPa |

**Source: SORL (2020)**

Note: "-" represents output (produced in the process)

**vii. Sulphur Recovery**

Sulphur will be recovered from stripping hydrogen sulphide ($H_2S$) from sour water and acid gas generated in desulphurization units of the refinery and converted to sulphuric acid. Sulphur recovery will take place in the sulfuric acid combined plant consisting of acidic water stripping, solvent regeneration and sulfuric acid production units.

*Sour water stripping*

Using a single-column atmospheric pressure stripping process, hydrogen sulphide and ammonia in sour water are stripped using steam, condensed, separated and then sent to the sulphuric acid production unit of the combined plant to produce sulphuric acid. The stripped water is re-cycled or discharged into the sewage treatment plant through the oily sewage pipe network as this waste water meets the input water quality requirements of the plant.

*Solvent regeneration*

Solvent regeneration strips off $H_2S$ from the $H_2S$-rich solvent from the hydrodesulphurization process and thereby regenerates lean solvent that meets the quality requirements for the upstream hydrodesulfurization units. The solvent regeneration part adopts the conventional steam stripping regeneration process. The selective Methyldiethanolamine (MDEA) solvent is used, and while the lean liquid after regeneration is returned to the upstream units for re-use, the extracted acid gas is sent to the sulphuric acid production unit of the combined plant.

*Sulphuric acid production*

The sulphuric acid production unit will be used to recover hydrogen sulphide in acid gas from both the sour water stripping and solvent regeneration units and ensure that the quality of the tail gas released to the environment meet the EPA and international quality standards.

The unit uses wet acid production technology. The process involves burning the raw material acid gas under low pressure, converting sulphur dioxide to sulphur trioxide in the converter and finally hydrating and condensing in the condenser to produce 98% sulphuric acid. The nitrogen oxides contained in the gas pass through the denitration reactor to generate nitrogen, which is discharged together with the tail gas. The process is very mature, the energy consumption of the component is low, and the environmental protection requirements are well met.

The Sulphuric acid material balance is shown in Table 3-7.13.

**Table 3-7.13 Sulphuric Acid Material Balance**

| Description | | Yield | |
|---|---|---|---|
| | | kg/h | Metric tons p.a. |
| Feedstock | Mixed acid gas | 4,049.1 | 1,7164.8 |
| | Air | 107,602.8 | 860,822.4 |
| | Demineralization water | 19,031.0 | 152,248.0 |
| | ***Total*** | ***130,682.9*** | ***1,045,463.2*** |
| Products | Concentrated sulphuric acid | 7,500.0 | 60,000.0 |
| | (Tail) Exhaust gas | 104,151.9 | 833,215.2 |
| | Steam | 19031.0 | 152,248.0 |
| | ***Total*** | ***130682.9*** | ***1,045,463.2*** |

**Source: SORL (2020)**

Table 3-7.14 shows the utilities and other consumables used in the sulphuric acid production

**Table 3-7.14 Utilities and Other Consumables Used in Sulphuric Acid Production**

| No. | Consumable | Unit | Consumption | Note |
|---|---|---|---|---|
| 1 | Fuel gas | $Nm^3/h$ | 2/612* | For continuous operation |
| 2 | Electricity | KWH/h | 920.66 | Continuous |
| 3 | 1.0MPa steam | t/h | .925/3.353* | Continuous / intermittent |
| 4 | Self-produced 4.0MPa steam | t/h | -24.122 | Continuous |
| 5 | Recycled water | t/h | 109.05 | Continuous |
| 6 | Demineralized water | t/h | 24.4485 | Continuous |
| 7 | Purified air | $Nm^3/min$ | 4.33 | Continuous |
| 8 | Nitrogen | $Nm^3/min$ | 4* | Intermittent |

**Source: SORL (2020)**

Note: "-" represents output (produced in the process) and "*" represents discontinuity.

### *3.7.2 Sub-project Components*

According to SORL (2019b, 2020), the sub-project processes in the operations phase include:

- Demineralized water and deoxygenated water production, condensed water removal;
- Compressed air production;
- Acid and tail-gas treatment

**i. Demineralized Water and Deoxygenated Water Production**

Demineralized water will be supplied by the desalination water plant while condensate will be removed to the condensate water station. Deoxygenated water produced in the heavy oil catalytic combined unit will be available to supply the other units of the plant.

**ii. Compressed Air Production**

Both purified and un-purified compressed air would be required in all the main component units of the refinery and auxiliary systems such as the thermal system and product storage and transportation systems. This air will be obtained from the on-site air compressor station.

### *3.7.3 Ancillary Components*

**i. Raw Material and Product Storage and Transport**

Table 3-7.15 presents the types, quantities and mode of transport of the raw materials and finished products of the refinery in the operations phase.

**Table 3-7.15 Types, Quantities and Mode of Transport of Raw Materials and Finished Products**

| Item No. | Material | | Yield / Purchase Amount (metric tons pa) | | Mode of Transport & Volume (metric tons pa) | |
|---|---|---|---|---|---|---|
| | | | Shipping | | Highway | |
| | | | % | Capacity | % | Capacity |
| 1 | **Raw material** | | | | | |
| 1.1 | Diesel | 1,500,000 | 100% | 1,500,000 | | |
| 1.2 | Methanol | 11,500 | 100% | 11,500 | | |
| | | | | | | |
| | ***Total*** | ***1,511,500*** | ***100%*** | ***1,511,500*** | | |
| | | | | | | |
| 2 | **Product** | | | | | |
| 2.1 | Gasoline | 476,113 | 0% | - | 100% | 76,113 |
| 2.2 | Diesel | 493,845 | 0% | - | 100% | 493,845 |
| 2.3 | Fuel oil | 48,585 | 0% | - | 100% | 48,585 |
| 2.4 | Asphalt | 154,980 | 0% | - | 100% | 154,980 |
| 2.5 | Liquefied gas | 126,075 | 0% | - | 100% | 126,075 |
| 2.6 | Acrylic | 65,088 | 100% | 65,088 | 0% | - |
| 2.7 | Benzene | 14,760 | 100% | 14,760 | 0% | - |
| 2.8 | Sulfuric acid | 32,596 | 0% | - | 100% | 32,596 |
| | ***Total*** | ***1,412,042*** | | ***79,848*** | | ***1,332,194*** |

**ii. Automatic Control and Information Technology**

The automation system of the refinery will be used for automation of crude oil atmospheric distillation processes, the heavy oil catalytic unit, diesel hydrogenation, the naphtha NMTG Unit, gasoline selective generation unit, sulphuric acid combined unit and scheduling of shipment of finished products to customers.

**iii. Solid Waste Management**

The solid wastes generated from the refinery operations are mainly waste catalysts, waste adsorbents produced by various units, a small amount of tank bottom mud generated during the maintenance of the tank area, and sludge from the sewage treatment plant.

Solid waste will be disposed of by recycling, comprehensive utilization, landfill and incineration according to the nature of the waste to be discharged. All waste catalysts containing precious metals and waste catalysts that must be recovered in connection with patents will be returned to the manufacturers. Wastes with recycling value, such as unqualified polymers will be downgraded for sale. Qualified companies will be contracted and entrusted to dispose of hazardous solid wastes such as waste catalysts without recovery value through, for example, safe landfill or incineration.

Domestic solid waste will be disposed of through the municipal waste disposal system.

**iv. Wastewater Management**

The project will basically follow the principle of pollution minimisation, decontamination and diversion, and classification treatment for the various types of waste water generated during the production process as well as re-use (SORL, 2019a).

Wastewater will be divided into sulphur-containing water, oil-containing water and domestic wastewater, which will enter different systems. Sulphur-containing waste water will undergo sour water stripping first before entering the sewage water treatment plant; oily water and domestic sewage will be sent directly to the waste water treatment plant, and most of the effluent reused.

When a fire occurs in the refinery, the wastewater for firefighting will be drained to the 13,000 $m^3$ accident pool using a pipeline for storage. After the fire is extinguished, the waste water in the pool will be pumped to the sewage treatment plant for treatment and discharge.

**v. Stormwater Management of Refinery Area**

Stormwater in the refinery plant area will be treated as sour water. It will, therefore, be collected and undergo sour water stripping before passing on to the wastewater treatment plant. Effluent from the wastewater treatment plant will be recycled as much as possible and any excess discharged to the environment through storm drains constructed at the site.

Stormwater from other areas including from outside the project site will be drained through the drainage system provided for the purpose and discharged into the outlet of the lagoon to avoid problems with flooding in the area, including the Heavy Industrial Area.

**vi. Venting and Flaring**

Venting and flaring will be used as part of routine operational and measures to safely dispose of vapours emitted by the process plant under normal production, accidents, shutdowns and emergency situations for personnel safety and to protect equipment. The new flare system takes into account the flare gas emitted by all process units and auxiliary facilities under various conditions. There will be a separate flare system for acid gas vented from the sulphur recovery plant. Flaring modifies, by means of combustion, the chemical nature of the emitted substances. For example, sulphur dioxide ($SO_2$) is generated from the combustion of $H_2S$ while the combustion of hydrocarbons generates $CO_2$ and water vapour.

A flare management plan will be used to monitor both pollutant concentrations at the ground level and the total quantity of pollutants released annually and to control flare volumes. For fugitive gas emissions control, Vapours Recovery Units, would be used as far as possible instead of open venting or flaring.

**vii. Gaseous Emissions**

The gaseous emissions generated in the operation of the refinery mainly comes from the combustion of flue gas of heating furnaces, sulfuric acid tail gas, and hydrocarbon gases emitted by the plant. The following measures will be adopted to control gaseous emissions from the refinery.

- Emission control of combustion of flue gases from heating furnaces

The fuel gas used in each unit of this project will be in the form of dry gas after desulfurization ($H_2S$ in dry gas <20mg / $Nm^3$). In order to reduce the emission of nitrogen oxides from flue gas combustion, low nitrogen burners will be used in the heating furnaces.

At present, the NOx reduction rate of various types of low NOx burners considered for this project is generally 30% to 60%.

- Control of exhaust gas emissions

The hydrocarbon gas released from the safety valves of each unit of the refinery plant will be discharged into the flare system; the gas discharged during accidents and the purge gas that is produced when the system is first started and stopped will also be discharged into the flare system.

- Control of fugitive emissions

In order to reduce the fugitive emissions of hydrocarbon gases, light oil products will be stored in floating roof tanks, and liquefied petroleum gas in spherical tanks.

- Treatment of hydrogen sulphide gas

The gas discharged from each unit will be desulphurized by a gas desulphurization unit, and the purified dry gas used as refinery fuel gas. The hydrogen sulphide will be sent to a sulphuric acid unit to produce sulphuric acid. The sulphur-containing waste water discharged from each unit will be treated in the acidic water stripping unit, and the resulting hydrogen sulphide gas will also be sent to the sulphuric acid unit to produce sulphuric acid. After incineration, the acid gas only needs to be cooled down to the temperature of $SO_2$ to catalyse the conversion to $SO_3$. In the presence of water vapour, it will finally condense into acid and the flue gas after the acid production discharged through the exhaust cylinder. To prevent fugitive hydrogen sulphide from being directly discharged into the environment, an acid gas flare system will be used (SORL, 2020).

During normal operations, the non-condensable gas generated at the top of the distillation tower will be adsorbed by activated carbon and discharged to the factory vent pipe network to reduce the emission of atmospheric pollutants. When plant operations are stopped for maintenance, the rich gas and safety valve overpressure relief gas will be discharged into the venting main pipe and sent to the main plant venting system for treatment and discharge.

The refinery emissions include:

- Total Particulate Matter;
- Particulate Matter < 10µ;
- Particulate Matter < 25µ;
- Nitrogen oxides;
- Sulphur dioxide;
- Carbon monoxide;
- Carbon dioxide
- Volatile organic compounds;
- Benzene;

**viii. Chemicals and Chemical Storage**

A variety of chemicals, additives and catalysts will be used during the refinery operations and dedicated on-site chemical storage facilities will be provided for them. Some of the types of chemicals required for normal refinery operations are (NFLRP, 2007):

- Alumina Absorbents;
- Ammonium Polysulphide;
- Antifoam;
- Antioxidant;
- Biocide;

- Boiler Feed Water Treating Chemicals;
- Caustic 50 Baume;
- Cooling Water Treatment Chemicals;
- Corrosion Inhibitor;
- Demulsifier;
- Refinery Distillate and Gasoline Additives;
- Filming Amine;
- Glycol;
- Hydrogen Sulphide Scavengers (e.g. MEA or MDEA);
- Methanol;
- Neutralizing Amine;
- Organic Chloride;
- Refinery Gasoline Additives;
- Scale Inhibitor;
- Sodium Hypochlorite;
- Wastewater Treatment Chemicals;
- Soda Ash;
- Activated Carbon.

Chemicals will be handled in accordance with recommended practices and stored in an approved storage area that has been designed for containment and segregation to avoid chemical interactions. They will be identified by their Chemical Abstract Registry Number together with associated quantities, characteristics and toxicities. Personnel will be trained in the correct handling of chemicals and response for spill cleanup and first aid. The project will implement a Workplace Hazardous Materials Information System training program for the safe handling and use of chemicals stored and used on-site. (NFLRP, 2007).

**ix. Noise**

The sources of noise of the units of the refinery plant are mainly pumps, compressors, heating furnaces, air coolers, vents and fans. The noise control design of this project is carried out in accordance with SH / T3146-2004, "Noise Control Design Specification for Petrochemical Industry", and the following control measures will be adopted.

- Use of low-noise equipment, such as low-noise pumps and air-cooler fans;
- Use of sound absorption processing indoors as needed for large compressors, fans and other high-noise equipment;
- Installation of mufflers at steam vents, air vents and induced draft fan inlets;
- Use of low-noise burners for heating furnaces;
- Placing of high-noise equipment from sensitive targets.
- Greening of the plant boundary in such a way as to reduce the impact of noise;
- Inspection workers required to wear noise-proof earmuffs when entering high noise areas;

**x. Public Health and Safety**

In order to prevent other enterprises and residents around the project site from being affected by atmospheric pollutants due to the refinery operations, the local wind direction, wind speed,

dominant wind frequency and topographical factors have been fully considered in the general laying out plan of the project site.

**xi. Operation of Clinic/First Aid Post**

A clinic and first aid post will be located near the front area of the plant, close to the edge that leads to the main road outside the plant. A competent medical institution will be contracted to operate the clinic to support emergencies and occupational health and safety processes.

### *3.7.4 Manpower Requirements*

The refinery project will employ a total of 369 people, 11 of whom will be engaged in direct operations while 14 will perform support services. Table 3-7.16 summarizes the personnel to be employed in the project in Phase 1.

**Table 3-7.16 Personnel to be Employed in Phase 1**

| No. | Unit | Shift | Indoor exercise/ class | Outdoor exercise/ class | Day Shift | Squad leader/ class | Subtotal |
|---|---|---|---|---|---|---|---|
| 1 | 1.5 million tons/year atmospheric distillation unit | 4 | | 2 | 4 | 1 | 28 |
| 2 | 800,000 tons/year heavy oil catalytic unit | 4 | | 3 | 5 | 1 | 36 |
| 3 | 600,000 tons/year diesel hydrogenation unit | 4 | | 1 | 2 | 1 | 16 |
| 4 | 300,000 tons/year naphtha NMTG plant | 4 | | 2 | 4 | 1 | 28 |
| 5 | 400,000 tons/year catalytic gasoline selective hydrogenation unit | 4 | | 1 | 2 | 1 | 16 |
| 6 | 60,000 tons/year sulfuric acid combined plant | 4 | | 2 | 4 | 1 | 28 |
| 7 | Storage and transportation | 4 | | 3 | 5 | 1 | 36 |
| 8 | Public Works Department | 4 | | 5 | 6 | 1 | 48 |
| 9 | Electrical dispatch and operation | 4 | | 1 | / | 1 | 8 |
| 10 | Central Laboratory | 4 | | 3 | 4 | 1 | 32 |
| 11 | Operation and Maintenance Centre | 4 | | 3 | 4 | 1 | 32 |
| 12 | Safety and Environmental Protection | / | / | / | 5 | / | 5 |
| 13 | Quality Technology | / | / | / | 6 | / | 6 |
| 14 | Mobile Engineering | / | / | / | 9 | / | 9 |
| 15 | Planning | / | / | / | 5 | / | 5 |
| 16 | Fire Station III | 3 | 4 | 4 | 2 | 1 | 36 |
| Total | | | | | | | 369 |

**Source: SORL (2020)**

### *3.7.4 Project Implementation*

The preparation of the feasibility study report shall be completed in March 2020.
The approval shall be completed by the end of May 2020.

Detailed design will be launched in May 2020.
The general construction of the project will be completed by the end of October 2021.

### 3.8 Decommissioning and Closure Phase

The service life of the structural design will be up to 50 years (SORL, 2020). However, in the event of the closure of the plant before or after 50 years, the procedures to be followed shall be according to an already developed and EPA-approved Rehabilitation and Decommissioning Plan. During this phase, the refinery will cease functioning and all structures, plants, machinery and equipment will be dismantled. In addition, all destroyed vegetative areas will be restored appropriately.

# CHAPTER 4 CONSIDERATION OF ALTERNATIVES

In the process of developing the SORL project, many decisions have been made concerning, for instance, the location, the type of technologies and the processes involved in the SORL project. However, some of the identified potential alternatives were unable to be considered due to technical or economic reasons. This chapter therefore gives some insight into key elements of alternatives that have been considered to date.

## 4.1 Location of Oil Refinery

### *4.1.1. Tema Heavy Industrial Area*

The Sentuo Oil Refinery is to be built on Plot No. IND/HI/21/5 at the Tema Heavy Industrial Area. The project fits into the zoning purposes of the area since refinery operations are considered as heavy industrial activities. The Tema Heavy Industrial Area is one of the core areas of Ghana's industrial activities and serves as the location for various industries including aluminium smelting, cement production, steel works, ceramics and food processing. The area is also home to Tema Oil Refinery (TOR), which was established in 1963 and could share some of its facilities such those used for transportation of raw and refined materials with the new oil refinery. The latter could also learn lessons from the experiences of the older refinery, while also sharing their experiences and technology with the former.

In addition to the above, the industrial city of Tema is served by a deep-water harbour that is currently nearing completion of a $1.5 billion Port Expansion Project that will treble the Tema Port's current traffic. A dredged 19-metre-deep port access channel, a new 1.4-km-long quay for four container berths, with a 16 m draft, and a 4-km-long breakwater will enable the expanded Tema Port to accommodate some of the world's largest container ships, and improve cargo-handling services and capacity (AECOM, 2020). This will enhance the port's competitiveness as a leading maritime hub in West Africa. Clearly, this development will facilitate the import of crude oil and export of refined petroleum products for the Sentuo Oil Refinery. The Tema Harbour also possesses a mixed crude oil pipeline that SORL intends to use in transporting crude oil from vessels to the SORL project site (SORL, 2019a).

Besides, Tema and its Heavy Industrial Area are served by a good network of roads that provide easy access to and from the proposed refinery site in addition to the availability of electricity and water supply and other social services. With the pool of experienced and talented industrial workers as well as proximity to other oil industry operators such as the oil marketing companies, the decision to locate the proposed Sentuo Oil Refinery in the Tema Heavy Industrial Area is well justified. Furthermore, given that there are no immediate plans to expand the capacity of the TOR, the only refinery in Ghana and in the Heavy Industrial Area, the construction of another refinery to meet the current demands for petroleum products in Ghana and the sub-region is imperative. At present, TOR is only able to supply 45,000 barrel per stream day capacity out of the national demand of 83,000 barrels per stream day, with the remainder being imported to meet demands (SORL, 2019a).

Using Ghana as a hub for the sub-region, the location of the refinery is appropriate. Ghana is well placed to serve Burkina Faso, Mali and Niger. The distance from Tema to Ouagadougou is approximately 1,050 km, while the distances from Ouagadougou to Abidjan and Lomé are respectively 1,500 km and 1,200 km. Trucks from Burkina Faso will therefore travel shorter

distances to lift products. Ghana can also offer lower product prices. While the ex-refinery prices for gasoline, kerosene and gas oil in Ghana are based on import parity prices, ex-refinery prices for kerosene and gas oil in Cote d'Ivoire are twice the levels in Ghana and gasoline prices are 25 per cent higher. Products from Ghana can compete favourably with those from Togo due to the shorter truck distances between Bolgatanga and locations in Burkina Faso.

In addition, because of the shorter distances involved; there will be less product loss through evaporation (SORL, 2019a).

### *4.1.2. Petroleum Hub in Western Region*

During the feasibility studies for this project, an alternative location was considered at Takoradi in the Western Region of Ghana. Government of Ghana has approved proposals, to use the Takoradi harbour as the nucleus, to develop an oil and gas hub in the Western Region (Daily Graphic, 2019), and naturally, that area was considered as a potential alternative location for the SORL project. The Government of Ghana has been working on the Western Region Hub proposal to turn the country into the West Africa's petroleum hub by 2030. It is expected that the proposal and the subsequent project of the Hub will cost US$60 billion. The Hub project will include refineries, petrochemical plants, power plants, light industry, waste and water treatment facilities, storage facilities, and business and residential centres (Petroleum Commission, 2019). However, the location has yet to be developed with the requisite amenities and facilities as obtainable in the Tema Heavy Industrial Area for the smooth take-off of the SORL project.

### *4.1.3 Other Locations*

The nearest industrial area to Tema is located in the KKMA Municipality. It boasts large industries such as the ASOGLI thermal plant and GRIDCO (KKMA, 2018). The area also has manufacturing and processing industries including Sentuo Ceramics as well as a light industrial where resident artisans are involved in various activities including car spraying, welding, fitting and vulcanizing. However, the industrial area in the KKMA has comparatively less facilities such as water and road networks. The location of the proposed oil refinery will require more investment in upgrading them. The same applies to other potential areas in the Greater Accra and other regions.

## 4.2 Technology for Oil Refinery

Various technologies assembled for the SORL project have been selected on the bases that the technologies are mature, advanced and reliable. In addition, the choice of process technologies is based on the fact that the technologies are adaptable to various grades and qualities of crude oil, saves investment and land occupation, and reduces energy consumption. Moreover, the selection of the process technologies is based on the need to protect the environment, ensure safety, and meet relevant laws and regulations (SORL, 2019a).

The main refinery process technologies applicable to the SORL project include the following units:

- Atmospheric distillation of crude oil, patented by the Tianjin University;
- Heavy oil catalytic complex, patented by Sinopec Luoyang Design Institute;
- Residue hydrogenation, patented by Sinopec Fushun Research Institute;
- Diesel hydrogenation modification, patented by Sinopec Fushun Research Institute;

- Catalytic gasoline hydrogenation, patented by China Petroleum Research Institute;
- Naphtha reforming, patented by Beijing Institute of Petrochemical Science
- Methyl tert-butyl ether (MBTE), patented by Karui Hebei
- Sulphur recovery, patented by Nanhua Group Research Institute

These process technologies for the above units are currently considered the best available techniques and are among the most efficient and environmentally friendly technologies available.

### 4.3 Roads and Transportation

At present, the project site is accessible only by means of road transportation through the VALCO Road and coming off the road from TOR. During construction and operations phases of the SORL project, a number of options would be considered to (i) ensure the smooth flow of traffic, and (ii) to ensure easy access to the project site and premises. The first option for improved road access to the project site would be the reconstruction of the VALCO Road from the point where it joins the TOR road. This reconstruction should include the widening of the road to be able to cater for more heavy-duty construction vehicles (during the construction stage) and long vehicles (during the operations stage). In addition, drains would be constructed along the road to ensure proper drainage. The second option for improved access to the project site will be to construct an access road from the project site that passes in front of the Wan Heng Cement factory to join the Tema Lube Road. A third Option would be to adopt the first and second options to (i) dilute the level of traffic entering the premises, and/or, (ii) provide a one-way entry and exit of the project's premises.

### 4.4 No-Action Alternative

For the purposes of this report the No-Action alternative means that the Sentuo Oil Refinery will not be established. In this alternative, no direct socio-economic advantages are anticipated.

The key potential disadvantages associated with this alternative include:

- Loss of the opportunity of development of the Ghanaian economy, especially the ability to satisfy the increasing demand for petroleum products;
- Loss of employment opportunities;
- Loss of revenue streams to the government in the form of taxes;
- Loss of opportunity for private investment within the country, which is a key initiative of the Government of Ghana.

Thus, this alternative is not considered favourable and will not be considered any further in this report.

# CHAPTER 5 EXISTING BASELINE CONDITIONS

## 5.1 Physical Environment

The construction and operation of the proposed Sentuo Oil Refinery and associated activities will have impacts on the project area and its environs, different parts of which fall under the jurisdiction of the Tema Metropolitan Assembly (TMA) and the Kpone Katamanso Municipal Assembly (KKMA). It is therefore imperative to describe the current existing natural environment and socio-economic conditions of the area before the beginning of the proposed project to allow for future comparison. The general methods involved description and analyses of baseline data and information on the Tema Metropolis and the Kpone Katamanso Municipality, especially, on the catchment of the Chemu Lagoon where the oil refinery is proposed to be located. Data and information have been sourced from available publications and through discussions with various stakeholders, in addition to studies undertaken during field visits.

This chapter thus presents baseline data and information on environmental parameters such as climate, topography and drainage as well as on socio-economic parameters including population, education and occurrence of diseases.

### *5.1.1 Topography, Geology and Soils*

**i. Topography**

The topography of the Tema/ Kpone area is generally flat and forms part of Ghana's coastal plains. The land rises gently towards the north, where the principal stream in the area takes its source. The mean height above sea level in Tema is about 15 m (EMA, 1994). It ranges from 0 m in the south, along the coast to 53 m above sea level in the Kpone Katamanso Municipality (KKMA, 2018; TMA, 2018). Likewise, the proposed project area is generally low lying and fairly flat (Figure 5-1.1). The almost flat nature of the area has made it flood prone and therefore demands a high cost for construction of drainage.

**ii. Geological Setting**

Geologically, the Tema/Kpone area is underlain by metamorphic rocks of Acidic Dahomeyan origin, with muscovite-biotite gneiss, quartz-feldspar gneiss, augen gneiss with minor amphibolites as the main rock components. These rocks decompose to become varying overburden thickness of permeable calcareous shale and clays. Depending upon its location, the underlying rocks may contain either biotite or muscovite minerals.

Details of previous geotechnical works carried out within the project area indicate that the basement rocks contain high levels of argillaceous minerals with high muscovite content. The rocks weather to depths that range between 1.5 and 20 m below ground level. This means that the hard rock at the close vicinity of the project area lies to a maximum depth of about 20 m below ground level. However, the overburden thickness varies from one place to another depending upon the local rainfall regime and topographic characteristics. The basement gneiss rocks are either fractured or massive depending upon the degree of structural deformation the rocks have undergone.

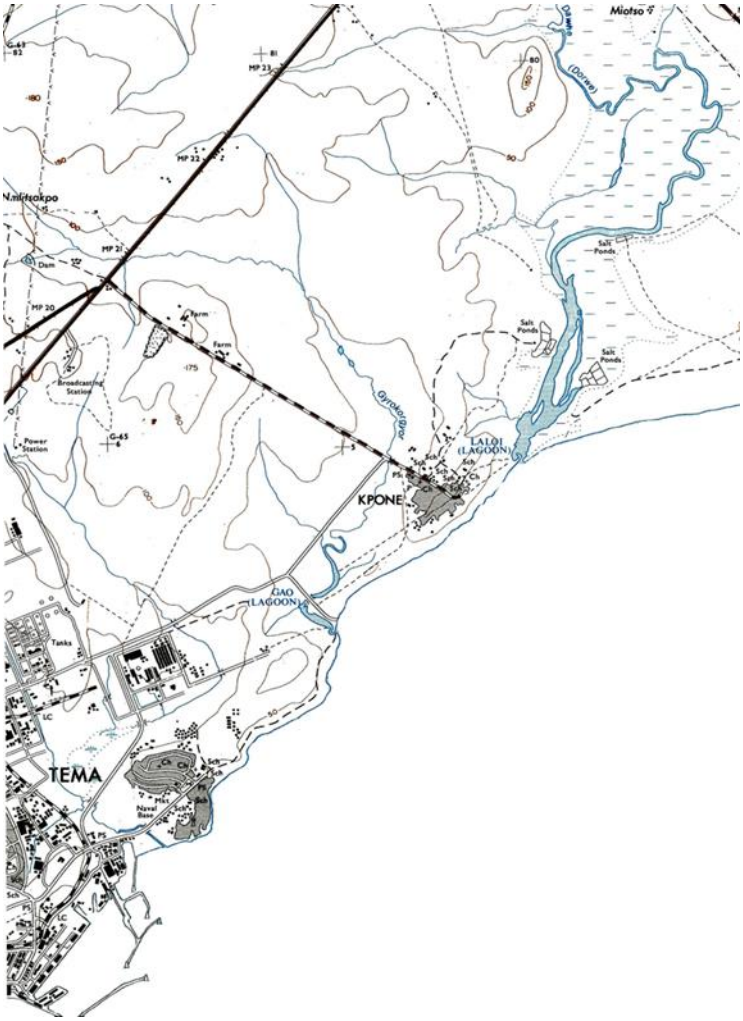



**Figure 5-1.1 Topographic Map of Project Area**

The weathering products are mainly mottles sandy clays. The depth of weathering is rather shallow, rarely exceeding 5 metres. Physical observation from pits and trenches dug in some factories within Tema area for the laying of pipes for effluent disposal showed that the overburden is only 1.5 metres thick. Geologic information obtained from test pilling across the Accra Plain indicates that it is underlain by a variable thickness of alluvial materials deposited along the meandering water course before the flow is discharged into the ocean. Water levels observed in the test pits (even in the dry season) were high or up to ground level indicating the closeness of the water table to the lagoon water level.

**iii. Seismic Conditions of the Project Area**

The coastal zone extending from Accra through Tema to Kpone is known to lie in an earthquake zone. Historical earthquake intensities that have occurred in Southern Ghana (Fig. 5-1.2) within the period 1906 and 1939 shows measurements between 1 and 6.8 on the open-ended Richter Scale.

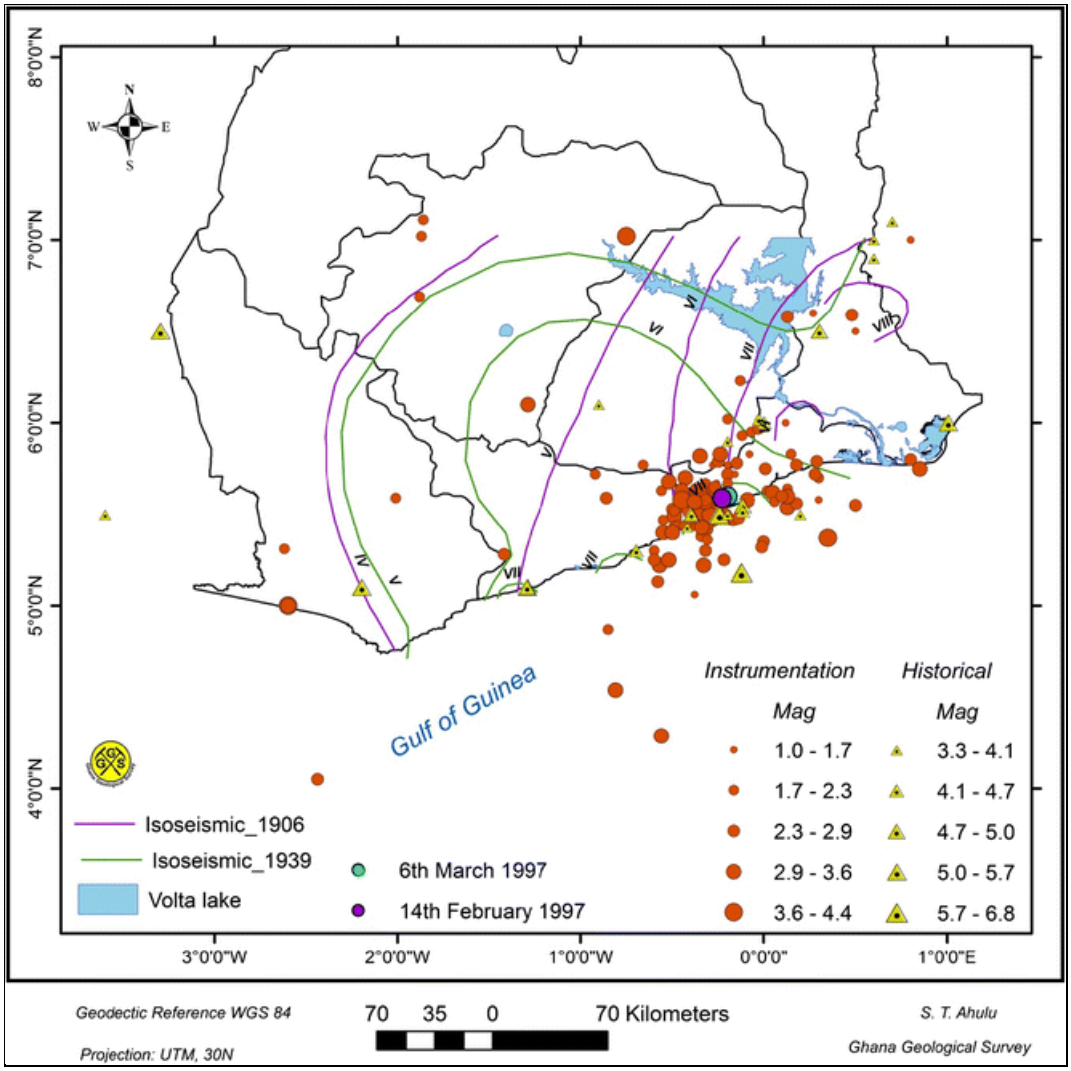



**Figure 5-1.2 Historical Earthquake Intensities of Southern Ghana**

Figure 5-1.2 shows that the proposed project area is located in the Isoseismal V-VI intensity zone. The Refinery is thus located close to a clearly mapped coastal fault. In recent times, seismic events on minor scales between 2 and 4 on the Richter Scale have been measured three or four times a year; and it is likely that the coastal fault is renewed with each event. Building foundations, water and sewerage pipes, and power cables might therefore be affected. It is not known however, when a major quake of the scale of 1939 might occur again. Nevertheless, based on the estimated 50 year cycle of major events around Ghana, it is predicted that it might happen sooner than later. Consequently, all engineering structures and service lines to and from the Refinery must therefore be designed with a measure of earthquake risk in view.

Figure 5-1.3 is the Geological Map of Southern Ghana, showing observed faults in the various rock formations of southern Ghana. The Map indicates that the Southern part of the country, including the project area has the potential of earthquake occurrence (https://www.Seismicity Map of Ghana).

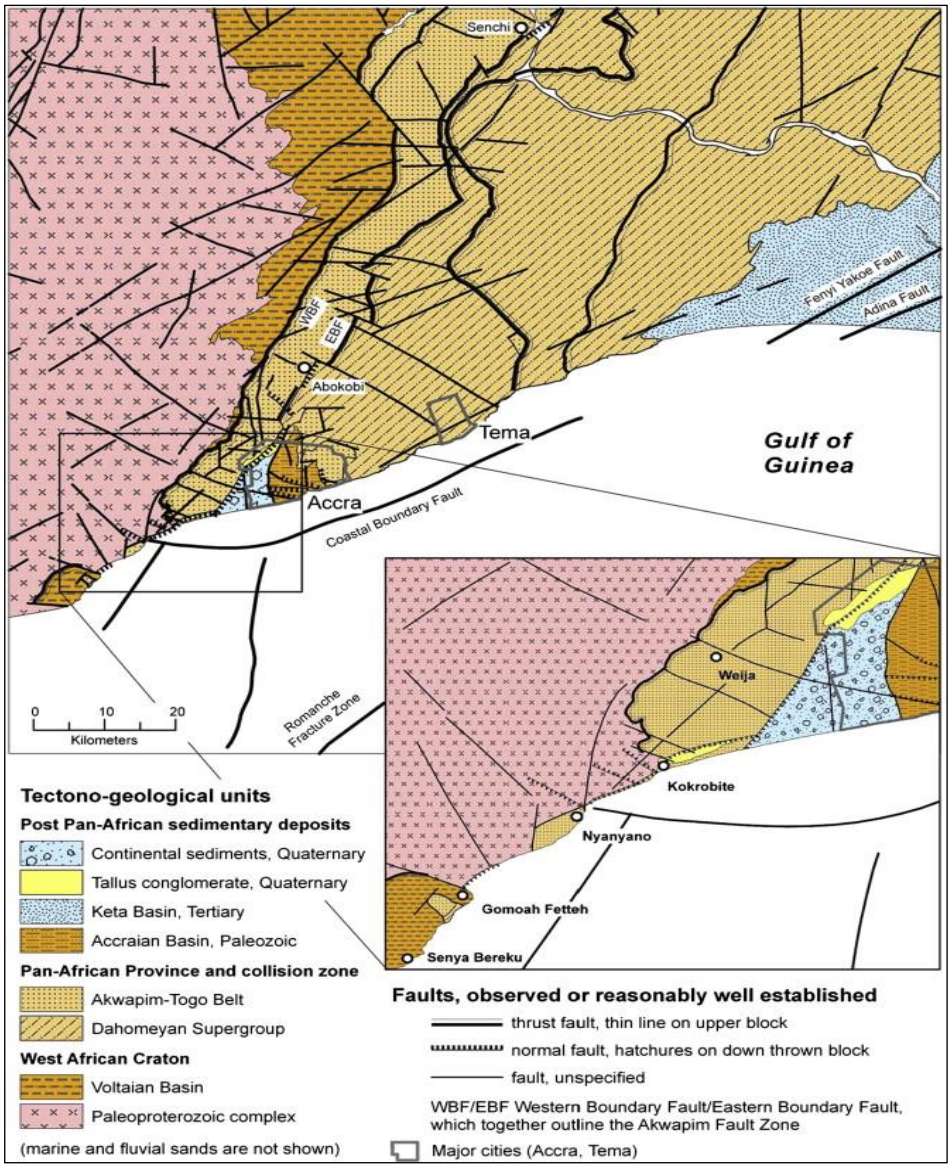



**Figure 5-1.3 Observed Fault Map of Southern Ghana**

### iii. Soils

The project area in the Tema Metropolis and Kpone Katamanso Municipality is underlain by the Precambrian rocks of the Dahomeyan formation, which are metamorphic rocks mainly consisting of granite, gneiss and schist that have been probably derived from sedimentary layers. Weathered gneiss is encountered within 120 cm depth. The soils of the project area are called Tropical Black Clays (Earths) which are typical of the coastal savanna zone that stretches along the coast of Ghana up to a few kilometers inland. They are developed over the basic gneiss in a generally gentle topography and comprise of very dark brown to black clays. These soils, apart from their black colour, also crack deep and wide during the dry season. Most profiles contain calcium carbonate concretions scattered in the subsoil. The profile morphology and topsoil textures are apparently influenced by total amount of rainfall received per annum (Brammer, 1962). The profiles appear deeper and topsoils are lighter (loamy) as the rainfall amounts increase.

The soils are one of the minor great soil groups referred to as Sodium Vleisols which are of taxonomic importance and are characterised by soils that border the saline coastal lagoons. They are black to dark grey clays with hard and sticky consistence and well noted for the presence of salt crust on the soil surface, especially on bare lands bordering the margins of the lagoons. The main limitation of these soils is their workability. They are very heavy and plastic when wet and very hard when dry. They can only be ploughed within a restricted range of soil moisture content that is difficult to attain under rainfed agriculture. Apart from a few thousands of hectares that have been developed for irrigation, the bulk of these soils are rarely cultivated.

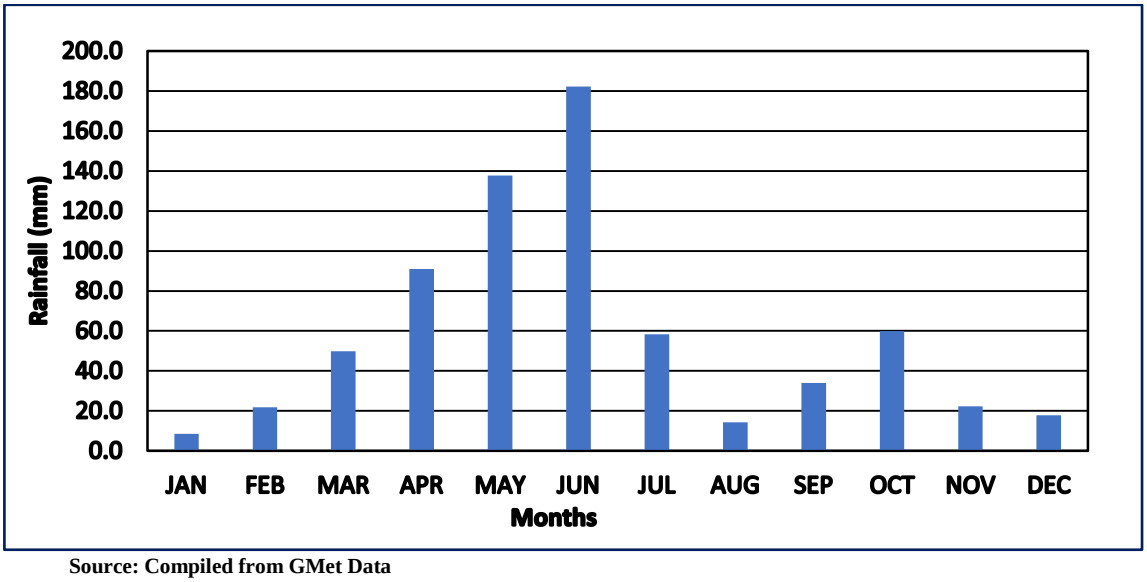
### *5.1.2 Climate*

The proposed site for the SORL oil refinery is covered by the synoptic station of the Ghana Meteorological Agency (GMet) at the Tema Harbour which collects climate data. EPL obtained from the GMA climate data for the last 30 years (1989-2019) for rainfall, maximum and minimum air temperatures, 0600 hour and 1500 hour relative humidity, daily sunshine hours, wind speed and evapotranspiration. Wind direction??

The data collected from the GMet had some gaps during some years and months. For instance, the sunshine data for 1983 and 1984 and for some months for different years were not available while the data for the evapotranspiration are from 2003 to 2018. In analysing the data, arithmetic means were calculated to fill the gaps. The daily average temperature and the daily average relative humidity values were calculated by finding the average of the maximum and minimum values and the same was applied for the relative humidity values for 0600 hr and 1500 hr.

**i. Rainfall**

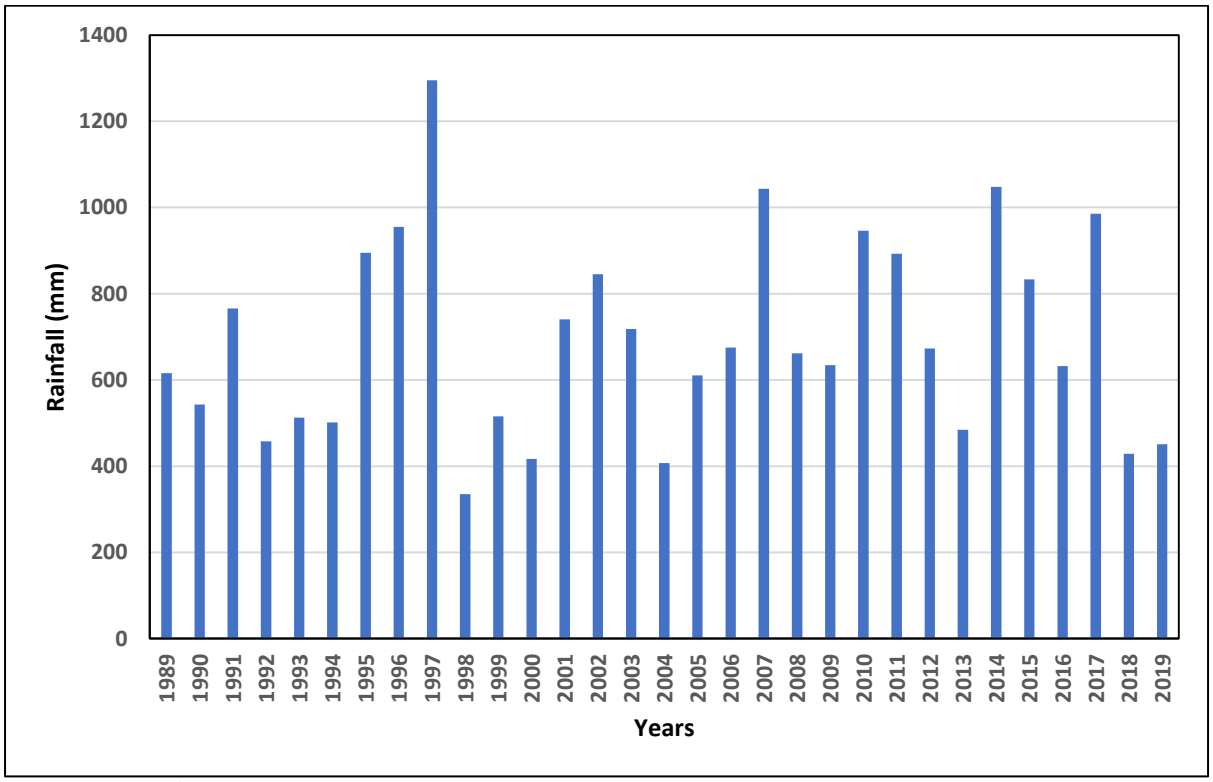
The proposed project site lies in the coastal savannah zone of Ghana and therefore experiences a dry equatorial climate with bimodal rainfall. The onset of the major rainfall season is in March and peaks in June with a break between July and August. The minor rainfall starts from September with the highest amount of rainfall registered in October. (Figure 5-1.4).




**Source: Compiled from GMet Data**

**Figure 5-1.4 Monthly Average Rainfall for Tema (1989-2019)**

Data for the last 30 years (1989-2019) show that the highest average monthly rainfall of 182.1 mm over the period was recorded in June with the lowest average of 8.5 mm in January (Figure 5-1.4). The annual total rainfall ranges between 335 mm in 1998 and 1,295 in 1997 (Figure 5-1.5).

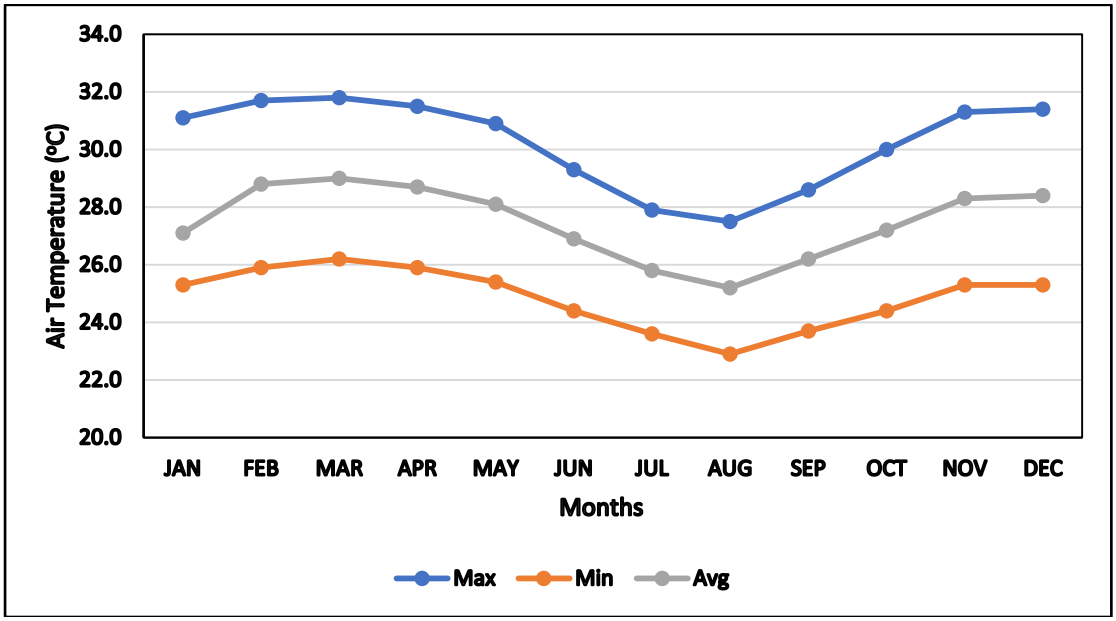



**Source: Compiled from GMet Data**

**Figure 5-1.5 Monthly Total Annual Rainfall for Tema (1989-2019)**

Figure 5-1.6 shows the trends of the monthly maximum, average and minimum temperatures of the project area for the last 30 years (1989-2019). It reveals that the monthly average temperatures of the project area range between 25.2$^{o}$C in August and 28.8$^{o}$C in February.

The minimum and maximum temperatures were recorded in August and March respectively. This trend is explained by the influence of the arrival of the cold monsoon winds in August as the Inter-Tropical Convergence Zone moves northwards creating a high along the coastal belt of the country. The high temperatures between February and March are due to the dry North Easterly winds ("Harmattan") blowing southwards from across the Sahara Desert laden with dust.

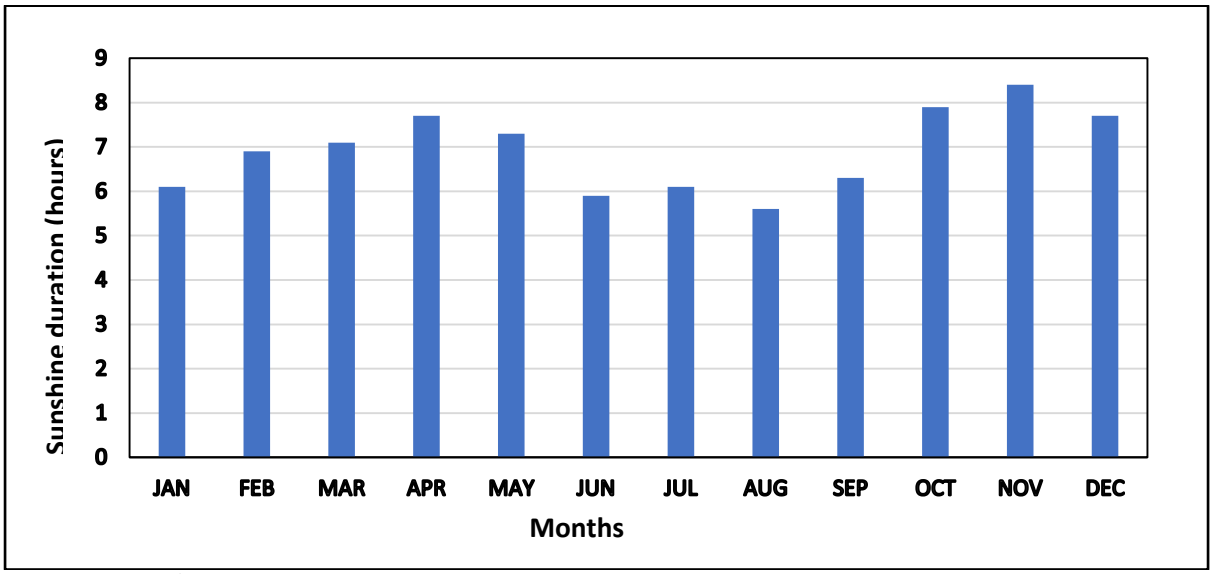



Source: Compiled from GMet Data

**Figure 5-1.6 Monthly Maximum, Average and Minimum Temperatures (ºC)**

### ii. Sunshine Hours

Available records from Ghana Meteorological Agency indicate that the proposed project area experiences sunshine throughout the year with an annual average ranging between 5.6hrs in August to 8.4hrs in November for the 30 years of data on sunshine (Figure 5-1.7).

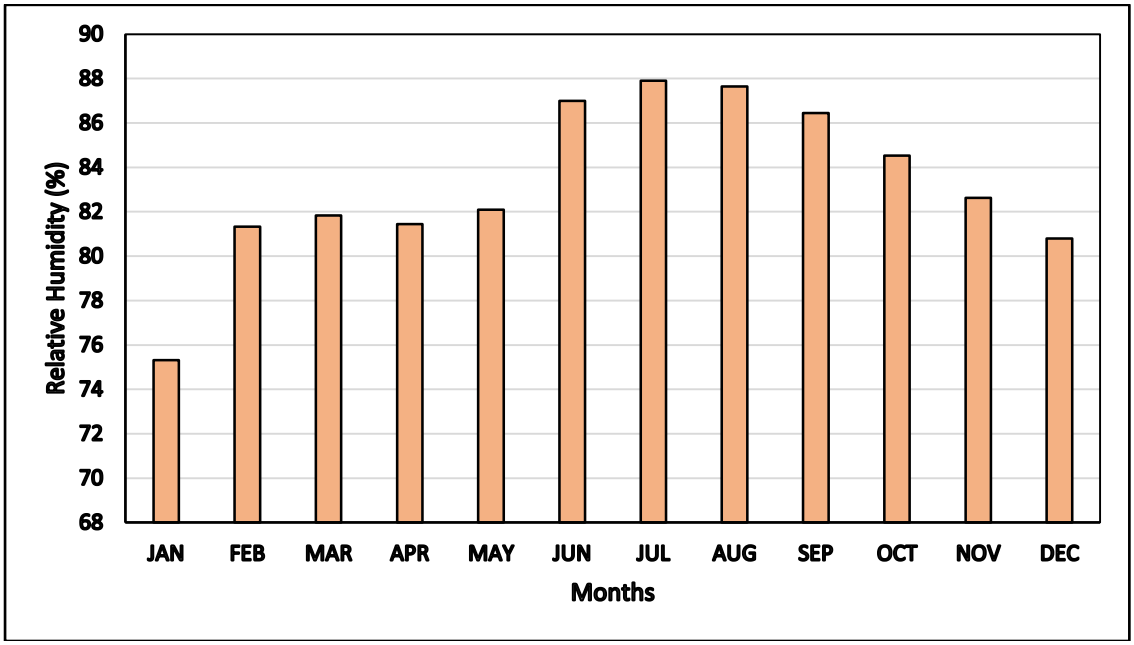



Source: Compiled from GMet Data

**Figure 5-1.7 Monthly Mean Sunshine Duration (1989-2019)**

### iii. Relative Humidity

The area is moist all year round with the lowest average relative humidity of 75% recorded in January while the highest average relative humidity of 88% is attained in July for the thirty-year period (1989-2019) of available data (Figure 5-1.8).

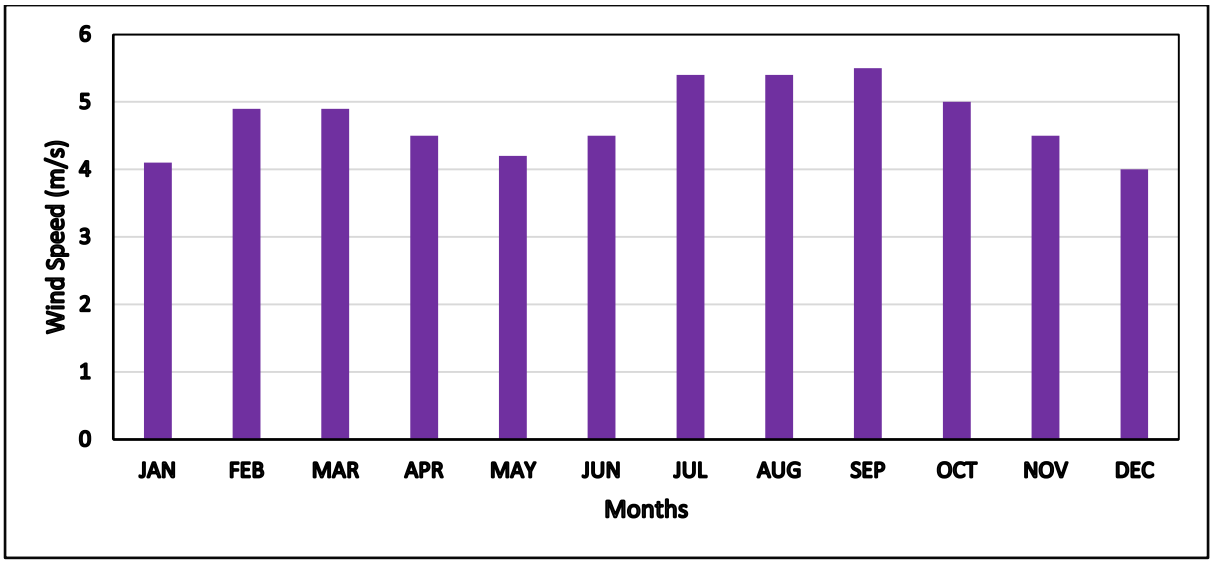



**Source: Compiled from GMet Data**

**Figure 5-1.8 Average Relative Humidity (1989-2019)**

### iv. Wind Speed and Direction

Records available from the Tema synoptic station for the past three decades (1989-2019) indicate that the average monthly wind flow ranges from 4.0 m/s in December to 5.5m/s in September (Figure 5-1.9). The December-February North-easterly dry winds described as "Harmattan" blowing across the desert and laden with dust particulates are experienced in the area. The wind direction fluctuates mostly between S and SW with the NE (Harmattan) winds occurring briefly from middle of December through January to the early parts of February.




**Source: Compiled from GMet Data**

**Figure 5-1.9 Monthly Average Wind Flow (1989-2019)**

### *5.1.3 Air Quality*

The Environmental Protection Agency and Ghana Standard Authority (GSA) have developed Environment Quality Standards –EPA/GS 1236: 2019 as indicators in monitoring the environment. The relevant portions pertaining to ambient air quality are presented in Table 5-1.1 below.

**Table 5-1.1 Maximum Permissible Limits for Ambient Air Pollutants**

| No. | Pollutant ($\mu g/m^3$) | Maximum Limits ($\mu g/m^3$) | Averaging Time |
|---|---|---|---|
| 1 | TSP | 150<br>80 | 24 hours<br>1 year |
| 2 | $PM_{10}$ | 70<br>70 | 24 hours<br>1 year |
| 3 | $PM_{2.5}$ | 35 | 24 hours |
| 4 | $NO_2$ | 250<br>150 | 1 hour<br>24 hours |
| 5 | $SO_2$ | 520<br>50 | 1 hour<br>24 hours |

**Source: EPA/GSA, Accra, 2019**

**Legend**

TSP Total Suspended Particles
$PM_{10}$ Particulate Matter with aerodynamic diameter of less than10 micrometre
$PM_{2.5}$ Particulate Matter with aerodynamic diameter of less than 2.5 micrometre
$NO_2$ Nitrogen Dioxide
$SO_2$ Sulphur Dioxide

The weather conditions during the period of monitoring were as followings; visibility was excellent extending to 11 km and beyond, temperature was $28^0$ C with a relative humidity of 88%. Wind flow was South West at 3 m/s while the mean sea level atmospheric pressure was 1010.0mb with a clear sky. Based on the prevailing weather conditions and without any vertical obstruction coupled with little human interface, three points (A, D and C) described in Table 5-1.2 were chosen for the air quality measurements (Figure 5-1.1).

**Table 5-1.2 Ambient Air Quality Measurement Locations**

| Location | Description | Coordinates |
|---|---|---|
| EM 1 (A) | Entrance to the proposed project site | Latitude 5° 39’ 35.31” N<br>Longitude 0° 0’ 57.07” E |
| EM 2 (C) | Tema New Town | Latitude 5° 39’ 32.54” N<br>Longitude 0° 01’ 08.13” E |
| EM 3 (D) | Near Wang Hang cement factory | Latitude 5° 39’ 8.58” N<br>Longitude 0° 0’ 42.69” E |


A motor driven SKC Dust Sampler 224-52TX air sampling pump was used to measure particulate matter (TSP, $PM_{10}$ & $PM_{2.5}$). The procedure involved mounting a pre-weighed filter paper at a height of 1.78 m and exposing it for 24 hours. The weight difference of the filter paper was determined and fitted in the formula, TWA = (C1 x T1) + (C2 x T2) + (Cn x Tn) 8,

The measurement for the noxious gases ($NO_2$ & $SO_2$) was carried out in May 2020 with an Aeroquel Series 500 Air Quality Monitor, which has a sensor and logging system. The added advantage is its continuous sampling and storage facility and so is used for outdoor quality air monitoring surveys by many regulators. The results are presented in Table 5-1.3.

**Plate 5-1.1 Sampling Monitors Mounted at Point A (Left) and D (Right)**

**Table 5-1.3 Concentrations of Particulate Matter and Noxious Gases (µg/m³)**

| Location | TSP | $PM_{10}$ | $PM_{2.5}$ | $NO_2$ µg/m³ | $SO_2$ µg/m³ |
|---|---|---|---|---|---|
| A | 71.10 | 18.15 | 9.69 | 0.08 | 2.70 |
| C | 118.40 | 37.35 | 15.02 | <0.05 | <0.05 |
| D | 79.64 | 23.13 | 12.00 | <0.05 | <0.05 |
| **EPA / GSA Standards** | **150** | **70** | **35** | **250** | **520** |

As stated above particulate matter refers to a mixture of solid particles and liquid droplets found in the air. The particles occur in a wide range of sizes and originate from different stationary and mobile sources such as movement on unpaved surfaces and windblown dust. Particulate matter larger than 10 µm are referred to as Total Suspended Particulates (TSP) while particles less than 10µm are generally referred to as $PM_{10}$ and $PM_{2.5}$ refers to the very fine particulates (dust).

From the above results, TSP values ranged from 71.10 to 118.40 µg/m³ compared to the EPA/GSA standard value of 150µg/m³ for a 24hour averaging time. The $PM_{10}$ values ranged between 8.15 and 37.35 µg/m³ compared with the EPA/GSA standard value of 70 µg/m³ for a 24hour averaging time. The $PM_{2.5}$ levels ranged from 9.69 to 15.02 µg/m³ as compared to the EPA/GSA Standard value of 35 µg/m³. The concentrations of particulate matter in the project area were therefore within the acceptable limits.

The noxious gases are mostly released into the atmosphere from automobile exhaust, industrial boilers, and chimney's, furnaces and generators through the burning of fossil fuels. These are also known as greenhouse gases. From the results, $NO_2$ and $SO_2$ values were within their respective EPA/GSA Standard values.

### *5.1.4 Ambient Noise Levels*

In Ghana, the EPA has National Ambient Noise Quality Guideline values for both industrial and residential sites that all development operations must comply with. These values are also acceptable to the World Bank, IFC and similar institutions.

As already stated above, the SORL project is proposed to be located at the Tema Heavy Industrial Area, which is about 80% a built up environment. The prime sources of noise in the area include operations of process plants, factory machinery, haul truck traffic as well as relatively quieter commercial vehicular movement from the nearby community of Tema New Town. The frequencies and severity of noise generation will vary during the different phases of the proposed project; construction, operations and decommissioning.

The ambient noise level measurements were carried out by the Consultant from 20 to 21 April 2020 to establish the baseline data for future environmental monitoring and evaluations of the operations of the oil refinery project. A portable digital EXTECH 407736 Sound Level Meter, with accuracy of ± 1.5dB was used for the measurements of ambient noise levels at selected locations with reference to the proposed site for the project including Tema New Town for its nearness to the site (Figure 5-1.10). The equipment was held 1.2 m above ground and readings

were taken *in-situ* in decibels on the A scale, i.e., dB (A) every 5 seconds for 5 minutes (Plate 5-1.2).

**Plate 5-1.2 Measuring Ambient Noise Levels at Tema New Town**

The results, presented in Table 5-1.4, below indicate that the measured Integrated Noise Levels (Leq) in and within the catchment of the proposed site ranged from 64.3dB (A) to 78.5dB (A), which is below the EPA acceptable and Department of Factories Inspectorate Guideline of 85dB (A) for industrial areas. The measured level for Tema New Town of 53.1dB (A) was also below the EPA acceptable noise level for daytime.

**Table 5-1.4 Ambient Noise Level Assessment-Daytime, dB (A) (0600hrs – 2000hrs)**

| Location | Coordinates | | Guidelines (dB) | | Measured (dB) |
|---|---|---|---|---|---|
| | Longitude | Latitude | EPA (Residential) | DFI* (Workplace) | Leq |
| A. The Main Entrance | $0^0$ 0'57.80"E | $05^0$ 39'35.31"N | - | 85 | 64.3 |
| B. Center of Site | $0^0$ 1' 1.53"E | $05^0$ 39' 36.53"N | - | 85 | 71.1 |
| C. NE of Site; close to Wan Heng Cement | $0^0$ 0'42.61" E | $05^0$ 39' 8.58"N | - | 85 | 78.5 |
| D. Tema New Town | $0^0$ 01' 08.31"E | $05^0$ 39' 32.54"N | 60 | | 53.1 |

***Department of Factories Inspectorate**

The measurements were carried out immediately after the partial lockdown of the Greater Accra Region and its environs due to the COVID-19 pandemic. So for the three weeks of the lockdown industrial processing plants and movement to and from the area was significantly reduced and this was reflected in the values recorded.

### *5.1.5 Hydrology*

**i. Surface Water Hydrology**

The SORL refinery will be located on a piece of land, which is part of the catchment of the Chemu Lagoon. The area is generally low lying and fairly flat (Figure 4-1.1). The mean height above sea level is about 15 m. The land rises gently towards the north, reaching maximum height of 53 m in the extreme north (EMA, 1994) where the principal stream in the Tema Metropolitan Area, Gynakorgyor, takes its source from. This stream flows into the Gao Lagoon between Manhean and Kpone (TMA, 2018).

The Chemu Lagoon drains a total area of 26 $km^2$ which stretches from the north-eastern end of the Accra-Tema motorway and the residential areas lying to the west and north of the lagoon. The riverine section of the lagoon flows in an approximately north to south direction before emptying into the Chemu Lagoon itself (EMA, 1994). The lagoon opens into the sea through a lined trapezoidal channel. Industrial liquid waste and water from the eastern part of the Tema New Town (Manhean) Township converge into a major drain ending up in the lagoon. These pollutants have destroyed the aquatic life of the lagoon (TMA, 2018). It has also lost part of its storage capacity due to siltation and the Tema Metropolitan Assembly has plans to dredge it. The site is also the downstream of three major drains in the Heavy Industrial Area. The project area and the adjacent Tema Mahean are prone to flooding.

**ii. Surface Water Quality**

The main objective of this section is to establish baseline information on the physico-chemical characteristics of surface waters in the project area that can serve as a basis for determining trends in the future. Being close to the sea however, the quality of the surface waters in the project area may vary with the influence of tidal spray and input of fresh water from upstream of the project area, among others. Large variations may also occur in the physico chemical characteristics depending on the seasons, being either wet or dry and on whether the surface waters are stagnant or free-flowing.

Where the relevant information is available, tabulated results are presented alongside unpolluted natural background levels for tropical coastal waters (Livingstone, 1963; Burton and Liss, 1976; Jorgensen, 1979; Stumm and Morgan, 1981). The results are compared with EPA Standards and World Health Organisation (WHO) guideline limits for drinking water.

Water samples were collected in March 2020, which is part of the dry season, from four (4) locations as follows (Figure 5-1.11):

A. Upstream (0.3 km) of Bridge over VALCO Haulage Road, near Tema New Town;
B. Bridge over VALCO Haulage Road;
C. Confluence of Chemu Lagoon and Drain from TOR (In front of warehouses);
D. Sea Water, east of the Fishing Harbour Breakwater and west of the Chemu Lagoon outlet.


**Figure 5-1.11 Water Sampling points**

Samples were analysed at the CSIR Water Research Institute at 2nd CSIR Close in Accra. The methods used for the physico-chemical analyses of surface and ground waters are summarized in Table 5-1.5. All field and laboratory determinations were according to the American Public Health Association (2012) Standard Methods for the Examination of Water and Wastewater, 22nd Edition. Also presented in the table are the equipment detection limits for the different parameters analysed.

**Table 5-1.5 Methods and Detection Limits for Water Analyses**

| Parameters for Water Analysis | Reference for Method* | Detection Limits |
|---|---|---|
| pH | pH Meter | 0.1 pH units |
| Turbidity (NTU) | HACH 2100P Turbidimeter | 0.01NTU |
| TSS (mg/l) | Gravimetric | 1.00 mg/l |
| Conductivity (µS/cm) | Cyberscan PC 510 | |
| DO (mg/l) | DO Meter | 0.2 mg/l |
| BOD (mg/l) | Dilution Method | 0.5 mg/l |
| COD (mg/l) | Closed Tube Reflux | 5.0 mg/l |
| Chloride (mg/l) | Argentometric Method | |
| Fluoride (mg/l) | Fluoride Meter | 0.001 mg/l |
| Sulphate (mg/l) | Barium Chloride Method | 1.0 mg/l |
| Nitrate (mg/l) | Hydrazine reduction | 0.001 mg/l |
| Phosphate (mg/l) | Stannous Chloride | 0.001mg/l |
| Ammonium (mg/l) | Direct Nesslerization Method | 0.001mg/l |
| Calcium (mg/l) | EDTA Titrimetric | 0.01 mg/l |
| Magnesium (mg/l) | EDTA-By Calculation | 0.5 mg/l |

| | | |
|---|---|---|
| Potassium (mg/l) | JENWAY Flame Photometer | 0.1 mg/l |
| Sodium (mg/l) | JENWAY Flame Photometer | 0.1 mg/l |
| Total Iron (mg/l) | AAS Graphite | <0.010 |
| Manganese (mg/l) | AAS Graphite | <0.005 |

*** American Public Health Association (2012)**

Tables 5-1.6 to 5-1.6 below present the characteristics of the surface waters of the project area as represented by key selected parameters. Further details are presented in Appendix 5-1.1.

The pH of natural waters is usually governed by the carbon dioxide/bicarbonate/carbonate equilibria due to such interactions as between suspended and sedimentary particles and bioactivity of plants. Natural background pH levels range between 7 and 8 (Table 5-1.6). The pH values of the surface waters analysed were near neutral, ranging from 7.43 to 7.80, which were within the natural background range of 7.0-8.0 as well as the EPA standard of 6.0 to 9.0.

Conductivity (COND) is an expression of water's ability to conduct an electrical current. This property depends on the ionic strength of water and is therefore related to the nature of various dissolved substances and their actual and relative concentrations. Conductivity influences the occurrence and diversity of plants and animals. Because of their saline nature (salinity), estuarine and coastal waters have higher conductivities compared to freshwater but changes may also indicate pollution. Thus, the conductivities and salinities of the surface waters increased from upstream of the VALCO Bridge (1.8‰) to the sea shore at the Fishing Harbour (about 34**‰**), close to the natural background level of 35**‰**.

**Table 5-1.6 Physico-chemical Characteristics of Surface Waters***

| Code | Location | pH | COND (µS/cm) | Turbidity (NTU) | TSS | Salinity (‰) | DO | COD |
|---|---|---|---|---|---|---|---|---|
| | **Estuarine Waters** | | | | | | | |
| **1** | Upstream of VALCO Bridge | 7.43 | 3,800 | 63 | 105 | 1.8 | 2.7 | 74 |
| **2** | VALCO Bridge | 7.94 | 7,600 | 52 | 100 | 3.5 | 4.8 | 57 |
| **3** | Confluence of TOR Drain and Lagoon | 7.71 | 2,830 | 78 | 113 | 1.24 | 0 | 350 |
| **4** | Seawater | 7.8 | 42,400 | 5 | 10 | 34 | 5.8 | 15 |
| | **WHO Guidelines** | **6.5-8.5** | **-** | **5.0** | **-** | | **-** | **-** |
| | **EPA Standards** | **6.0-9.0** | **1,500** | **75** | **50** | | **-** | **250** |
| | **Natural Background Levels** | **7-8** | **-** | **-** | **-** | **35** | **7.0** | **-** |

* All concentrations in mg/l except where otherwise stated

The concentrations of dissolved oxygen (DO) in the surface waters ranged from 0 mg/l in the deoxygenated waters of the drain from TOR to 5.8 mg/l in sea water off the Fishing Harbour. The drain from TOR carries waste materials from different sources including organics from the abattoir, spent oil from vehicle repair shops and miscellaneous discharges from the various industries in the vicinity. These conditions are also reflected in the high concentrations of Total Suspended Solids (TSS) in the surface waters. Decay of such suspended material will lead to conditions of deoxygenation, especially during the dry season when the drain and stream waters are not renewed regularly. The presence of suspended solids results in water turbidity, high

levels of which reduce the amount of light penetration of the water, making it difficult for a high diversity of algae and other aquatic plants, to survive.

Thus, apart from the seawater, the other surface waters showed similar poor conditions with high suspended solids and turbidities. The physico-chemical characteristic of the surface waters were thus a reflection of poor or unorganised waste disposal practices in the project area and its surroundings.

In the same vein, nutrient concentrations – phosphate ($PO_4$-P), nitrate ($NO_3$-N) and ammonia ($NH_3$-N) - occurred in concentrations higher than their respective natural background values (Table 5-1.7). The major sources of phosphates and ammonia include land runoff containing domestic waste waters with high concentration of sewage and untreated industrial waste. Furthermore, the levels of Biochemical Oxygen Demand (BOD), which is an indication of organic pollution, were high (2.30 to 134 mg/l) compared to the EPA standard of 50 mg/l. On the other hand, the pattern of occurrence of the major ions was: Na>Mg>Ca>K; Cl>SO4, which is normal for estuarine and coastal surface waters.

In line with their unsatisfactory physico-chemical characteristics, bacteriological analyses of the surface waters (Table 5-1.8) showed the excessive presence of faecal coliforms and *E. coli* in all of the surface waters, which makes them unfit, not only for direct human consumption but also for primary contact activities such as swimming. *E. coli* is an indicator of recent faecal pollution and its presence also shows that the lack of toilets in the nearby areas have resulted in open defaecation.

**Table 5-1.7 Nutrients and Major Ions in Surface Waters (mg/l)**

| Code | Location | $NO_3$-N | $NH_3$-N | $PO_4$-P | Ca | Mg | Cl | $SO_4$ | Na | K |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Estuarine Waters** | | | | | | | | | |
| **1** | Upstream of VALCO Bridge | 0.70 | 0.24 | 0.19 | 132 | 280.2 | 3,077 | 123 | 1,520 | 25 |
| **2** | VALCO Bridge | 0.86 | 0.16 | 0.24 | 134 | 227 | 2,551 | 120 | 1,304 | 13.5 |
| **3** | Confluence of TOR Drain and Lagoon | 1.10 | 0.47 | 0.35 | 62.1 | 60.9 | 844 | 30.0 | 362 | 90 |
| **4** | Seawater | 0.30 | 0.13 | 0.12 | 36.6 | 70.2 | 859 | 145 | 510 | 42.2 |
| | **WHO Guidelines** | **10** | **1.5** | | **200** | **150** | **250** | **250** | **200** | **30** |
| | **EPA Standards** | **50** | **1.0** | **2.0** | | | **250** | **250** | | |
| | **Natural Background Levels** | **0.23** | **0.01** | **0.02** | **412** | **1,294** | **19,340** | **2,712** | **10,770** | **399** |

**Table 5-1.8 BOD and Bacteriological* Characteristics of Surface Waters***

| Code | Location | BOD (mg/L) | Total Coliform* | Faecal Coliform* | *E. coli* |
|---|---|---|---|---|---|
| | **Estuarine Waters** | | | | |
| **1** | Upstream of VALCO Bridge | 9.10 | 220,000 | 95,000 | 95,000 |
| **2** | VALCO Bridge | 6.90 | 372,000 | 93,000 | 93,000 |
| **3** | Confluence of TOR Drain and Lagoon | 134 | 21,000 | 20,000 | 0 |
| **4** | Seawater | 2.30 | 10,302 | 930 | 56 |
| | **WHO Guidelines – Primary Contact** | **-** | **0** | **0** | **0** |
| | **WHO – Secondary Contact** | | **10,000** | **5,000** | **-** |
| | **EPA Standards*** | **50** | | | |
| | **Natural Background Levels** | | | | |

* Counts/100 ml

### *5.1.6 Hydrogeology*

From a study of the hydrogeologic conditions in the entire Accra Plains area based mainly only on data obtained from the few production and test wells drilled by the CSIR Water Research Institute, there is limited potential for the transmission and storage of groundwater in the underlying rocks. This is mainly due to the generally impermeable nature of the overburden and the absence of interconnected fractures and joints in the bedrock itself. Also, rainfall in the area being low, most of it results in high run-off over the impermeable surface into gullies and streams that discharge into nearby lagoons.

The proposed project will not be very dependent on groundwater sources as there is very little bank storage along nearby ephemeral streams as base flows of these streams are negligible. Infiltration of surface water into the sub-soils is therefore thought to be very limited. The general lack of knowledge of the groundwater resources of the area can not only be attributed to the unfavorable hydrogeologic conditions but also the fact that Tema township is adequately served with pipe borne water supply by the GWCL; thus, this constitutes a disincentive for testing for groundwater sources in the area. Limited investigation has been carried into the feasibility of supplementing the water requirements of the proposed project area.

With this background, it is possible to design a well field on the flood plain to tap shallow groundwater. Nonetheless it is highly suspected that the general quality of the water will be brackish because of tidal flows and evaporative effects on the lagoon waters. However, this source of water is also most likely to be polluted by contaminants discharged into the riverine section and into the main body of the Chemu Lagoon, upstream of the proposed site.

## 5.2 Biological Environment

The Ghanaian coastal zone may be divided into three geomorphologic areas (EPA, 2004); the West, Central and East Coasts. The West Coast covers 95 km of stable shoreline and extends from Ghana's border with Côte d'Ivoire to the estuary of the River Ankobra, near Axim. It is basically fine sand with gentle beaches backed by coastal lagoons. The Central Coast shoreline is 321 km long and extends from the estuary of the Ankobra River to Prampram, east of Tema. It represents an embayed coast of rocky headlands, rocky shores and littoral sand barriers enclosing coastal lagoons. The East Coast, which is made up of 149 km of shoreline, extends from Prampram eastwards to Aflao, at the border with Togo and is characterised by sandy beaches with the deltaic estuary of the Volta River situated halfway in-between.

The proposed project area forms part of the Central Coast and lies between the shores of Tema and the slightly elevated reaches of the Kpone Katamanso area (Figure 5-1.1). The coastal lagoons that occur in this area are, from the west, the Sakumo, Chemu, Gao and Laloi.

As specifically indicated in Section 1 above, the site for the proposed oil refinery in the Tema Heavy Industrial Area, lies within the catchment of the Chemu Lagoon (Plate 1-1.1). The Chemu Lagoon has for more than half a century suffered from the impacts of urbanization and industrialization in the Tema metropolis. Various previous studies, including those of Biney, (1982); EMA, (1989) and Biney et al., (1995), described the lagoon as grossly polluted. Other recent studies including an Environmental Sensitivity Map for the Coastal Areas of Ghana (EPA, 2004) observed that the Chemu Lagoon had virtually disappeared as a result of discharges from municipal and industrial sources containing faecal waste, garbage and used

oil, among others. Open defaecation has also been observed to occur in the catchment. This situation has come about as a result of weak enforcement of regulations and lack of awareness and education on the need to protect wetlands of all types.

The Tema Metropolitan Authority (TMA) is currently making efforts to dredge some sections of the lagoon. For example, it is partnering Meridian Port Services to dredge and canalize the section of the lagoon close to Wan Heng Ghana Limited (Plate 5-2.1). Meridian Port Services is engaged in the project on the expansion of the Tema harbour as well as other auxiliary works.

### *5.2.1 Flora*

The methods used in obtaining information on the vegetation of the project area included desk reviews of existing literature, interviews of people and contacts with experts. The Consultant also made direct observations during field studies.

Generally, two main vegetation zones exist within the low lying plain of the Ghanaian coastline. In the Western zone from Côte d'Ivoire to Cape Coast, the coastal plain is dominated by semi-deciduous and evergreen secondary tropical forest. The Eastern zone from Cape Coast to the eastern border with Togo, in which the project area falls, comprises a relatively dry zone with low-lying thickets and savannah-grassland (Armah and Amlalo, 1998). Thus, the vegetation of the here is the following types (Ministry of Local Government et al., 1991):

- Benthic algal zone occupying the intertidal/littoral areas;
- Straggling grasses, forbs, herbs and coconuts on sand dunes;
- Mangroves in the estuarine and lagoon areas;
- Sedges in the immediate catchments of the lagoons and estuaries;
- Zone of saline grasslands and evergreen shrub thickets.


**Plate 5.2-1 Dredging of Lower Reaches of Chemu Lagoon**

The vegetation types in and around the Chemu Lagoon catchment have been greatly disturbed in step with the industrialization of the Tema area. The sand dune has also been heavily mined for sand leaving the area with little vegetation. Thus, a study conducted in the same area by EMA (1994), reported that as a result of the various anthropogenic activities (Construction of Harbour Complex, roads and settlements, sand winning, industrial pollution, etc.) most of the original vegetation in the project area have all been removed except for those in and around the Chemu Lagoon and its flood plains and low lying areas. The area beyond the inter-tidal zone was virtually devoid of coconut plantations. The major flora in the lagoonal ecosystem consisted of the Olive/Black mangrove *Avecinnia africana,* the Button mangrove *Conocarpus erectus* with grasses (*Sporobolus virginicus, S. robustus, Andropogon gayanus, Imperata cyndrica*, forbs/herbs (*Canavalia rosea, Sessuvium portulacastrum*) and reeds (*Typha domingensis, C. articulatus*). Further inland, the vegetation occurred in the form of shrubs often shaped or dwarfed by the effect of the winds. Common plant species encountered included *Eugenia coronatus, Chrysobalanus orbicularis, Thespesia populnea* and *Phoenix reclinata*.

However, the present vegetative cover in the project area reflects a diminishing presence of shrubs and a domination of grasses, mainly *Typha* and *Cyperus* sp (Plate 5-2.2). This trend is attributed to the expansion of estate and industrial development as well as illegal stone quarrying and sand wining (TMA, 2018; KKMA, 2018). A list of floral species known to occur in the general area of the project or otherwise identified in the study is presented in Appendix 5-2.1.

**Plate 5-2.2 Typical Vegetation of Project Site**

### *5.2.2 Fauna*

The present survey was guided in part by knowledge of the different habitats of various faunal groups. In addition, the method relied on searches, sightings and calls as well as interviews with local residents.

Drastic changes and or destruction of the faunal habitats have taken place in the project area due to anthropogenic activities as described above. These have led to decreases in both diversity and populations of the original faunal species in the project area. There does not appear to be any fishes, crabs or mud skippers in the main Chemu Lagoon. Animal fauna that occur in the catchment include the following:

**i. Mammals**
The mammals include giant rats and squirrels, which are increasingly rarely seen or hunted. The major component of animal protein requirements of the locals come from the marine fisheries sector.

**ii. Birds**
Many avian species including resident and important paleoarctic migrants can be found in the general area. Species commonly occurring include the common or hooded vulture (*Necrosyrtes monachus*), Pied crows (*Corvusalbus*) Cattle egrets (*Ardeola ibis*), Grey headed bulbul (*Pycnonotus barbatus*), King fishers (*Halcyon senegalensis*), Plowers, Sandpipers and Terns (eg. *Sterna hirundo*- common tern, Grey heron - *Ardea cineria*).

**iii. Reptiles**
Reptiles common around the project area include Agama lizards (*Agama agama*) skinks (*Scinidae*), Scorpions (*Chactus* sp.) and snakes (eg. African python - *Python sebae*).

**iv. Fishes**
The Bulk of the fish comes from both the artisanal and deep sea fisheries both of which have landing facilities close to the project area.

Though heavily polluted, some tilapias, catfishes, prawns and land crabs are occasionally caught along some stretches of the Chemu lagoon catchment. These include the brackish land crab *Cardiosoma armata*, the white sand crab *Ocypode africana*, and fishes (*Hemichromis* sp., Tilapia sp. and *Sarotherodon* sp).

**v. Insects**
Insects form the most diverse of the fauna of the area. They include crickets, cockroaches, moths, houseflies and mosquitoes, bees and wasps and termites.

None of the faunal species is of global conservation significance or rare or protected except for the vulture, *Necrosyrtes monachus* whose population decline across Africa has resulted in the species being reclassified from the status of Least Concern to Endangered and, quite recently to, Critically Endangered (Gbogbo et al., 2016).

The list of fauna found in the project area is presented in Appendix 5-2.2.

## 5.3 Socio-economic Environment

The proposed project site lies in the Heavy Industrial Area of the Tema metropolis. The project's area of influence, thus, includes Tema Metropolitan Assembly (TMA) and the Kpone Katamanso Municipal Assembly (KKMA). In this subsection, the socio-economic conditions of the project area are discussed, taking into consideration the demographic characteristics, principal economic activities, available health and education facilities, and road networks.

### *5.3.1 Demographic Characteristics*

**i. Tema Metropolitan Area**

The Tema metropolis is entirely urban. Data available from the Ghana Statistical Service (GSS, 2010), following the 2010 Population and Housing Census (PHC), shows that the area has a total population of 292,773 of which 47.8% is male and 52.2% female. In terms of age distribution, the population is mostly comprised of adults (15-64 years of age) who represent 66.7% of the population, whereas children (0-14 years of age) represent 29.4% (Table 5-3.1).

Going by the 2010 PHC data, more than half of the population (56.9%) in the metropolis are migrants (166,506). Besides, 20.5% of the migrant population was born in the Greater Accra Region, whereas 75.3% of the migrant population was born outside the Greater Accra Region. Thus, the metropolis is constituted by migrants who have been attracted mostly by the manufacturing industries and commercial activities in the area.

**Table 5-3.1 Population Distribution by Sex and Age (TMA)**

| Age Group | Both Sexes | | Male | | Female | | Sex Ratio | Type of Locality |
|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | | Urban |
| All Ages | 292,773 | 100.0 | 139,958 | 100.0 | 152,815 | 100.0 | 91.6 | 292,773 |
| 15 - 19 | 28,148 | 9.6 | 12,598 | 9.0 | 15,550 | 10.2 | 81.0 | 28,148 |
| 20 - 24 | 32,583 | 11.1 | 14,989 | 10.7 | 17,594 | 11.5 | 85.2 | 32,583 |
| 25 - 29 | 33,475 | 11.4 | 15,788 | 11.3 | 17,687 | 11.6 | 89.3 | 33,475 |
| 30 - 34 | 26,417 | 9.0 | 12,942 | 9.2 | 13,475 | 8.8 | 96.0 | 26,417 |
| 35 - 39 | 20,985 | 7.2 | 10,351 | 7.4 | 10,634 | 7.0 | 97.3 | 20,985 |
| 40 - 44 | 16,371 | 5.6 | 8,008 | 5.7 | 8,363 | 5.5 | 95.8 | 16,371 |
| 45 - 49 | 12,793 | 4.4 | 6,172 | 4.4 | 6,621 | 4.3 | 93.2 | 12,793 |
| 50 - 54 | 10,889 | 3.7 | 5,145 | 3.7 | 5,744 | 3.8 | 89.6 | 10,889 |
| 55 - 59 | 7,618 | 2.6 | 3,601 | 2.6 | 4,017 | 2.6 | 89.6 | 7,618 |
| 60 - 64 | 5,952 | 2.0 | 2,897 | 2.1 | 3,055 | 2.0 | 94.8 | 5,952 |
| 65 - 69 | 4,021 | 1.4 | 1,901 | 1.4 | 2,120 | 1.4 | 89.7 | 4,021 |
| 70 - 74 | 3,302 | 1.1 | 1,594 | 1.1 | 1,708 | 1.1 | 93.3 | 3,302 |
| 75 - 79 | 1,868 | 0.6 | 835 | 0.6 | 1,033 | 0.7 | 80.8 | 1,868 |
| 80 - 84 | 1,178 | 0.4 | 507 | 0.4 | 671 | 0.4 | 75.6 | 1,178 |
| 85 - 89 | 703 | 0.2 | 291 | 0.2 | 412 | 0.3 | 70.6 | 703 |
| 90 - 94 | 359 | 0.1 | 142 | 0.1 | 217 | 0.1 | 65.4 | 359 |
| 95 - 99 | 178 | 0.1 | 65 | 0.0 | 113 | 0.1 | 57.5 | 178 |

**Source: Ghana Statistical Service (2014)**

**ii. Kpone Katamanso Municipality**

From the 2010 PHC, the population of the Kpone Katamanso Municipality was 109,864 comprising 48.7% male and 51.3% female. In terms of age distribution, the 0-4 years age group was the highest proportion (13.5%) followed by the 5-9 age group (11.0%). In effect, over half of the population (54.1%) was below 24 years (Table 5-3.2). The proportion aged 60 years and older was 3.5 percent in the district. Young adults and (15-29) constituted 30.2 percent of the population (Ghana Statistical Service, 2014; KKMA, 2018).

Over the years, the Kpone-Katamanso Municipality has seen in-migration from Tema, Accra and all over the country due to the availability of land, its proximity to Tema and the free zone area which is an industrial hub. Furthermore, numerous industries, including BOST, CARGIL, TOR, BEL-AQUA, B5, and GROUP 5, in addition to the availability of other social services such as roads, water, and electricity serve as pull factors (KKMA, 2018). According to figures from the 2010 PHC, 70.4% of the KKMA's population was composed of migrants who were living elsewhere and have moved into the Municipality.

**Table 5-3.2 Population Distribution by Sex and Age (KKMA)**

| | Sex | | Male | | Female | | |
|---|---|---|---|---|---|---|---|
| Age Group | Both Sexes | Percent | Number | Percent | Number | Percent | Sex Ratio |
| All Ages | 109,864 | 100.0 | 53,376 | 100.0 | 56,488 | 100.0 | 94.5 |
| 0 – 4 | 14,807 | 13.5 | 7,518 | 14.1 | 7,289 | 12.9 | 103.1 |
| 5 – 9 | 12,087 | 11.0 | 6,019 | 11.3 | 6,068 | 10.7 | 99.2 |
| 10-14 | 11,016 | 10.0 | 5,153 | 9.7 | 5,863 | 10.4 | 87.9 |
| 15 – 19 | 10,289 | 9.4 | 4,629 | 8.7 | 5,660 | 10.0 | 81.8 |
| 20 - 24 | 11,238 | 10.2 | 5,234 | 9.8 | 6,004 | 10.6 | 87.2 |
| 25 - 29 | 11,645 | 10.6 | 5,368 | 10.1 | 6,277 | 11.1 | 85.5 |
| 30 - 34 | 10,566 | 9.6 | 5,109 | 9.6 | 5,457 | 9.7 | 93.6 |
| 35 - 39 | 8,648 | 7.9 | 4,343 | 8.1 | 4,305 | 7.6 | 100.9 |
| 40 - 44 | 6,338 | 5.8 | 3,376 | 6.3 | 2,962 | 5.2 | 114 |
| 45 - 49 | 4,365 | 4.0 | 2,279 | 4.3 | 2,086 | 3.7 | 109.3 |
| 50 - 54 | 3,145 | 2.9 | 1,628 | 3.1 | 1,517 | 2.7 | 107.3 |
| 55 - 59 | 1,941 | 1.8 | 988 | 1.9 | 953 | 1.7 | 103.7 |
| 60 - 64 | 1,332 | 1.2 | 645 | 1.2 | 687 | 1.2 | 93.9 |
| 65 - 69 | 802 | 0.7 | 373 | 0.7 | 429 | 0.8 | 86.9 |
| 70 - 74 | 628 | 0.6 | 296 | 0.6 | 332 | 0.6 | 89.2 |
| 75 - 79 | 344 | 0.3 | 144 | 0.3 | 200 | 0.4 | 72 |
| 80 - 84 | 286 | 0.3 | 121 | 0.2 | 165 | 0.3 | 73.3 |
| 85 + | 387 | 0.4 | 153 | 0.3 | 234 | 0.4 | 65.3 |

**Source: Ghana Statistical Service (2014)**

### *5.3.2 Land Use*

Although the 38.59 ha plot secured for the oil refinery is wholly located in the Tema Heavy Industrial Area, land use in the vicinity of the site as well as within the project's area of influence is a mixture of residential, civic, industrial, military and commercial activities.

To the east and south-east of the proposed project site is the sprawling Tema New Town. In some areas, the township is as close as 20 m from the project site, with only the VALCO service road as the barrier (Plates 5-3.1 and 5-3.2). Tema New Town has the highest population density in the project area (TMA, 2018) and land use includes schools, churches, commercial areas, parks and transport stations. Construction of wooden fish crates, cold stores, and other fish related industrial activities are also common. The Ghana Naval Base is located next to the township on the coastline.


**Plate 5-3.1 Sprawling Tema New Town East of Proposed Project Site**

**Plate 5-3.2 Section of Tema New Town Separated by VALCO Road from Project Site**

To the immediate south of the project site are located various industries including Wan Heng Ghana Ltd., manufacturers of cement (Plate 5-3.3), which is built on land reclaimed from the lagoon catchment. Further south are located important economic structures such as the offices of the Ghana Ports and Harbours Authority, Tema Port and Fishing Harbour, all within 2 to 4 km of the project site (Plate 5-3.4).

**Plate 5-3.3 Southern Edge of Project Site with Wan Heng Ghana Ltd. In Background**

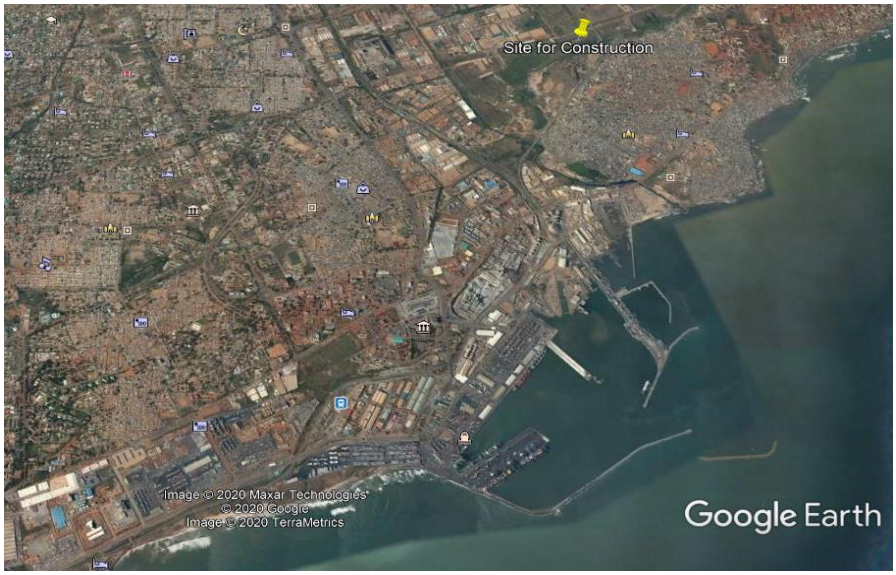



**Plate 5-3.4 Project Site with Tema Port and Fishing Harbour to the South**

To the north of the proposed site, within the Heavy Industrial Area are various industries including VALCO and Tema Oil Refinery, located about 1 km and 1.7 km respectively away. VALCO's service road to the Tema Port forms a boundary with the project site. To the west, on the edges of the site, are warehouses that store bananas, cashew and other edibles for export using paper packages produced in the same area. A slaughter house is also located nearby. In

the area of the VALCO Round About, are located a multitude of businesses and civic activities including banks, schools, churches, hotels and restaurants. Further west, about 7.5 km away is located the Sakumo Lagoon, which is a Ramsar Site because of its importance to local and migratory birds. The lagoon is also considered an important greenbelt but its value has diminished to encroachment for estate development.

On the actual project site, current land use activities include VALCO's haulage road to the Tema Port, pig farms belonging to residents of Tema New Town, Sports Park and location for sewer lines. Importantly, as the area lies within the catchment of the Chemu Lagoon (Plate 5-3.5), it plays an important role as a passage way for flood waters.


**Plate 5-3.5 Catchment of Chemu Lagoon (Green) within Project Site**

Furthermore, just as for many areas along watercourses in Ghana, large quantities of refuse were observed in many areas within and outside of the proposed site (Plate 5-3.6). These were made of mainly plastic ware and waste of domestic and industrial origin, which unfortunately lead to siltation of the watercourses, stagnation of water and subsequent water-related diseases.

**Plate 5-3.6 Refuse-Laden Stream near VALCO Haulage Road**

In their Medium Term Development Plans, both TMA and KKMA cite among their key development problems choked and collapsed drains, poor sanitation, ineffective waste collection and management and indiscriminate refuse dumping (TMA, 2018; KKMA 2018).

### *5.3.3 Economic Activities*

**i. Tema Metropolitan Area**

From the PHC (GSS, 2014), 72.0% of the adult population in the Tema metropolis (15 years and older) was economically active and the remaining 28.0% not economically active. From among the economically active population, 90.4% was employed whereas 9.6% was unemployed. In terms of gender distribution, the male population had a higher proportion of the economically active (73.9%) compared to the proportion among the female population (70.4%). On the other hand, the proportion of the employed among the male economically active population (90.4%) was only marginally higher than the proportion among the females (90.3%).

In terms of the distribution of the employed population among various occupations, 31.5% were found to be in service and sales, 20.2% in craft and related occupation, 10.4% in elementary occupations and 9.8% were professionals. The lowest proportion of the employed population were in skilled agriculture, forestry and fishery occupation (4.2%), and clerical support occupation (4.4%). Among the employed females, higher proportions were in service and sales occupations (46.2%), elementary occupations (11.7%) and clerical support occupation (4.7%) than the proportions among employed males (15.9%, 9.0%, and 4.2%, respectively). In all the other occupations, the proportions among employed males were higher than those among employed females. In terms of the sectors that employs the most, the PHC 2010 shows that the private informal sector is the largest employer with 65.4%, followed by the private formal sector (23.6%) and then public sector (9.3%). See Table 5-3.3.

**Table 5-3.3 Employment Sectors of Employed Adult Population (TMA)**

| Employment sector | Both Sexes | | Male | | Female | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| All | 134,640 | 100.0 | 65,336 | 100.0 | 69,304 | 100.0 |
| Public (Government) | 12,558 | 9.3 | 7,489 | 11.5 | 5,069 | 7.3 |
| Private Formal | 31,794 | 23.6 | 21,637 | 33.1 | 10,157 | 14.7 |
| Private Informal | 88,019 | 65.4 | 34,717 | 53.1 | 53,302 | 76.9 |
| Semi – Public/Parastatal | 438 | 0.3 | 299 | 0.5 | 139 | 0.2 |
| NGOs (Local and International) | 1,565 | 1.2 | 1,036 | 1.6 | 529 | 0.8 |
| Other International Organisations | 266 | 0.2 | 158 | 0.2 | 108 | 0.2 |

**Source: Ghana Statistical Service (2014)**

**ii. Kpone Katamanso Municipality**

The local economy of the Municipality is influenced mostly by industrial activities, agriculture, mining, commerce and services. A number of big and small industries exist in KKMA. These industries offer employment to the local people as well as the neighboring communities.

Among the type of industries are manufacturing, processing and an oil refinery. Also existing in the Municipality are industries that offer transport and haulage services as well as banking services. It is also important to mention that there is a thermal power plant in the Municipality and it supplies electric power to the national grid and hence industries in the Municipality.

Although majority of the people are in the industrial and the service sectors, agriculture employs about 13.5 percent of the population. Agricultural activities in the Municipality are very prominent and include crop and livestock production, fishing and agro-processing. Crop farming is predominant in the northern part of the Municipality while fishing dominates in the south. Major food crops produced in the Municipality include maize, cassava, tomatoes, onions, pepper and okro. Also, vegetables such as cabbage, carrots, green pepper, spring onions, and cucumber are cultivated in the Municipality. According to the Department of Agriculture of the KKMA, crops production in the municipality has been on the decline and that has been attributed to urbanization, land tenure problems, and general lack of interest of the youth in farming, and reduction of cultivable land (KKMA, 2018).

KKMA is also noted for fishing. Fishing and related activities play a vital role in the economic development of the Municipality and is predominant in the Kpone are, which is closest to the sea. The type of fishing practiced includes ring net fishing, hooking and wide net fishing. The fishermen use local canoes operated by outboard motors for fishing. There is ready market for the fishermen due to the presence of the fishing harbour. Market women and fishmongers buy the catch from the fishermen for sale to markets in the Municipality and beyond (KKMA, 2018).

### *5-3.4 Health*

**i. Tema Metropolitan Area**

Tema Metropolitan Assembly in collaboration with stakeholders has constructed and operationalized a total number of 51 health facilities in the metropolis. These facilities comprise both public and private and are spread across the entire metropolis based on their functions and the range of services they provide. Even though the Private Sector has a number of facilities, they are not evenly distributed; they are mostly concentrated in the bigger settlements (Community 1, Community 2, Sakumono, etc.) and are also associated with high cost, though the quality of care is guaranteed. The Assembly in collaboration with concerned stakeholders is constructing 2 additional CHPS Compounds in addition to the 2 existing ones. This is to improve access to health care in the underserved areas, reduce travel time, as well as mortality rates in the communities. In terms of staffing in the metropolis, there are 50 medical officers spread across public health institutions in the metropolis to deliver a range of health services. The Doctor-Patient Ratio of 1:6,403 is below the World Health Organization (WHO) recommended ratio of 1:5,000 (TMA, 2017).

In terms of the prevalent diseases in the area, malaria and upper respiratory tract infections are the most prevalent, based on available data between 2014 and 2016. Hence, poor sanitation and air quality continue to be a challenge for the TMA (TMA, 2018).

HIV/AIDS is a disease that is of concern to the Tema Metropolitan Assembly, because the age group most affected by the disease is the age cohort of 20-39 years who are in the reproductive period of their lives. The prevalence of HIV in the Tema Metropolis was highest (3.6%) in 2012 and it has since been reducing steadily in the past 5 years with 2015 recording 2.0%. However, it went up slightly to 2.6% in 2016. The most vulnerable population when it comes

to HIV/AIDS are women within the ages of 15 to 45 years. Unfortunately, this segment of the population falls within the economically active group needed to develop the metropolis. The Assembly is particular about HIV/AIDS and has therefore designed specific interventions to respond to it in the Metro. Some of the interventions include Behaviourial Change Communication, Prevention of Mother to Child Transfer, and Support to People Living with HIV/AIDS (TMA, 2018).

**ii. Kpone Katamanso Municipality**

The Municipality has access to both private and public health facilities, which number 41 in total (as of 2017). The number of health facilities is broken into 26 public facilities and 15 private facilities (KKMA, 2018). In terms of incidence of diseases in the KKMA, malaria was the most recorded case at the Out-Patient Departments (OPDs) of health facilities in the municipality from 2014 to 2016; however, from 2016, upper respiratory tract infections have been the most recorded cases.

Although the Municipal Medium Term Development Plan does not provide statistics, the document claims that HIV prevalence rate in the Municipality "is alarming" (KKMA, 2018: p.107) and therefore, various sensitization programs in HIV/Aids, HIV Testing Services (HTS), Community Strengthening System, work place policy, in-school and out of school programs for the youth and various exercises are being organized to help control the disease in the Municipality.

Since March 2020, the COVID-19 pandemic has become a leading health issue of all over the world, including Ghana, with infections and deaths recorded in both the Tema Metropolis and the Kpone Katamanso Municipality. Indications are that all countries will have to learn to live with the virus infection just like other new diseases like Ebola and Severe Acute Respiratory Syndrome.

### *5-3.5 Education*

**i. Tema Metropolitan Area**

In the Tema Metropolis, educational concerns are addressed by the Metropolitan Education Directorate (MED). Tema is privileged to have access to all levels of education in the metropolis. The metropolis has both tertiary and pre-tertiary institutions which can be found in both the public and private sectors. Out of 474 schools in the metropolis, private institutions constitute 67% while public schools constitute 33%. Thus, private schools complement the number of public schools that exist in the metropolis and thus help with the provision of quality education. There are four private universities in the metropolis (TMA, 2018). Also, the metropolis has satellite campuses for three other universities, namely, Presbyterian University, Ghana Institute of Management and Public Administration (GIMPA) and Kwame Nkrumah University of Science and Technology (Ghana Statistical Service, 2014).

**ii. Kpone Katamanso Municipality**

The Kpone Katamanso Municipality has 456 educational institutions, out of which 89 are public and 367 private institutions. Furthermore, the Municipality has one private university, (the Valley View University) at Oyibi; three (3) private SHS and one (1) public SHS (KKMA, 2018). The total enrolment in public schools in the Municipality as at April of 2017 was 22,220 pupils. The gross enrolment of boys and girls over the years have increased due to government policies such as Free Compulsory Universal Basic Education (FCUBE), Ghana School Feeding, and Free Uniforms. Available records on enrolment show that girls enrol (36,142

[51%]) more than boys (35,167 [49%]). The records also show that 38% of pupils do not continue their Junior High School education in the Municipality (KKMA, 2018).

### *5-3.6 Roads and Transportation*

**i. Tema Metropolitan Area**

Tema Metropolitan Area has a very good network of roads, but a significant number of these roads have no drains, bicycle or pedestrian facilities and those that exist are generally in deplorable conditions. This situation causes a lot of difficulties for travelers when commuting from one place to the other and impact negatively on travel time, rate of accidents and productivity within the metropolis.

The main mode of transporting goods and services in the metropolis is by road. However, the rail system in the metropolis is functioning and it is helping to take pressure off road transport, although more rail services are needed through expansion from the metropolis to other major cities. This is important because goods like cocoa that serve as raw materials for some of the food production companies are transported not by rail but by road from the hinterland. This situation often results in congestion on the major roads in the metropolis. Due to the location of the harbour, a number of shipping companies operate in the metropolis to facilitate the export and import of goods from other countries. There are private and commercial transport systems operating in the metropolis. Heavy-duty trucks come from all over the country carting goods to and from the harbour and the industries in Tema.

**ii. Kpone Katamanso Municipality**

The Municipality is accessible and well connected to other towns and districts. However, apart from the major roads within the Municipality that are tarred most of the road networks are untarred. Surface condition of roads in most of the areas can therefore be described as dusty, rough, bumpy and sometimes very muddy during the rainy season. In areas where drains are lacking, the roads become impassable during the rainy season. The Tema Oil Refinery road which connects Tema, the project site, and other industries to Kpone is “in a deplorable state” and needs to be reconstructed. It is worth mentioning that, due to the presence of industries and the deplorable nature of the road, there is constantly traffic on this same road (TOR Kpone). Expanding the road as well as repairing it could ease the problem.

The mode of transporting goods in the Municipality is mainly by road, which compounds the rate at which roads deteriorate in the Municipality. The capacities of vehicles that ply these roads are usually higher than the capacity of the roads. Hence in upgrading the roads, the types of vehicle that ply the road should be considered in order to provide a very strong surfacing that will last a long time. It is worth mentioning that currently the Government of Ghana is constructing an 84 km railway track from Tema to Akosombo to ease the strain the heavy trucks put on the roads in the Municipality.

### *5-3.7 Area of Project Influence*

**i. Tema New Town (Manhean)**

The closest human settlement to the project site is Tema New Town (Manhean), which borders the eastern and south-eastern boundaries of the project site. Tema New Town can be described as a mixed settlement that comprises mainly of residential with light commercial and industrial properties. Manhean (the literal translation of “New Town” in the local language) was created as a village to replace the original fishing settlement that existed prior to the construction of

the Tema Harbour and the industrial city of Tema (Jackson & Oppong, 2014). When Manhean was created, the predominant occupations of the people at the time were fishing and farming; however, over the years, farming activities in the area have dwindled due to growing industrialization and urbanization in Tema and the area. Although Tema Manhean is generally inhabited by the native Ga people, in recent times it has become a more integrated community, dominated by the Akans, Ewes and Ga-Adangbes.

**ii. Kpone**

Kpone is located approximately 3 to 4 km to the east of the project site. It is the administrative capital of the Kpone-Katamanso Municipal Assembly. The town is mainly a residential area and is divided into two major suburbs namely Jorshie and Alata. The main occupations in the town include fishing, fish mongering, farming (crop production and livestock rearing), petty trading and commerce.

# CHAPTER 6 PUBLIC PARTICIPATION

## 6.1 Stakeholders Identified

According to the Environmental Assessment Regulations, 1999 (L.I. 1652), an Environmental Impact Assessment (EIA) begins with a scoping exercise the report of which shall set out the scope or extent of the EIA in the form of a draft Terms of Reference (ToR) indicating the key issues to be addressed. Therefore, at the beginning of the impact assessment process, it is mandatory to consult various stakeholders to seek their concerns and appreciation of the project.

In connection with the above, an EPL team consulted with stakeholders within the proposed area for the oil refinery project at the Tema Heavy Industrial Area as well as with traditional authorities and relevant government and interested private institutions. The consultations took place between 10 February and 11 March 2020.

As indicated in Section 1.2 above, the objectives of the interactions with the stakeholders were to:

- Inform and educate the stakeholders on the proposed oil refinery project;
- Highlight key environmental and socio-economic issues concerning the project;
- Gather critical stakeholder appreciation and concerns to be incorporated into the EIA process;
- Inform and make recommendations to EPA towards the conduct of the EIA and subsequent issuance of an environmental permit to Sentuo Oil Refinery Ltd.

The discussions focused on the following issues, among others:

- Commitment by project proponent to pursue best environmental practices;
- Land acquisition issues;
- Location of project with respect to other businesses and activities;
- Potential impacts on human health and economic activities;
- Potential for flooding of the proposed project site and adjacent areas.

The consultations are summarized below.

***10 February 2020***

- Management Team of Sentuo Oil Refinery Ltd. (SORL);
- Tema Mantse and elders.

***11 February 2020***

- Volta Aluminium Company Ltd. (VALCO);
- Golden Exotic Ltd.;
- Macro Fertil Ghana;
- Space in Ghana;
- Ghana Police Service, Tema;
- Ghana Fire Service, Tema
- Environmental Protection Agency, Tema;
- Electricity Company of Ghana, Tema.

***12 February 2020***

- SONAPACK Ghana Ltd.;
- Slaughter House, Tema Heavy Industrial Area;
- Wan Heng Ghana Ltd.;
- Ghana Water Company Ltd.;
- Ghana Ports and Harbours Authority;

***17 February 2020***

- Ministry of Energy, Accra;
- Petroleum Commission, Accra;
- National Petroleum Authority, Accra;
- Water Resources Commission, Accra;

***18 February 2020***

- Tema Metropolitan Authority;
- Ghana Water Company Ltd., Tema;
- Environmental Protection Agency, Tema;

***19 February 2020***

- Tema Metropolitan Authority;
- Ghana Water Company Ltd., Tema;

***26 February 2020***

- Tema Metropolitan Authority;
- Tema Veterinary Services;

***05 March 2020***

- Kpone Katamanso Municipal Assembly

***11 March 2020***

- Volta Aluminium Company Ltd.;

The lists of stakeholders consulted are attached as Appendix 6-1.1

## 6.2 Issues, Concerns and Appreciation of Stakeholders

### *6.2.1 Tema Mantse*

In the absence of the Tema Mantse, the Mankralo Nii Adjetey Agbo II and his elders welcomed a combined EPL/ Sentuo team to the Mantse's Palace at Tema New Town (Plate 6-2.1). Following introductions, the representative of SORL explained that the team requested for the meeting to inform the Mantse about SORL's proposal to construct an oil refinery on Industrial Plot No. IND/HI/21/5, close to the north-western edge of Tema New Town. He added that the plot has been leased to SORL by the Tema Development Company (TDC). Among others, the objective of the visit was also to seek permission for the EPL team to consult with various stakeholders in Tema New Town as part of the scoping exercise for the EIA of the proposed oil refinery. The Mankralo and his elders responded as follows:

i. The area earmarked for the construction of the oil refinery falls within a piece of land covering 87.89 ha (217.11 acres) leased to the Traditional Council by TDC in

December 2011 (Appendix 6-2.1). This was in response to complaints made by the Traditional Council to the TDC about the compulsory acquisition of land in Tema at the expense of traditional farming activities and with few employment opportunities for locals;
ii. TDC has therefore leased the land in question to SORL without informing the owners, an action which the Mantse disagreed with;
iii. Without a solution to the issue raised, the EPL team would not be allowed to conduct its scoping exercise in Tema New Town. This was also for the safety of the team;
iv. A meeting should be held at the Mantse's Palace with representatives of SORL and TDC to find a way forward.

The representative of SORL promised that his company will hold further discussions with TDC and revert to the Mantse and his elders. As at the time of the presentation of this report, the meeting with the Mantse has not taken place to enable further consultations with the larger community.

**Plate 6-2.1 Group Photo with Tema Mantse's Palace**

### *6.2.2 Golden Exotic Limited*

The EPL team held discussions with the Supervisor of Golden Exotic Ltd. (GEL), which is an agro-products export company. It currently exports bananas from its warehouse office near the

proposed project site. The warehouse is owned by Space in Ghana, which rents space to other businesses including Macro Fertil. The highlights of the discussions are presented below:

i. Emissions from operations of the oil refinery may contaminate the paper boxes used to package bananas by GEL, thus increasing the likelihood of exports being rejected;
ii. Emissions from operations of the oil refinery may also increase fire hazards and affect the health of GEL's workers as well;
iii. Increased vehicular traffic in the area will hinder the movement of GEL's vehicles, especially in emergencies;
iv. More information on the construction and operations of the oil refinery, including possible harmful emissions, should be provided to businesses located in the vicinity of the project site:
v. SORL should invest in improving safety for all businesses in the area;
vi. The possible impacts on Tema Newtown could be worse and need to be given high priority by SORL;
v. SORL may consider the option of finding an alternative site.

### *6.2.3 Macro Fertil Ghana*

Macro Fertil is one of the tenants of Space in Ghana. It deals in industrial and agro chemicals and also stores food items including soya bean flour and cashew, which is highly ignitable. The EPL team met with the Operations Manager. Concerns raised were similar to those of GEL and are presented below:

i. More information is required on the proposed project, especially on possible emissions and their impacts;
ii. There is the need to improve accessibility to the general area of the proposed project site to minimise threats to occupational and public health and safety;
iii. SORL should consider an alternative location in a more open area.

### *6.2.4 Space in Ghana*

Space in Ghana owns the warehouse located in the vicinity of the proposed project site. Officials here commented as follows:

i. SORL should provide more information on the project to businesses located close to the proposed project site, including potential negative impacts;
ii. Operations of the proposed oil refinery will increase fire hazards in the project area;
iii. There are too many industries already in the project area, which hinder ease of accessibility. With TOR already established nearby, SORL should find another location for the proposed project.

### *6.2.5 Ghana Police Service, Tema*

At the Regional Police Headquarters in Tema, the EPL team was assured that the Police Service is prepared to help all parties involved maintain law and order in respect of the proposed construction and operation of the oil refinery. The project, if it was realised, would reduce unemployment particularly among the Tema New Town youth and bring down crime in the community. It was also revealed that the police station at Tema New Town, which is close to the proposed project site, has been closed down because the building was sinking. This brings to the fore the need for detailed geotechnical studies prior to start of construction at the proposed project site.

### *6.2.6 Ghana National Fire Service, Tema*

At the Ghana National Fire Service (GNFS) offices in Tema, the EPL team interacted with a Divisional Officer who noted the following:

i. GNFS requires the technical drawings and layout plans in order to guide SORL in the installation of safety equipment;

ii. There could be incompatibility problems with the use of the proposed project site if VALCO started using all its pot lines, which will release a lot of heat;

iii. The various components of the oil refinery may be sited in such a manner to minimise safety issues, taking into consideration the activities of VALCO and locations of the West Africa Gas Pipeline and Tema New Town;

iv. The channel between VALCO and Tema New Town should be maintained as a buffer zone;

He assured the EPL team that GNFS will provide support to ensure that adequate safety measures are put in place. A formal response from the GNFS is attached as Appendix 6-2.2.

### *6.2.7 Electricity Company of Ghana, Tema*

The EPL team interacted with the Regional Engineer of the Electricity Company of Ghana (ECG), who was aware of the proposed project. He revealed that ECG has had a number of meetings with SORL on the relocation of the national electric grid pylons that run through the proposed site. He indicated that the pylons will be removed and placed along the VALCO road to the Tema Harbour. A recent quotation from ECG to SORL for the relocation of the pylons is presented in Appendix 6-2.3.

He expressed concern about the safety of the residents of Tema New Town who live in close proximity to the proposed project site and advised that SORL should engage the community leaders in a planned manner to develop sustainable and effective solutions against the potential negative impacts of the proposed oil refinery.

### *6.2.8 SONAPACK Ghana Ltd.*

The EPL team held discussions with the Quality Manager of SONAPACK Ghana Ltd., which produces paper packing used for export of fruits and other products. Below is a summary:

i. The Quality Manager noted the absence of detailed information on the proposed oil refinery and advised that SORL should improve its interaction with businesses located in the vicinity of the proposed project site;

ii. He also raised concerns about the possible impacts of pollution, especially of air, which may lead to contamination of packaging and subsequent rejection of exports;

iii. He further advised that it would be safer to locate the project in another area that is more open.

### *6.2.9 Wan Heng Ghana Ltd.*

Wan Heng is a Chinese cement production factory situated to the south-west of the proposed project site and about 800 m from Tema New Town. The Company produces SOL Cement. The EPL team interacted with the Sales Manager and his Assistant who indicated that:

i. That portion of the industrial area where the project is to be sited was already very congested and SORL may therefore have to look for another location;

ii. The proposed site for the oil refinery was also too close to the highly populated Tema New Town, which would increase safety concerns;

### *6.2.10 Ghana Ports and Harbours Authority*

The EPL team held discussions with the Estate and Environment Manager who indicated that the Ghana Ports and Harbours Authority (GPHA) had no objection to the construction of the oil refinery in the Tema Heavy Industrial Area as long as the relevant regulations were complied with. He however pointed out that:

i. GPHA did not have enough information on the project to allow it to make comments on the proposed activities. For example, the site plan was not signed by a licensed surveyor and did not provide sufficient information. GPHA does not know how SORL intends to transport crude oil from the Tema harbour.

ii. Also, there has been no indication or request from SORL to use any of GPHA's facilities, some of which are of strategic national interest.

iii. To allow the sustainable involvement of a key stakeholder such as GPHA, SORL should be willing to provide more detailed data and information including approved and signed drawings of the project.

iv. There are some pipelines that run through the proposed project area and some components of the oil refinery may not be compatible with them. Detailed information from SORL would be key to the GPHA making such assessments.

### *6.2.11 Ministry of Energy*

Discussions with officials of the Petroleum Directorate and the Refinery Unit of the Ministry of Energy revealed that the Ministry was not aware of plans by SORL to establish an oil refinery at the Heavy Industrial Area in Tema. On policies relating to such activities, it was also explained that the Ghana Government has two main options. The first is to do with the establishment of a Petroleum Hub in the Western Region where four oil refineries are expected to be constructed, each with a minimum capacity of 150,000 barrels per day of crude oil. The Government is therefore seeking investors to be part of the Petroleum Hub. On the second option, investors may partner with Tema Oil Refinery (TOR) to refine crude oil. Beyond these 2 options, there may be no institutional or technical support from the Government. It was further indicated that the minimum capacity for a new oil refinery in Ghana, which should also be export oriented, is 100,000 barrels per day of crude oil.

The EPL team was advised that SORL should formally inform the Ministry, which will then respond and inform it about the relevant government policies.

A response from the ministry to EPL's invitation to provide comments on the proposed project is attached as Appendix 6-2.4.

### *6.2.12 Petroleum Commission*

The EPL team was informed that the Petroleum Commission is concerned with upstream policies, institutions and operations in the petroleum industry of the country. The establishment of the oil refinery is considered a downstream activity.

### *6.2.13 National Petroleum Authority*

The EPL team met with the Chief Inspector/Director and staff of the Inspections and Monitoring Department of the National Petroleum Authority (NPA), which is concerned with downstream operations in the petroleum industry. The NPA has a 3-stage permitting process for oil refineries, namely i) Establishment ii) Construction and iii) Authorization processes.

The Establishment process requires, among others, the applicant to submit a Feasibility Study Report for the study of NPA and subsequent inspection of the proposed project site. The outcome of this stage is the issuance of an Establishment Permit. The requirements for the second stage, the Construction process, includes the submission by the applicant of detailed drawings, fire permit, development plans and geotechnical study report. It is also at this stage that the applicant is required to carry out an EIA for an Environmental Permit from EPA. Upon approval by the NPA, the proponent will then be issued a Construction Permit. In addition, NPA will monitor the proponent's construction activities. Lastly, the issuance of an Authorization Permit allows the proponent to operate the Oil Refinery.

Currently the government through Ministry of Energy has laid an embargo on the development of oil refineries with production capacity of less than 100,000 barrels/day. The Ministry of Energy has also come out with a policy for the development of oil refineries in the country. A formal response from the NPA is attached as Appendix 6-2.4.

### *6.2.14 Water Resources Commission;*

A letter from the Water Resources Commission (WRC), in response to EPL's invitation for comments, is attached as (Appendix 6-2.5). The response focused on the need for SORL to:

- Avoid degradation of existing buffer areas and flooding of the project site and surroundings including Tema New Town;
- Maintain vegetative buffers, 20 m wide, around any streams in the project area;
- Ensure that Tema New Town residents and traditional authorities are informed and agree to the proposed project to prevent avoidable conflicts in the future;
- Ensure that applicable permits are obtained from the WRC.

### *6.2.15 Ghana Water Company Ltd;*

At the Ghana Water Company Limited (GWCL), the EPL team met with the Tema Regional Distribution Manager. GWCL is responsible for the supply of potable water to all the communities as well as the industrial areas of Tema. The source of water supply is the Volta River with the use of booster pumps at strategic locations. The groundwater quantity and quality of Tema metropolis are poor hence the company does not rely on this source for water supply. The increasing population in the metropolis and the proliferation of industries has resulted in increasing demand for water. GWCL therefore is facing challenges with inadequate water availability leading to water rationing in the metropolis. GWCL advised that SORL incorporates water reservoirs in the design of the proposed refinery to store enough water.

### *6.2.16 Tema Metropolitan Authority*

Following a courtesy call on the Metropolitan Coordinating Director, Alhaji Shebu Kadiri, initial discussions were held with the Planning Officer who indicated that the Tema Metropolitan Authority (TMA) is currently encouraging investors to 'go green'. She advised

that a field trip should be undertaken to the project site with EPL and SORL to enable the TMA properly assess the proposed project. She added that approved and signed drawings of the proposed oil refinery, including layout plans and structural designs would be required by TMA staff (Physical Planning, Waste Management, Roads, Engineers, Environmental Health, etc.) to ascertain if the project activities conform to existing regulations, including those on waste discharges, air pollution, and potential for recycling or reuse of materials. She further revealed that TMA is in the process of looking for funds to dredge and restore the Chemu Lagoon.

A field visit was tentatively scheduled for Wednesday 26 February 2020. The field visit was deemed necessary (by the Planning Officer) because the site plan provided by SORL was not signed. Consequently, the field visit would be an opportunity for verifying the site plan.

The Planning Officer also added that the TMA is encouraging companies to go green by adopting sustainable practices. For instance, the TMA has embarked on tree planting as a means to help in carbon sequestration. Hence, the TMA would be interested to know how SORL intends to contribute to the greening objective.

Officials of TMA (Planning, Environment and Health, Engineering and Architecture) and EPA (Greater Accra East) accompanied the EPL team on a visit to the proposed project site on 26 February 2020 (Plate 6-2.2) during which the following were noted:

i. The area falls under the jurisdiction of Tema Metropolitan Assembly;
ii. The area forms part of the core catchment of the Chemu Lagoon. It is therefore a wetland as indicated by the presence of aquatic vegetation (*Typha sp*.) and mangrove trees (*Avecinnia sp.*) (Plate 6-2.3). This sensitive environment acts like a buffer such that it gets flooded during periods of heavy rains;
iii. It was observed that a sewer line runs through the area and may interfere with construction activities;
iv. An organization, GOIL Ghana, has already secured an Environmental Permit from EPA to construct a bitumen plant south of the proposed area, close to Wan Heng Ghana Ltd. The proposed oil refinery may thus add to an already congested situation;
v. The project area is too close to Tema New Town;
vi. SORL may look for another location that is more open;
vii. The leader of the TMA team promised to make available a copy of their report to EPL.

**Plate 6-2.2 Field Visit to Project Site with TMA and EPA Officials**

**Plate 6-2.3 Aquatic Vegetation on Southern Edge of Project Site**

### *6.2.17 Volta Aluminium Company Ltd.*

On behalf of the head of Volta Aluminium Company Ltd. (VALCO) who was not available, a four-man team led by the Technical Director received the EPL team. Discussions were held, among others, on current land use of the proposed project site, flooding of project area, impacts of refinery operations and land ownership. The highlights are presented below:

**i. Current Land Use**

Current land uses that should be taken into account by SORL in the planning, construction and operation of the proposed oil refinery are:

- VALCO's main haulage road is on the border between Tema New Town and the proposed project site;
- There are piggeries close to or on the proposed site that belong to residents of Tema New Town (Plate 6-2.4);
- The youth of TNT use portions of the land in the proposed site for sports including football;
- If there was dissatisfaction among the people of Tema New Town that led to protest action, VALCO's haulage activities could be hampered from possible blockage of the only access road that VALCO uses to transport its inputs and finished products;
- The Tema Liquefied Natural Gas (LNG) Terminal Company intends to lay pipe lines along the boundary line between the proposed project site and Tema New Town, which is parallel to the VALCO haulage road. This pipe line will carry gas from offshore to the LNG processing plant located eastwards of SORL's proposed site (Plate 6-2.5).

**Plate 6-2.4 Piggeries on the Border of Proposed Project Site**


**Source: Tema LNG Terminal Ghana Project March 2019**

**Plate 6-2.5 Route of Proposed Tema LNG Pipelines**

## ii. Flooding

- VALCO alleged that SORL, in an apparent attempt to construct an access road to the proposed project site, had recently dumped heaps of soil into one of the streams that runs through the site, thus blocking the free-flow of water from VALCO. The blockage had resulted in flooding of sections of the main access road to and from VALCO;
- For the proposed project, SORL should therefore take into consideration effective drainage designs that can cater for the huge volumes of water that run through the entire area in order to avoid future flooding of nearby areas including VALCO and its hospital.
- For the present, SORL should take immediate action to ensure the free flow of drains and streams in the proposed project area since the area is a wetland that receives water from its catchment during the rainy season;

**iii. Impacts of Refinery Operations**

On the potential impacts of the oil refinery, SORL needs to provide more information on:

- Types of emissions that the refinery would produce, the direction of the emissions and the baseline data on these emissions in the project area as well as on noise levels;
- Construction of pipelines from the jetty of the Tema Harbour to the proposed project site;

**iv. Land Ownership**

- VALCO does not own the land but it had plans to acquire it for the construction of a power plant and in about 2008 cut the sod for its construction (Daily Graphic, 2008);
- VALCO operates under the jurisdiction of TMA, not KKMA;

The meeting ended with a tour of VALCO's haulage road and adjoining areas (Plate 6-2.6) during which the EPL team took water samples from the streams for laboratory analysis.

**Plate 6-2.6 Tour of VALCO Haulage Road**

### *6.2.18 Kpone Katamanso Municipal Assembly*

At the Kpone Katamanso Municipal Assembly (KKMA), the EPL team paid a courtesy call on the Municipal Coordinating Director, Mr. Michael Owusu Darko who invited the team to hold discussions with the Municipal Works Engineer.

The Municipal Works Engineer:

- Acknowledged that he was very much aware of the SORL project and had indeed visited the project site;
- Emphasised that the proposed SORL project site falls under the jurisdiction of KKMA and not TMA. He explained that parts of the boundary between KKMA and TMA are set from the "TT Brothers Traffic Lights" southwards. All land eastward of the road falls within the jurisdiction of KKMA while all land westward falls under the jurisdiction of TMA. The demarcation was the outcome of a dispute resolution process under the auspices of the Greater Accra Regional Coordinating Council. This process became necessary because the Heavy Industrial Area was apparently not assigned to either TMA or KMA after the creation of the KKMA out of the TMA. The outcome of the process was however rejected by TMA. In spite of this, all companies located within the demarcated area pay their taxes to the KKMA. These industries include VALCO.
- Noted that the proposed location of the SORL project is perfect because the area is part of an already designated heavy industrial area and moreover, the project will provide jobs to the residents of the KKMA and provide revenue as well;
- Requested SORL to undertake the project with measures to reduce and mitigate pollution and other negative environmental impacts;
- Recommended that the two Assemblies work together to resolve the issue to ensure sustainable development.

During further discussions with a KKMA Planning Officer and an Engineer from TDC, who happened to be present, it was noted that TDC normally refers matters relating to properties/land in the enclave where SORL's project will be sited to KKMA.

### *6.2.19 Management of SORL*

Further to the invitation of EPL by SORL to conduct an EIA of the proposed project through SORL's letter dated 23 January 2020, the EPL team met with some members of the management team of SORL at various times as indicated below:

- 27 January 2020
- 05 February 2020
- 09 February 2020;
- 10 February 2020

Issues discussed included:

- Letter of Introduction of the EPL team;
- Selection and consultation of stakeholders;
- Reference documents, especially on description of the proposed project;
- Liaison and communication with management of SORL;
- Registration of proposed project with EPA;

## 6.3 Summary of Project Concerns and Appreciation

Below is presented a summary of the concerns and appreciation for the proposed oil refinery project. The concerns are presented based on their ranking according to how many times they were raised or came up for discussion during the consultations:

***Concerns***

i. SORL to strengthen communication on project details – 11;
ii. Possible flooding of project area and maintenance of buffer zone - 7
iii. Potential negative impacts on the adjacent Tema New Town -7;
iv. Potential negative impacts of refinery on public health in the industrial area - 7;
v. Increased congestion in proposed project area - 7;
vi. Consideration for another location for the proposed refinery – 6;
vii. Acquisition of permits and approvals – 5;
viii. Location of pipelines and other facilities in the proposed project area - 5;
ix. Potential negative impacts of refinery on nearby food and packaging industries - 4;
x. Proposed project area is a wetland – 4;
xi. Issues on and dissatisfaction with land ownership – 2;
xii. Local youth employment – 2;
xiii. Safety of buildings in the proposed project area – 1;
xiv. Incorporation of water storage facilities into project design - 1

The need for SORL to strengthen communication on the project ranked the highest as it was raised eleven (11) times by various stakeholders. The possibility of flooding of the proposed project site and adjacent areas was the second highest (7) with the same ranking as concerns on the potential negative impacts on the adjacent Tema New Town as well as potential negative impacts on public health and increased congestion in the proposed project area. Other key concerns were on consideration for another location for the project (6), acquisition of permits and approvals (5) and location of pipelines and other facilities in the proposed project area (5). In spite of its low ranking, the issue on land ownership is also considered important.

***Appreciation***
The Police Service noted that if the project was realised, it would reduce unemployment particularly among the Tema New Town youth and bring down crime in the community.

The Kpone Katamanso Municipal Assembly noted that the project will provide jobs to residents of the municipality and provide revenue to the Assembly as well.

VALCO also indicated that, under its envisaged Integrated Aluminium Project, the presence of an oil refinery could be beneficial since the refinery could serve as a source of pitch and coke, which are used in processing of aluminium,

# CHAPTER 7 IDENTIFICATION AND EVALUATION OF POTENTIAL IMPACTS

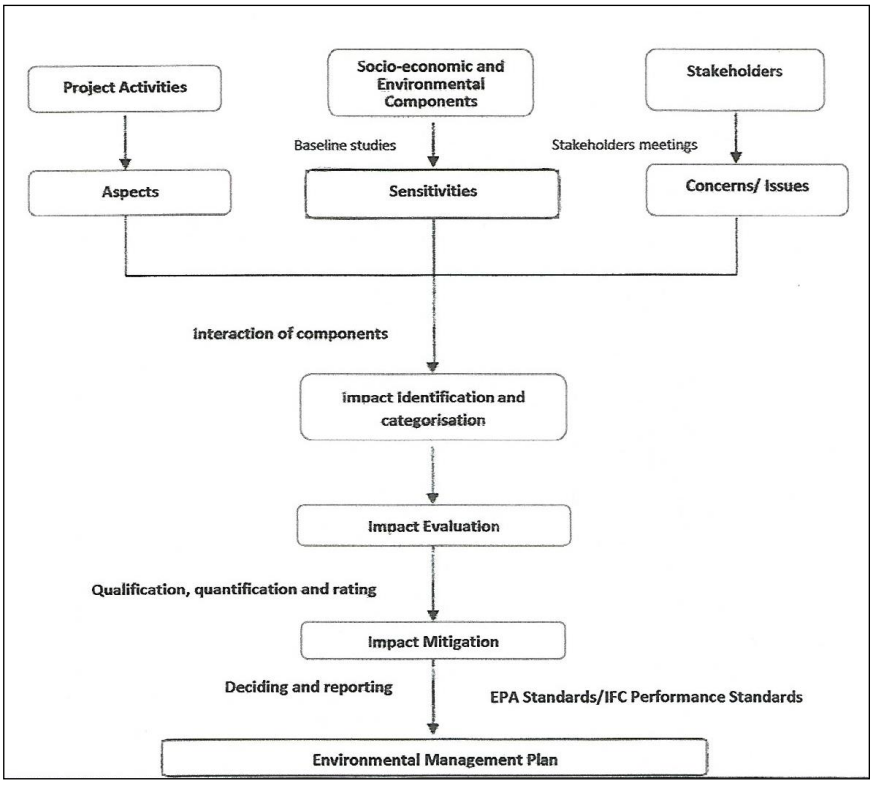
## 7.1 Overview

The key objective of an EIA is to predict the impacts on the environmental and socio-economic components of the project area resulting from a proposed development project or activity as well as to recommend mitigation measures to minimize, eliminate or offset the negative impacts and enhance the positive ones. This chapter presents the identification and evaluation of the potential impacts of the proposed Oil Refinery Project at Tema Heavy Industrial Area in the Greater Accra Region. It is based on the EPA Environmental Assessment Regulations, 1999 (L.I. 1652).

The assessment approach involved matching the various activities under the different phases of the proposed project with the environmental and socio-economic components. Subsequently, the possible impacts were identified and evaluated based on legal and regulatory requirements, magnitude of impacts, risk posed by impacts, public perception and importance of the affected environmental and socio-economic components.

## 7.2 Impact Assessment Methodology

The methods used in the identification and evaluation of the potential impacts of the proposed oil refinery project are illustrated in Figure 7-2.1 below.




**Source: EPL, 2019**

**Figure 7-2.1 Illustration of Impact Assessment Process**

As indicated in Chapter 3 on Project Description, the oil refinery project will be executed in four phases; pre-construction, construction, operations and decommissioning & closure. Various activities will be carried out in the different phases that would have positive or negative impacts on the associated environmental and socio-economic components. For example, project activities will include recruitment of local people, which will have positive impacts on the local economy but negative impacts may arise from project activities through the use of resources such as water and energy and also through atmospheric emissions. The project would also need to be sustained through measures such as fire control and treatment of waste water.

## 7.3 Identification and Evaluation of Impacts

The first step in identifying impacts associated with the project is the development of interaction matrices, which show the relationships or interactions between the project's environmental and socio-economic components and planned project activities. These interactions constitute the potential impacts of the project. Tables 7-3.1 to 7-3.4 present the interactions between the components and activities to be conducted in the various phases of the project.

### *7.3.1 Impact Identification and Characterisation*

The identified impacts have been described in terms of their nature, which includes the type of impact, physical characteristics and significance. The impact type indicates the relationship of the impact to a project activity or activities (in terms of cause and effect). The terms employed for the types of impacts are:

i. *Direct* - impacts that result from a direct interaction between a project activity and an environmental or socio-economic component (e.g., between occupation of a plot of land and the habitats which are affected);

ii. *Indirect* - impacts that follow on from the direct interactions between a project activity and an environmental or socio-economic component as a result of subsequent interactions within the component (e.g., viability of a species population resulting from loss of part of a habitat as a result of a project activity occupying a plot of land;

iii. *Induced* - impacts that result from other activities (which are not part of the Project) that happen because of the project;

iv. *Cumulative* - impacts that arise because of an impact and effect from a project activity interacting with those from another activity to create an additional impact and effect.

The physical characteristics of an impact are their *duration, areal extent, scale, frequency, likelihood, reversibility and magnitude*

The duration connotes the time period over which an environmental or socio-economic component is affected; temporary (< 3 years), short term (< 5 years) long term (>5<15 years) and permanent (> life of project). The extent is the reach of the impact, that is, the physical distance an impact will extend to (on-site, local, regional, national and trans-boundary/international). The scale describes the quantitative measure of the impact such as the size of the area damaged or impacted, and the fraction of a resource that is lost or affected) or the professional viewpoint on the measure of impact. The frequency is the measure of the constancy or periodicity of the impact. The likelihood pertains to unplanned events determined either qualitatively or quantitatively on the basis of experience and/or evidence that such an outcome has previously occurred (unlikely, possible, likely). The magnitude is typically a function of some combination (depending on the environmental or socio-economic component

in question) of the impact characteristics of areal extent, duration, scale and frequency. The universal magnitude designations for negative effects are: negligible, small, medium and large

The criteria used for assessment of impact significance was based on both the physical characteristics of an impact as described above and the context-specific value characteristics (e.g., ecological, social, cultural, public health, and economic values) that adhere to the affected environmental or socio-economic component. Regulatory standards and the results of stakeholder consultations, were also employed for the assessment of significance. The impact significance is usually described as *minor*, *mode*rate, *or major* (Wood, 2008).

### *7.3.2 Pre-construction Phase Impacts*

The major pre-construction activities cover feasibility studies, land acquisition and project planning and design including consultations with various stakeholders. Other activities include creation of access to the project site to allow for inspection by ECG staff in preparation for the relocation of pylons at the site, technical surveys for siting the oil refinery and its components, updating engineering and technical designs, and acquisition of required permits and approvals.

In the pre-construction phase (Table 7-3.1), none of the project activities will interact with the biological environment. With respect to the physical environment and socio-economic components, the most negatively affected components in this phase will be Regulatory Requirements and consultation with the relevant stakeholders.

**Table 7-3.1 Matrix of Pre-construction Phase Activities and Environmental and Socio-economic Components**

| Environmental and Socio-economic Components | Technical Surveys, Design & Consultations | Feasibility Studies | Land Acquisition | Land Access and Inspection | Acquisition of Permits | Recruitment |
|---|---|---|---|---|---|---|
| **Physical** | | | | | | |
| Drainage (Flooding) | | | | | | |
| Soils | | | | | | |
| Erosion | | | | | | |
| **Socio-economic** | | | | | | |
| Employment | | | | | | |
| Local Economy | | | | | | |
| Occup. / Public Health and Safety | | | | | | |
| Land Use | | | | | | |
| Regulatory Requirements | | | | | | |
| Relevant Stakeholders | | | | | | |

**Legend:**

| | |
|---|---|
| | **Activity does not interact with environmental or socio-economic component** |
| | **Activity interacts positively with environmental or socio-economic component** |
| | **Activity interacts negatively with environmental or socio-economic component** |

With respect to project activities, land access and inspection will generate the most negative interactions. On the other hand, some project activities, notably, recruitment will generate positive interactions affecting employment and the local economy. Information from the technical surveys will also enhance the use of the industrial area in general.

**i. Physical Environment**

***Drainage***

In accessing the project site for inspection and surveys, SORL may carry out limited land clearing and construction of a temporary access road. These limited activities could result in blockage of drainage channels passing through the site causing possible flooding and erosion of exposed surfaces from storm runoff. Indirectly, these impacts can disrupt access to roads by nearby industries and the general public. *The negative impacts on drainage are assessed as moderately significant and would require mitigation measures*. These limited activities would also generate dust, gaseous emissions and noise from the use of machinery and equipment but these negative impacts would be of low significance on the environment.

***Soils***

The use of heavy machinery to access the project site is likely to loosen the soils of the area and make them susceptible to erosion. The possible leakage of oil and diesel fuel from the heavy machinery is also likely to contaminate the soils of the area. The duration of this direct impact would be temporary and is unlikely to be of major concern. *The impact is thus of minor adverse significance and would not require any mitigation.*

***Erosion***

Erosion of excavated material during cutting inroads to the project site and trenching for temporary drainage channels may add to siltation challenges of the Chemu Lagoon (Plate1-1.1 and Figure 3-2.1). The adverse impact will be local in extent and of a short duration during the pre-construction phase. Although the adverse impact will be *local in extent and of a short duration, the ecological value of the project area makes the impact to be rated as moderately significant and would require mitigation measures.*

**ii. Socio-economic Components**

***Employment and Improvement in Economy***

In the pre-construction phase (Table 7-3.1), positive impacts will be associated with employment opportunities for skilled and unskilled workers as well as with business opportunities that would lead to improvement in the local economy. For example, to undertake technical surveys, consultations and feasibility studies for the SORL project, experts and consultants will be engaged by SORL. However, these potential positive impacts will be of relatively short duration in the pre-construction phase.

***Occupational and Public Health and Safety***

During the pre-construction phase, the activities of accessing and inspecting the proposed oil refinery area as well as technical surveys of the area could result in accidents that may affect the health and safety of those involved. The exposure of technical teams carrying out topographical surveys, geotechnical surveys, and environmental baseline studies to injury and bites from insects and dangerous reptiles are likely. There is also the possibility of disruption of normal activities by flooding due to blocked drainage channels on the project site. *Such potential negative impacts, although of short duration during the phase is rated as moderately significant because of the occupational and public health values of the impact for which mitigation measures are necessary.*

Inadequate dissemination of information with regards to the scope, schedule and impact of the proposed project, as well as measures to safeguard the interests of nearby communities and potentially affected institutions could result in strong resistance to the implementation of the project. This could be expressed in terms of obstruction of workers from carrying out their respective services, attacks on the workers, public demonstrations and violent behaviour. Failure to develop amicable relationship with residents of the nearby Tema New Town may also result in such occurrence.

As already pointed out, the COVID-19 pandemic has become a leading health issue in Ghana and other countries of the world since March 2020. Infections and deaths have been recorded in both the Tema Metropolis and the Kpone Katamanso Municipality. The pandemic is still ongoing and can therefore have negative impacts during all phases of the oil refinery project. The impacts could be direct or indirect and the duration could be short or long term while the likelihood is high. *They are rated as moderately significant and would require mitigation.*

***Land Use***

Given that the area allocated for the project is within the Heavy Industrial Area of Tema, pre-construction phase activities, which are intended to prepare for the project to take off, will add value to the land in terms of its intended purpose of industrial development. Furthermore, by designing better drainage systems for the oil refinery, the project will have a positive impact in contributing to manage occasional flooding in the area as has been reported by VALCO.

***Regulatory Requirements***

Of importance in the pre-construction phase is the possibility that the project activities may not start as scheduled due to SORL's failure to apply for and obtain the relevant permits and approvals. Regulatory requirements need to be followed and respected during all activities in this phase and in all the other phases otherwise this could even affect the investment schedule of the project.

Regulatory requirements will, among others, be required in respect of government policies such as the National Energy Policy and the Local Content Policy. They will also be required to satisfy various legal and regulatory frameworks such as for land acquisition (State Lands Act, 1962 (Act 125) planning, design and alignment of Chinese to Ghanaian standards (Environmental Assessment Regulations, 1999 (L.I. 1652); National Petroleum Act, 2005 (Act 691); and the GHPA Law, PNDC 160), employment (Labour Act 651, 2003), as well as in acquisition of various permits governed by such legislation as the Local Government Act, 1993, (Act 462); Ghana National Fire Services Act, 1997 (Act 537) and the Water Use Regulations, 2001 (L.I. 1692). In addition, failure to consult with the relevant local and administrative stakeholders may lead to conflicts and delays in project schedule.

The adverse impacts of disregarding regulatory requirements are direct and national in extent. *Mitigation measures are required for these highly significant potential negative impacts.*

***Relevant Stakeholders (Social Conflicts)***

A concern that may lead to social conflict is the general lack of awareness on the details of the project by many stakeholders. In addition to the need to consult various stakeholders, one specific issue that could also lead to social conflict is the dissatisfaction of the traditional ruler of Tema New Town, Tema Mantse and his elders, with TDC for allocating the proposed project site to SORL. *The potential negative impacts are considered significant and mitigation measures are required to ensure a sustainable project.*

### *7.3.3 Construction Phase Impacts*

In the construction phase, activities to be carried out under project site preparation include relocation of utility lines (such as electricity pylons) at the site, clearing, levelling and zoning of the site for installation of the various infrastructure and facilities. Site clearing will be followed by the construction of access and refinery roads and construction of the processing plant, the components of which are summarised in Table 3-6.3 and Figure 3-6.1. Further to this, sub-components to be constructed include storage and transportation facilities, water supply, drainage and fire control systems as well as power and telecommunications facilities. Other ancillary facilities to be constructed include administration block, central laboratory, maintenance workshop and clinic. All these activities will be accompanied by mobilization of heavy construction equipment.

All the components (physical, biological and socio-economic) will be affected by the activities in this phase. Activities that will generate the most negative impacts are site preparation and zoning, construction of access and refinery roads and development of the main and ancillary infrastructure (Table 7-3.2). Positive impacts will result from recruitment of workers and associated improvement mainly in the local economy.

**i. Physical Environment**

***Air Quality***

During the construction phase, airborne particulates would be generated. Fugitive dust will negatively affect air quality from the relocation of ECG pylons, land clearing and excavation, construction of access and refinery roads as well as development of main and ancillary refinery infrastructure. Dust from exposed surfaces such as cleared areas and waste dumps are also likely to negatively affect air quality. High levels of fine particulate matter in the atmosphere can initiate a variety of respiratory diseases such as bronchitis, emphysema and cardiovascular diseases. In addition, gases from combustion of fuels in stationary and mobile equipment will be important emission sources. These are likely to result in increases in the local concentrations of pollutants such as particulates, sulphur dioxide and carbon monoxide that may cause headaches, dizziness, nausea and convulsions. *The spatial scope and duration of airborne particulates, point source dust, non-point source dust and gaseous emissions are rated to be severe and would require mitigation measures.*

***Noise and Vibration***

Data presented in Table 5-1.4 indicate that the baseline noise levels within the catchment of the project site (64.3 to 78.5 dB) and in Tema New Town (53.1 dB) fall below the acceptable noise level of 85dB (A) for day time by EPA and Department of Factories Inspectorate. Activities that will contribute to increased noise levels during the construction phase include vehicular and truck movements, relocation of ECG Pylon, site preparation and construction of roads and refinery infrastructure. Noise and vibration generated from these activities are likely to go beyond the baseline noise levels and cause negative occupational health and safety effects including discomfort and loss of hearing.

This impacts will be direct, temporary and moderate in scale; the impacts are also local in extent, that is, limited to the project site and adjacent industries. *They are rated moderately significant and would require mitigation measures.*

**Table 7-3.2 Matrix of Construction Phase Activities and Environmental and Socio-economic Components**

| Environmental and Socio-economic Components | Recruitment | Relocation of ECG Pylons | Site Preparation and Zoning | Construction of Access and Refinery Roads | Development of Main and Ancillary Infrastructure | Water Use / Disposal | Solid Waste Disposal | Gas and Dust Emissions |
|---|---|---|---|---|---|---|---|---|
| **Physical** | | | | | | | | |
| Air Quality | | | | | | | | |
| Noise | | | | | | | | |
| Drainage | | | | | | | | |
| Erosion | | | | | | | | |
| Soils | | | | | | | | |
| Surface Water | | r | | | | | | |
| Groundwater | | | | | | | | |
| **Biological** | | | | | | | | |
| Flora | | | | | | | | |
| Fauna | | | | | | | | |
| **Socio-economic** | | | | | | | | |
| Employment | | | | | | | | |
| Local Economy | | | | | | | | |
| National Economy | | | | | | | | |
| Occupational Health and Safety | | | | | | | | |
| Public Health and Safety | | | | | | | | |
| Local Traffic | | | | | | | | |
| Land Use | | | | | | | | |
| Regulatory Requirements | | | | | | | | |
| Relevant Stakeholders | | | | | | | | |

**Legend:**

| | |
|---|---|
| | **Activity does not interact with environmental or socio-economic component** |
| | **Activity interacts positively with environmental or socio-economic component** |
| | **Activity interacts negatively with environmental or socio-economic component** |

***Drainage (Flooding)***
Exposed surfaces from land clearing and excavations will generate loose sediment which could be carried by surface runoff into the lagoon channel potentially causing siltation of the channel and reducing its carrying capacity. In addition, construction activities at the site could destroy or block drains in the Heavy Industrial Area passing through the site. Thus, flooding conditions in the project area could be exacerbated. *Therefore, the potential impacts are significant in this phase and would require mitigation measures.*

***Soils and Erosion***
Except for recruitment, all the activities of this phase (Table 7-3.2) such as land clearing and excavations will expose bare soil to erosion. The use of heavy machinery and equipment would also result in soil compaction thereby negatively impacting its structure and permeability while leaks of oil and diesel fuel from the use of the heavy equipment are likely to contaminate the soils. In addition, the blocking of drainage channels during land preparation and installation of infrastructure could exacerbate flooding in the area which could also lead to increased erosion and sediment transport. *The potential negative impacts are assessed as significant in this phase and would require mitigation measures.*

***Surface Water and Groundwater Quality***
Analysis of surface waters in the project area and the Chemu Lagoon showed that both their physico-chemical and biological quality were very poor (Tables 5-1.6, 5-1.7 and 5-1.8) due to industrial effluents and domestic wastes being discharged into the channels draining the lagoon and directly into the lagoon. In the construction phase, surface water pollution may increase during construction of refinery access and haulage roads, site preparation and development of refinery and other infrastructure, especially during the wet season when erosion of exposed surfaces and sediment transport into the lagoon by runoff could increase appreciably. Pollution can also arise from disposal of wastewater and other construction waste into the lagoon channel draining the area. It is not expected that chemical spillages will occur to impact groundwater in the construction phase.

*The negative impacts on surface water quality could be severe and of long duration (>5 years). They are therefore assessed to be significant and would require mitigation measures.*

***Waste Disposal / Management***
Activities during the construction phase include recruitment of personnel, construction of roads, mobilization of equipment and construction of infrastructure. These activities would be associated with a corresponding increase in quantities of solid and liquid wastes to be generated in temporary offices, work camps and maintenance workshops. Solid wastes would include wood, scrap metal, food remnants, glass and refuse while examples of liquid wastes are sewage, waste chemicals and oily water. Improper disposal and management of such wastes could pose health and safety hazards to both workers and nearby communities and increase pollution of surface waters. *The potential impacts of waste generation are negative and of high severity because waste generation will occur throughout the life of the refinery. Mitigation measures are therefore required.*

**ii. Biological Environment**

***Flora***
In the construction phase, especially during land clearing and site preparation, the already degraded flora at the project site will be lost. This loss of habitat will directly affect the occurrence of fauna in the project area. Also, during this phase, accidental spills of lubricants and fuel, depending on the quantities, may lead to further losses of vegetation. *Mitigation measures are required for these moderately significant impacts.*

***Fauna***
In addition to those activities that will have potential negative impacts on the flora of the project site, others such as vehicular movement and associated noise and vibration and waste disposal will have negative impacts on the occurrence of land-dwelling fauna such as reptiles and insects in and around the project site. *The potential impacts are considered moderately significant and mitigation measures will be required.*

**iii. Socio-economic Environment**

***Employment and Improvement in Economy***
In the construction phase, major activities to be carried out such as recruitment, relocation of ECG Pylons presently on the site, site preparation, construction of access and refinery roads and main infrastructure (Table 7-3.2), have the potential to provide jobs for skilled and unskilled youth of the area. The impacts from these activities will be positive for employment generation and in contributing to the growth of the local economy.

For employment generation, the construction phase will employ contractors and subcontractors who will in turn recruit people to carry out various construction and installation activities and thus provide employment opportunities to the skilled and unskilled youth from the Tema New Town community and beyond. Local workshops, mechanics, and engineering services will also be engaged to help repair machines, equipment, and other components where necessary. It is anticipated that most of the materials for construction of tanks and other infrastructure will be sourced locally and therefore, the local economy will see some injection of capital from the construction of the oil refinery.

***Occupational Health and Safety***
All the construction activities, except recruitment will have potential negative impacts on occupational health and safety. The construction phase activities including site preparation, construction of roads and infrastructure and waste management are likely to give rise to dust and obnoxious gaseous emissions. During construction workers will also be exposed to risks of injuries from operation of machinery, possible fires and explosions, inhalation of dust and fumes and accidents from falling objects, among others. Improper handling of wastes and hazardous materials as well as inadequate sanitary facilities will also constitute a health threat to workers.

Airborne particulates are of particular concern because they are well known to be associated with classical widespread occupational lung diseases such as pneumoconiosis, as well as systemic intoxications such as lead poisoning, especially at higher levels of exposure. But, in the modern

era, there is also increasing interest in other dust-related diseases, such as cancer, asthma, allergic alveolitis, and irritation, as well as a whole range of non-respiratory illnesses, which may occur at much lower exposure levels. Wherever the particulates are deposited, either in the head or in the lung, they have the potential to cause harm either locally or subsequently elsewhere in the body.

*These potential negative impacts are assessed to be of high significant and would require mitigation.*

***Public Health and Safety***

Just as for occupational health and safety, dust obnoxious gases and noise from various construction activities as indicated above pose health risks for the general public. Improper disposal of both solid and liquid wastes as well as unsecured excavations will also have adverse impacts on public health and safety, particularly in the immediate neighbourhood of the refinery including Tema New Town. Furthermore, exposed surfaces and improperly covered trenches may result in stagnation of water and increased breeding mosquitoes and other insects associated with water borne diseases. Another potential negative impact is the influx of people to the project area during the construction period, which may promote irresponsible sexual behaviour and use of illicit drugs. Coupled with the fact that congestion of the project area was one of the major concerns raised during the stakeholder consultations, these *impacts are assessed as highly significant and would require mitigation measures.*

***Local Traffic***

As already pointed out, the project area is congested with many industrial and commercial activities, in addition to the current heavy vehicular traffic. Increased vehicular traffic will occur during the mobilization of equipment and transportation of construction materials to the project site from Tema Harbour and other local sources, which will worsen the state of congestion and increase the risk of accidents. Other direct impacts will come from the exposure of the general public to increased noise, dust and gaseous emissions. In addition, the poor state of the existing road leading to the SORL project site could be worsened by the increased frequency of movement of heavy-duty trucks transporting equipment and materials to the project site. Any unattended mechanical breakdown of trucks on the VALCO road could interfere with access to the VALCO plant and offices. *The combined negative impacts are considered significant for which mitigation measures are required.*

***Land Use***

Potentially, there will be negative impacts on land use during the construction phase of the SORL. This will mainly arise from two major activities, namely construction of access and refinery roads and solid waste disposal. As indicated above, construction of the roads could potentially contribute to increased traffic on the VALCO Road and other roads in the heavy industrial area and thus inconvenience other users and neighbouring land uses. In addition, where solid waste from SORL's construction site is not properly disposed of, it could have negative impacts on the adjacent land uses. *The potential negative impacts are considered significant and mitigation measures are required.*

***Regulatory Requirements***
Just as for the pre-construction phase, regulatory requirements will be required during the construction phase to avoid delays or suspension of activities. Apart from requirements related to the environment (Environmental Assessment Regulations, 1999 L.I. 1652) and the petroleum sector (National Petroleum Act, 2005 (Act 691), others will be required for such activities as construction (Local Government Act, 1993 (Act 462); Building Code), employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), and for water use (Water Use Regulations, 2001 (L.I. 1692). Failure by SORL to satisfy the above regulatory requirements may lead to delays in project schedule. As in the pre-construction phase, the adverse impacts of disregarding regulatory requirements are direct and national in extent. *Mitigation measures are required for these highly significant potential negative impacts.*

***Relevant Stakeholders***
During the construction phase, the inability of SORL to consult with the relevant local and administrative stakeholders may lead to social conflicts and delays in construction schedules. This is particularly important with respect to activities such as relocation of ECG pylons, construction of the main access road to the refinery and waste water disposal. Concerning the relocation of the ECG pylons for example, this activity may conflict with the use of the VALCO haulage road by both VALCO and nearby residents of Tema New Town. *The potential negative impacts are considered significant and mitigation measures are required.*

### *7.3.4 Operations Phase Impacts*

In the operations phase, the processing plant, its sub-components and ancillary facilities will be used to distil 1.5 million tons of crude oil per year in Phase 1 and a total of 3.0 million tons in Phase 2 into various products including gasoline, diesel, LPG, benzene, sulphuric acid bitumen and fuel oil. The raw materials and finished products will be transported to and from the refinery in trucks and stored in tank farms on site. During this phase, the project activities will generate positive interactions in employment and business opportunities in connection with the operations and management of the oil refinery leading to improvement in the local, regional and national economies (Table 7-3.3). Negative interactions will be associated with the transportation, handling and storage of raw materials and finished products as well as with waste water discharges, solid waste disposal and gaseous emissions. These will affect air and surface water quality, occupational and public health and safety and regulatory requirements, among others. The details are discussed below.

**i. Physical Environment**

***Ambient Air Quality (Dust and Gaseous Emissions)***
In the operations phase, various gaseous emissions and airborne particulates would be generated. Gaseous emissions generated in the operation of the refinery mainly come from the combustion of flue gas from heating furnaces, sulfuric acid tail gas, exhaust hydrocarbon gases from various processing and sulphur recovery units, fugitive emissions of hydrocarbon gases from raw material, intermediate and finished products storage tanks and exhausts from stationary diesel generators for supplemental electricity supply. As indicated in sections 3.6.3, the various emissions envisaged from the refinery include:

- Total Particulate Matter;
- Particulate Matter < 10µ;
- Particulate Matter < 25µ;
- Nitrogen oxides;
- Sulphur dioxide;
- Carbon monoxide;
- Carbon dioxide
- Volatile organic compounds;
- Benzene

These emissions, causing pollution both at the ground level (e.g. within the refinery) and in the atmosphere (affecting the neighbourhood of the refinery and beyond), could have severe and widespread environmental impacts if not properly managed. For example, sulphur dioxide and carbon monoxide that may cause headaches, dizziness, nausea and convulsions while nitrogen dioxide can cause smog. Carbon dioxide is well known for its role in the phenomenon of climate change worldwide.

*The severity, spatial scope and duration of airborne particulates and gaseous emissions are rated to be of major significance and would require mitigation measures.*

***Noise***

The equipment that produce continuous noise in the operations phase include pumps, air coolers, heating furnaces and compressors. Intermittent noise sources will be mainly torches, safety valves and steam vents. The noise level may be around 80-110dB (A). Such noise levels are likely to impact negatively on the hearing of workers. Also during the operations phase, raw materials such crude oil and various chemicals will be transported by trucks to the oil refinery for processing. After the crude oil is refined into the various products, they will be transported to various storage tanks from which the finished products will be conveyed to users and clients, also by trucks. The movement of a fleet of heavy-duty vehicles will cumulatively create increased noise levels during this phase. The noise impact will be felt both on site and in the immediate environs of the project site. *The impacts will be direct, of long duration (throughout the life the oil refinery) and high in scale. Thus, these negative impacts are rated to be of major significance and would require mitigation measures.*

***Drainage***

In the operations phase, stormwater will be generated from runoff in the refinery process plant and tank storage areas and from other areas including from outside the project site. If this stormwater is not properly managed in addition to ensuring proper functioning of those drains passing through the project site and carrying effluents from parts of the Heavy Industrial Area, flooding conditions in the project area could be exacerbated. *The impacts are direct, of long duration and high in scale. Therefore, they are rated as major significance and would require mitigation measures.*

**Table 7-3.3 Matrix of Operations Phase Activities and Environmental and Socio-economic Components**

| Environmental and Socio-economic Components | Recruitment | Wastewater Management | Solid Waste Management | Management of Gaseous Emissions | Transportation of Raw Materials and Finished Products | Handling and Storage of Raw and Intermediate Materials and Finished Products | Handling and Storage of Other Materials | Resource Use ( Water and Electricity) | Corporate Social Responsibility |
|---|---|---|---|---|---|---|---|---|---|
| **Physical** | | | | | | | | | |
| Air Quality | | | | | | | | | |
| Noise | | | | | | | | | |
| Drainage | | | | | | | | | |
| Erosion | | | | | | | | | |
| Soils | | | | | | | | | |
| Surface Water | | | | | | | | | |
| Groundwater | | | | | | | | | |
| **Biological** | | | | | | | | | |
| Flora | | | | | | | | | |
| Fauna | | | | | | | | | |
| **Socio-economic** | | | | | | | | | |
| Employment | | | | | | | | | |
| Local Economy | | | | | | | | | |
| National Economy | | | | | | | | | |
| Occup, Health and Safety (fires, explosions, heat) | | | | | | | | | |
| Public Health and Safety (explosions) | | | | | | | | | |
| Local Traffic | | | | | | | | | |
| Regulatory Requirement | | | | | | | | | |
| Relevant Stakeholders | | | | | | | | | |

**Legend:**

| | |
|---|---|
| | **Activity does not interact with environmental or socio-economic component** |
| | **Activity interacts positively with environmental or socio-economic component** |
| | **Activity interacts negatively with environmental or socio-economic component** |

***Soils and Erosion***
Erosion could be a problem in the operations phase from exposed areas at the refinery site and flooding from improper management of storm drains and stormwater. Loose soils from exposed soil surfaces could easily be eroded and carried away as sediment in storm runoff. *The potential impacts are assessed as moderately significant in this phase and would require mitigation measures.*

***Surface Water Quality* (*Runoff, Chemical spillages and effluents)***
In the operations phase, surface water pollution (Chemu Lagoon) may increase from chemical and oil spillages, refinery effluents such as acid and oily water, domestic waste water and sediment transport by runoff from erosion of exposed surfaces, especially during the wet season. *These potential impacts are assessed to be moderately significant and would require mitigation measures.*

***Groundwater Quality* (*Chemical spillages and effluents)***
Chronic, long term chemical spillages and discharges of refinery effluents in the operations phase could negatively affect the quality of groundwater. These *potential long term impacts are assessed as moderately significant and would require mitigation measures.*

***Waste Disposal / Management***
The activities during the operations phase will generate various kinds of solid and liquid waste including hazardous wastes. Solid wastes generated from the refinery operations will include waste catalysts, waste adsorbents, tank bottom mud generated during the maintenance of the tank area, and sludge from the sewage treatment plant. The refinery operations will also produce acidic and oily waste water. In addition, a variety of solid and liquid wastes will be generated in offices, laboratory, kitchen/canteen, clinic, vehicle and other machinery and equipment maintenance workshops. All the waste streams will have to be properly assessed and managed to ensure that they do not adversely affect the physical environment of the refinery and other areas. *The potential impacts of waste generation are negative and of major significance because waste generation will occur throughout the life of the refinery. Mitigation measures are therefore required.*

**ii. Biological Environment**

***Flora***
There will be no land clearing during the operations phase and therefore the loss of vegetation will be insignificant. However, what remains of the existing degraded vegetation will need to be augmented and maintained.

***Fauna***
In the operations phase, the negative impacts on fauna would be minimal because those that survived the land clearing activities in the construction phase would have moved to more habitable areas, away from the project site. No mitigation measures would thus be required.

### iii. Socio-economic Components

***Employment and Improvement in Economy***

The project is expected to have a high positive economic impact at the local, regional and national levels during the operational phase since much revenue and other benefits would accrue, and employment opportunities would be expanded.

Specifically, the operations phase will see the recruitment of highly skilled labour to manage and operate refinery installations as well as manage administrative and other technical operations. Thus, this will provide employment to Ghanaians and contribute to reducing unemployment in Tema and the nation. In addition, the operation of the oil refinery is expected to contribute significantly to the local and national economies.

According to SORL (2019b) the overall plan of the project is to invest a total 1.92 billion US dollars, of which the first phase will take 0.75 billion US dollars. It is estimated that the annual revenue from the project's operations will be US$ 782 million US dollars under Phase 1 and 1.564 billion US dollars after Phase 2 is completed (SORL, 2020). The pro-forma operating statement reveals that the project is profitable. The estimates show that, the project will yield a profit of 73.6 million US dollars in the first year of operations, rising to 156.7 million US dollars after the Phase 2 is operational. It is also estimated that 22.5 million dollars will be paid in taxes by Year 3, rising to 48 million dollars by Year 7.

The project can thus promote the joint development of chemical, rubber, machining, automotive and logistics industries in Ghana and nearby African countries. It can create nearly 400 jobs in Ghana alone. The company is committed to building the Tema Industrial Park into a petrochemical demonstration base in Ghana and Africa (SORL, 2019b).

In spite of the above positive impacts on the local and national economies, the operations phase of the project could have potential negative impacts on the local and national economies if the gaseous emissions are not managed well. For instance, there are warehouses in the industrial area, close to the project site, that keep food packaging materials, packaged food, and food to be packaged. If emissions from the operations stage are not managed properly, food and packaging materials could be contaminated. This could lead to a rejection of the food and packaging material and hence losses to the warehouses with the concomitant impact on export earnings. *These potential long term negative impacts are of major significance require mitigation measures.*

***Occupational Health and Safety***

Occupational health and safety impacts from oil processing and other refinery activities will be manifested through such hazards as poor ambient air quality from gaseous and particulate emissions, increased noise, increased risk of fires, explosions and electric shocks, high heat levels, exposure to hazardous chemicals and waste generation. These potential impacts are summarised below.

*Ambient Air Quality (Gaseous Emissions and Particulate)*

As indicated above, obnoxious gas and air particulate emissions from refinery activities will be significant in the operations phase. Apart from emissions to the atmosphere, there is the potential of emissions at the ground level (e.g. within the refinery). The potential release and accumulation of nitrogen gas into work areas may result in the creation of asphyxiating conditions due to the displacement of oxygen. In addition, workers may be exposed to potential inhalation hazards (e.g., $H_2S$, CO, VOCs, PAHs) during routine plant operations (IFC, 2016). *These potential impacts on occupational health and safety are assessed to be significant requiring mitigation measures*.

*Noise*

Noise will be generated by refinery activities as indicated above and the impact will also be felt on site. The continuous noise produced during the operation of some equipment is likely to increase the level of discomfort or even impair the hearing of workers. *Thus, the negative impacts of noise on occupational health and safety will be significant. Mitigation measures will be required.*

*Fires and Explosions*

In the production process of a petroleum refinery, most of the raw materials, semi-finished products, products, additives and other materials are flammable and explosive liquids and gases. Fire and explosion hazards generated by process operations include accidental releases of syngas (containing carbon monoxide and hydrogen), oxygen, methanol, and refinery gases. Refinery gas releases may cause "jet fires" if ignited in the release section, or give rise to a vapour cloud explosion, fireball, or flash fire, depending on the quantity of flammable material involved and the degree of confinement of the cloud. Methane, hydrogen, carbon monoxide, and $H_2S$ may ignite even in the absence of ignition sources at temperatures that are higher than their auto-ignition temperatures of 580°C, 500°C, 609°C, and 260°C, respectively. Flammable liquid spills present in petroleum refining facilities may cause "pool fires**.**" Explosive hazards may also be associated with the accumulation of vapours in storage tanks (e.g., sulfuric acid and bitumen) (IFC, 2016).

Under the high temperature and pressurized conditions, in which processing of crude oil is carried out, the occurrence of leaks, sparks or static electricity can also cause fires and explosions. Again, fluid media may generate static electricity during transportation, venting, leaking, pumping, sampling, etc. and cause fires and explosions.

The potential for fires from refinery oil processing and other operations is summarised in Table 7-3.4. Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to project workers. *The potential negative impacts on occupational health and safety during this phase, are assessed as of major significance and would require mitigation measures.*

**Table 7-3.4 Potential for Fire/Explosion Hazards from Main Processes and Other Refinery Operations**

**A. Main Refinery Processes**

| No. | Refinery Process | Fire/Explosion Hazard |
|---|---|---|
| 1 | ***Crude Oil Pre-treatment (Desalting)*** | The potential exists for a fire due to a leak or release of crude from heaters in the crude desalting unit. Low boiling point components of crude may also be released if a leak occurs. |

| No. | Refinery Process | Fire/Explosion Hazard |
|---|---|---|
| | | |
| 2 | ***Crude Oil Distillation (Fractionation)*** | Although these are closed processes, heaters and exchangers in the atmospheric and vacuum distillation units could provide a source of ignition, and the potential for a fire exists should a leak or release occur. |
| 3 | ***Fluid Catalytic Cracking*** | Because of the presence of heaters in catalytic cracking units, the possibility exists for fire due to a leak or vapour release.<br><br>The potential also exists for explosive concentrations of catalyst dust during recharge or disposal. When unloading any coked catalyst, the possibility exists for iron sulphide fires. Iron sulphide will ignite spontaneously when exposed to air if not wetted with water to prevent it from igniting vapours. |
| 4 | ***Catalytic Hydrotreating*** | The potential exists for fire in the event of a leak or release of product or hydrogen gas. |
| 5 | ***Catalytic Reforming (Naphtha)*** | This is a closed system; however, the potential for fire exists should a leak or release of reformate gas or hydrogen occur. |
| 6 | ***Amine Plants (Sulphur Recovery)*** | The potential for fire exists where a spill or leak could reach a source of ignition. |
| 7 | ***Sweetening and Treating Processes*** | The potential exists for fire from a leak or release of feedstock or product. Sweetening processes use air or oxygen. If excess oxygen enters these processes, it is possible for a fire to occur in the settler due to the generation of static electricity, which acts as the ignition source |
| 8 | ***Blending*** | The potential for fire exists where a leak or release of blending compounds could reach a source of ignition. |

## B. **Other Refinery Operations**

| No. | Other Operations | Fire/Explosion Hazard |
|---|---|---|
| 1 | ***Heat Exchangers, Coolers, and Process Heaters*** | There exists the chance of explosions when lighting fires in heater furnaces. If flammable product escapes from a heat exchanger or cooler due to a leak, fire could occur. |
| 2 | ***Steam Generation*** | The most potentially hazardous operation in steam generation is heater startup. A flammable mixture of gas and air can build up as a result of loss of flame at one or more burners during light-off with the potential of a fire and explosion. |
| 3 | ***Pressure-Relief and Flare Systems*** | The potential exists for fires if vapours and gases discharge where sources of ignition could be present. |
| 4 | ***Wastewater Treatment*** (for process, runoff, and sewerage water prior to discharge or recycling.) | When cooling water is contaminated by hydrocarbons, flammable vapours can be evaporated into the discharge air. If a source of ignition is present, or if lightning occurs, a fire may start. A potential fire hazard also exists where there are relatively dry areas in induced-draft cooling towers of combustible construction. |

| No. | Other Operations | Fire/Explosion Hazard |
|---|---|---|
| 5 | ***Electric Power*** | Generators that are not properly classified and are located too close to process units may be a source of ignition should a spill or release occur. |
| 6 | ***Gas and Air Compressors*** | There is a potential for fire should a leak occur in gas compressors or if the compressors are located such that their suctions take in flammable vapours or corrosive gases. |
| 7 | ***Tank Car, and Tank Truck Loading and Unloading*** | The potential for fire exists where flammable vapours from spills or releases can reach a source of ignition. |
| 8 | ***Pumps, Piping and Valves*** | The potential for fire exists should hydrocarbon pumps, valves, or lines develop leaks that could allow vapours to reach sources of ignition. |
| 9 | ***Tank Storage*** | The potential for fire exists should hydrocarbon storage tanks be overfilled or develop leaks that allow vapours to escape and reach sources of ignition. |

**Source: Adapted from OSHA (1999).**

*Heat*

Most components of the refinery (e.g., desalting, fractionation, FCC, reforming units, amine plants, steam system, gas and air compressor plant, and process and heat pipe network) operate at very high temperatures. Steam and hot surfaces could pose dermal hazards during refinery operations. *This major significant impact requires mitigation measures.*

*Hazardous chemicals*

As indicated in the section on project description (Chapter 3), a variety of chemicals, additives and catalysts, many of which are toxic and corrosive, will be stored on site and used during the refinery operations. Improper handling and storage of these chemicals could pose health hazards to workers. In addition, dermal hazards may occur from contacts with acids from the processing units of the refinery. In particular, workers may be exposed to hydrofluoric acid (HF) in the HF alkylation unit. *The impact is of major significance and requires mitigation measures.*

*Wastewater Management*

As indicated under physical environment, various streams of waste water would be generated throughout the operations phase of the refinery. Improper treatment, handling and disposal of this waste water could pose health hazards to workers and the work environment. *The impact is assessed as moderately significant and would require mitigation measures.*

*Solid Waste Management*

Poor solid waste management, particularly of hazardous waste such as used catalysts could have adverse impact on the health of workers if they come into contact with such waste without the requisite PPEs. *The impact is assessed as moderately significant and would require mitigation measures.*

*Electric Shocks*

Another occupational health and safety issue is the danger of electric shocks. The proposed project will be provided with high and low voltage power distribution rooms. However, if the equipment

switch body or the protective grounding device becomes defective or it is operated in an improper manner, the equipment will likely produce electric shocks resulting in injuries to workers. With or without electric shocks, there is also the possibility that workers may fall from heights of some infrastructure or equipment frames in the process plant, tank area, dock and other units, resulting in injuries. *The negative impacts are assessed as of major significance and would require mitigation.*

***Public Health and Safety***

Public health and safety impacts from operations of the oil refinery will arise from various activities and incidents. These include fires and explosions, reduced ambient air quality due to gaseous and particulate emissions, increased noise and runoff, discharges of waste water and solid waste disposal.

*Fires and Explosions*

Fire and explosions at the proposed oil refinery site, as discussed under Occupational Health and Safety, will affect the nearby industries and Tema New Town community. They will also negatively affect vehicular movement to and from the Heavy Industrial Area. Accidents at the oil refinery site or involving loaded tankers may occur during the transportation of raw materials and finished products, handling and storage of raw and intermediate materials and finished products, as well as during handling and storage of other materials at the oil refinery. *The potential impacts will be of high significance and will require mitigation measures.*

*Ambient Air Quality*

As already stated, gaseous and particulate emissions will occur from such refinery operations as oil and gas processing, and handling, storage and transport of materials. These emissions to the atmosphere could impact adversely on surrounding industries, businesses and communities, especially Tema New Town community. *The potential impacts will be moderately significant and will require mitigation measures.*

*Noise and Vibration*

Noise from refinery operations and also from trucks and tankers transporting refinery inputs and products could be a nuisance to neighbouring businesses and Tema New Town. Also, vibrations due mainly to explosions at the refinery could impact adversely on the integrity of buildings and other infrastructure in the neighbourhood of the refinery. *The impacts of noise and vibration on public health and safety are assessed as moderately significant and therefore require mitigation measures.*

*Runoff, Solid Waste and Wastewater Management*

Poor management of storm runoff, solid waste and waste water from the refinery could cause flooding in both upstream and downstream neighbour industries and cause further deterioration of the waters of the Chemu Lagoon. *The potential negative public health and safety impacts are assessed as moderately significant, requiring mitigation measures.*

***Resource Use (Water and Electricity)***

Excessive water and electricity consumption by the refinery in the operations phase may deprive other users of adequate access to these resources. This is especially critical for treated water supply

from the GWCL since its quantity is currently not enough to meet demand in the Tema Municipality and rationing is being implemented to manage the situation. *The impact is assessed as significant and would require mitigation.*

***Regulatory Requirements***
As already indicated, regulatory requirements need to be followed and respected during all phases of the project activities. In the operations phase the relevant regulatory requirement will include those for the petroleum sector (National Petroleum Act, 2005 (Act 691), Petroleum Local Content and Participation Regulations, 2013), employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), and water use (Water Use Regulations, 2001 (L.I. 1692). Others are the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917 and the EPA Environmental Quality Standards for noise, air quality and effluent discharges. *As in the pre-construction and construction phases, the adverse impacts of disregarding regulatory requirements are assessed as of major significance and would require mitigation measures.*

***Relevant Stakeholders***
A major potential impact during the operations phase is the relationship of SORL with the nearby Tema New Town community and the surrounding businesses and industries. This can either be positive or negative depending on the decisions taken by SORL and their outcomes. *The negative impact is rated as of major significance. Mitigation measures would be required.*

### *7.3.5 Decommissioning and Closure Phase Impacts*

During the decommissioning and closure phase, the oil refinery will cease functioning and all structures and equipment will be dismantled to be followed by reclamation of the project site to a stable and safe condition for appropriate use.

The decommissioning and closure phase interactions are presented in Table 7-3.5 Most negative interactions will result from dismantling of infrastructural components and waste disposal and will affect air quality, noise levels, water quality as well as occupational and public health and safety. All the activities in this phase will also generate some positive impacts.

**i. Physical Environment**

***Air Quality***
During the decommissioning and closure phase, gaseous emissions will occur mainly from vehicular movements and operations of machinery used for dismantling the components of the refinery and other structures. Also, these activities will result in dust emissions and are likely to affect air quality. Deterioration of air quality will pose health problems to workers. *These are considered moderately significant impacts because of their likelihood of affecting human health and would require mitigation measures.*

***Noise***
Noise and vibrations will occur from both vehicular movements and operations of machinery used for dismantling structures. Apart from the workers, these will also disturb the nearby industries.

*The impacts are assessed to be moderately significant impacts because they would affect human health and will require mitigation measures.*

**Table 7-3.5 Matrix of Decommissioning and Closure Phase Activities and Environmental and Socio-economic Components**

| Environmental and Socio-economic Components | Dismantling of Components | Management of Movable Assets | Management of Unmovable Assets | Waste Management | Land Reclamation |
|---|---|---|---|---|---|
| **Physical** | | | | | |
| Air Quality | | | | | |
| Noise and Vibration | | | | | |
| Landscape / Drainage | | | | | |
| Soils | | | | | |
| Surface Water | | | | | |
| **Biological** | | | | | |
| Flora | | | | | |
| Fauna | | | | | |
| **Socio-economic** | | | | | |
| Employment | | | | | |
| Local Economy | | | | | |
| National Economy | | | | | |
| Occupational Health and Safety | | | | | |
| Public Health and Safety | | | | | |
| Local Traffic | | | | | |
| Regulatory Requirements | | | | | |
| Relevant Stakeholders | | | | | |

**Legend:**

| | |
|---|---|
| | **Activity does not interact with environmental or socio-economic component** |
| | **Activity interacts positively with environmental or socio-economic component** |
| | **Activity interacts negatively with environmental or socio-economic component** |

### *Drainage (Flooding)*

Poor management of storm runoff and the drainage system could result in flooding of neighbouring areas. The flooding is likely to cause disruptions in the operations of businesses and industries such as VALCO, which *are of national economic value. The impacts are therefore assessed to be of moderate significance and would require mitigation measures.*

### *Soils and Erosion*

Land clearing and excavation will not occur in this phase to cause soil loss. However, poor maintenance of the drainage system for proper handling of storm runoff could cause flooding and result in erosion of land areas. *The negative impacts are project-site specific and of short duration and thus rated as being of minor significance and would not require mitigation measures.*

### *Surface Water and Groundwater Quality*

Surface water pollution from storm runoff, oil and other waste spillages from vehicles, machinery used for dismantling structures and fuel dumps could occur in this phase. On the other hand, no chemical spillages or process plant effluents will occur to negatively impact groundwater. The

*potential negative impacts are assessed as moderately significant and would require mitigation measures*

***Waste Disposal / Management***
Poor management of waste generated during this phase could pose serious hazards to the refinery's environs. *The potential impacts are negative and would affect human health and contaminate stored finished petroleum products of high economic value and therefore rated as of major significance and would therefore require mitigation measures.*

**ii. Biological Environment**

***Flora***
Potential negative impacts on vegetation during this phase will arise mainly from waste disposal of oils and lubricants from dismantled equipment at the project site. *In spite of the relatively short period of this phase, these significant impacts will require mitigation measures.* On the other hand, rehabilitation of the site, when fully completed, will be beneficial for recovery and increase in diversity of plants.

***Fauna***
After the seizure of operations and dismantling of the various components of the oil refinery, land rehabilitation will be beneficial for faunal diversity.

**iii. Socio-economic Components**

***Employment and State of Economy***
Every phase of a project as grand as the oil refinery will have potential positive impacts on employment at every stage, including even for decommissioning and closure. During this phase of the project, experts, skilled personnel, and unskilled personnel will be recruited to dismantle components and reclaim the land. However, the magnitude of this positive impact will be reduced because of the job losses that would arise from lay-offs from the refinery due to its closure.

Furthermore, the decommissioning of the refinery would have detrimental impacts on the national and local economies. The dismantling of components and disposal of movable assets are the main activities in this phase that would impact the economies. Once these activities are carried out, the closure of the refinery will be confirmed and local businesses that relied on the refinery for business will no longer have business opportunities. Also, the export of finished products to neighbouring countries will cease and the country will lose some foreign exchange from such exports.

***Occupational and Public Health and Safety***
Increased dust emissions are expected during dismantling of the components of the refinery in the decommissioning and closure phase. Gaseous emissions are also expected from the movement of vehicles to and from the project site. Furthermore, fire outbreaks and explosions arising from improper handling of fuel or chemicals on site or leakages from equipment and vehicles may also pose hazards to the workers and the general public. Accidents may also occur from the transfer of dismantled components from the project site. These are all likely to result in negative impacts on

the health of workers and the general public. *The potential negative impacts are of short duration but because they will affect human health are assessed to be of major significance and would require mitigation*.

***Regulatory Requirements***

During the decommissioning and closure phase, regulatory requirements that have to be taken into account include those for employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537) and the EPA Environmental Standards for noise, air quality and effluent discharges.

***Relevant Stakeholders***

Potential positive impacts will arise due to the engage of the relevant stakeholders by SORL during the decommissioning and closure phase. These will be important during the disposal of movable and unmovable assets after the dismantling of the various components of the oil refinery. With respect to the latter, movable assets such as furniture and pipes may be sold to EPA-certified collectors to enhance their businesses and therefore, the local economy. Immovable assets may be disposed of in consultation with local and government administrators.

# CHAPTER 8 MITIGATION OF POTENTIAL IMPACTS

## 8.1 Introduction

According to the Ghana Environmental Assessment Regulations, 1999 (L.I. 1652) Regulation 30, *Interpretations,* "Mitigation" means, in respect of a proposed or existing undertaking, the elimination, reduction or control of the adverse environmental effects of the undertaking and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

From the identification, prediction and evaluation of impacts as described in Chapter 7 above, SORL shall institute mitigation measures for the environmental and socio-economic components that would be affected by significant potential negative impacts in the various project phases.

## 8.2 Mitigation Measures for Project Phases

### *8.2.1 Pre-construction Phase*

In the pre-construction phase, there will be no significant negative impacts associated with the biological environment. Regulatory requirements will be the most affected socio-economic component while land access and inspection are the activities that would generate significant negative impacts affecting drainage and erosion in particular. Mitigation measures are proposed below.

**i. Physical Environment**

***Drainage***
Activities in the pre-construction phase that may have significant negative impacts on the environment requiring mitigation measures pertain to access to the project site and undertaking of inspections and technical surveys on site.

The project area is a wetland that is a receptacle for runoff during the rainy season and is thus susceptible to flooding. The site is also at the downstream of three major drains in the Heavy Industrial Area. Therefore, SORL shall design and put in place an adequate drainage system that can cater for the water that runs through the entire project area to avoid problems with flooding in the proposed project area. In view of the importance of flood control in the project area and the serious concerns expressed by some of the adjoining land owners on the need for an adequate drainage system for the area, SORL shall produce drainage designs that would show that the design and the system to be constructed can indeed evacuate the volumes of water that drain the area during the rainy season. Construction of the drainage system will only proceed when these designs are certified by the relevant authorities (TMA, KKMA) as being adequate.

Thus, in the pre-construction phase, SORL shall ensure that only limited land clearing takes place to minimise exposure of soils to erosion. Use of heavy machinery shall also be avoided. In addition,

drains that go through the project site shall not be blocked or otherwise disturbed, ensuring that they remain functional to avoid flooding situations.

***Erosion***

To mitigate the negative impacts on erosion, SORL will adopt a system of cutting inroads to the project site and trenching for temporary drainage channels that respect the natural land contours. The control of soil erosion during the phase will involve the following two basic approaches:

- Reducing runoff amount;
- Reducing runoff velocity.

The most effective form of erosion control is to minimize the area of disturbance, retain as much as possible existing vegetation and employ detention devices and contour drains. Contour drains are temporary ridges or excavated channels or a combination of both, constructed to convey water across sloping land on a minimal gradient. These can break overland flow across disturbed areas by limiting slope length and thus the erosive power of runoff and diverting sediment-laden water to appropriate controls or stable outlets.

The soil surface outside the inroads has to be protected by some soil cover since this practice guarantees a minimised area of disturbance. Surface cover is a major factor for controlling erosion because it reduces the impact of raindrops falling on bare soil and wind removing soil particles. It also reduces the speed of water flowing over the land and controls runoff before it develops into an erosive force.

**ii. Socio-economic Components**

***Occupational and Public Health and Safety***

As already stated, activities to facilitate access to the project site for inspection and the carrying out of technical surveys on site in the pre-construction phase could cause flooding resulting in negative impacts on workers, neighbouring businesses and Tema New Town. Mitigation measures proposed for erosion and soils above shall also apply to occupational and public health and safety.

To ensure the health and safety of technical teams conducting surveys during the pre-construction phase, SORL shall insist on the mandatory use of appropriate personal and protective equipment such as safety boots and gloves by all team members.

Also, in order to cope with, and help control the spread of the COVID-19 pandemic, SORL shall insist on the observance of all recommended protocols by teams during field inspections and surveys as well as during consultations.

To minimize the possibility of social conflict, SORL, as a matter priority, shall also disseminate information on the scope and schedule of the proposed oil refinery project to the various interested stakeholders. This shall include measures to safeguard the interests of the nearby Tema New Town community and other potentially affected institutions.

***Regulatory Requirements***

SORL, aware of the need to develop the oil refinery project in a systematic and timely manner, shall in the pre-construction phase:

- Be guided by all the relevant government policies such as the National Energy Policy and the Local Content Policy;
- Satisfy all the relevant regulatory frameworks such as for land acquisition (State Lands Act, 1962 (Act 125), planning and design (Environmental Assessment Regulations, 1999 (L.I. 1652); National Petroleum Act, 2005 (Act 691); and the GHPA Law, PNDC 160);
- Apply for and obtain all the relevant permits including those pertaining to the Local Government Act, 1993, (Act 462), Ghana National Fire Service Act, 1997 (Act 537) and the Water Use Regulations, 2001 (L.I. 1692);
- Ensure local content and local participation, with respect to employment of workers and general procurement according to the Petroleum (Exploration and Production) Act, 2016 (Act 919), Petroleum (Local Content and Local Participation) Regulations, 2013. Labour Act 651, 2003 and Labour Regulations, 2007 (L.I. 1833);

Also, aware that the process technology and equipment for the oil refinery were sourced from China, SORL shall ensure that during the updating of technical designs, the implementation codes for design and operation of the oil refinery will be aligned to available Ghana standards such as those of EPA and NPA.

***Relevant Stakeholders***

During the scoping exercise, the need for SORL to strengthen communication on the project ranked as the highest concern of stakeholders. Also, as indicated in Chapter 7 above, a specific issue that could lead to social conflict is the dissatisfaction of the traditional ruler, Tema Mantse, with TDC for allocating the proposed project site to SORL without consulting the traditional authority.

As a general mitigation measure to address the concerns raised on inadequate information sharing, SORL shall develop and make operational its Communication Plan on the proposed project activities, detailing the necessary internal and external alerts and communication during all phases of the project. SORL shall designate a Public Relations Officer to be responsible for implementing the Communications Plan and consulting with all relevant local and administrative stakeholders. Subsequently, SORL in partnership with TDC shall hold discussions with the Tema Mantse to find an amicable solution to the issue.

### *8.2.2 Construction Phase*

In the construction phase, there will be significant negative impacts associated with the physical and biological environments and the socio-economic components. The key potential impacts relate to air quality, drainage, soils and erosion, occupational and public health and safety and regulatory requirements. Mitigation measures are proposed below.

**i. Physical Environment**

***Air Quality***

During the construction phase, dust and emissions from vehicles, machinery and other equipment will occur from relocation of ECG pylons, land clearing, land preparation and construction of roads and infrastructure. To maintain ambient baseline levels of suspended particulate matter and emissions such as CO, $SO_2$ and $NO_2$ as well as to mitigate the impacts of dust, SORL shall:

- Ensure that site preparation and clearing are not conducted in the peak of the dry season;
- Maintain all its work equipment at optimal operating conditions, according to the manufacturers' specifications;
- Minimize dust generation by using covers for sand heaps and / or control systems such as dust suppression by dowsing with water.

***Noise***

To mitigate the negative impacts of increased noise levels arising from the various construction activities, SORL shall:

- Use construction vehicles and equipment with low noise and vibration capacity;
- Use well maintained equipment and screen or muffle noisy systems;
- Ensure that all personnel wear appropriate Personal Protection Equipment (PPE) such as ear plugs in areas of high noise;

***Drainage***

To mitigate the impact of construction activities on flooding in the project site and its environs, SORL shall:

- Ensure that drains passing through the site from the Heavy Industrial Area are not blocked or destroyed. If these drains will be affected by construction activities, they shall be properly relocated in consultation with the relevant authorities and the neighbouring businesses.
- Design and construct adequate drainage systems in the project site for post-construction stormwater and treated waste water discharges;
- Avoid or cover exposed surfaces from land clearing and excavations that will generate loose sediment to be carried by surface runoff to cause sedimentation of drains and the lagoon.

***Soils and Erosion***

To mitigate the negative impacts of erosion, SORL shall adopt a system of construction activities and water management that will control soil erosion during the construction phase. As indicated for the mitigation measures during the pre-construction phase, SORL shall adopt the two basic approaches of i) reducing runoff amount and ii) reducing runoff velocity.

To protect soils of the project site from being eroded, compacted and contaminated by the use of heavy duty trucks and equipment during construction, SORL shall institute the following mitigation measures:

- Use types of heavy-duty trucks and equipment that will not overburden the soils;
- Ensure that the heavy-duty trucks and equipment used for the construction are properly maintained on schedule to prevent oil / diesel leakages into the soils;

- Ensure that efficient water and waste management practices are adopted during the construction period.

***Surface Water Quality***

To minimise water pollution, SORL shall institute the following mitigation measures:

- Schedule site clearing and road construction activities to avoid heavy rainfall periods to the extent that is practical;
- Avoid or cover exposed surfaces from land clearing and excavations to prevent loose sediment from being transported by surface runoff into surface waters;
- Use impervious surfaces for refuelling and other fluid transfer areas to prevent their discharge into surface waters;
- Train workers on the correct transfer, handling of fuels, chemicals and response to spills;
- Provide portable spill containment and clean-up equipment on site and training in the equipment deployment.

***Waste Disposal / Management***

Activities during the construction phase would generate various quantities of solid and liquid wastes from temporary offices, work camps and machinery and equipment maintenance workshops, among others. All the waste streams shall be properly assessed and managed to ensure that they do not pose health and safety hazards and also pollute surface waters. In particular, SORL shall:

- Provide waste bins with covers at vantage points at the project site for collection of solid waste;
- Contract a Waste Management company in collaboration with TMA and KKMA, to collect solid waste from the project site for final disposal in a landfill;
- Provide sanitary facilities at the temporary work camp and around the project site for workers to prevent open defecation;
- Prohibit dumping or storage of litter/debris, tools and equipment on the sides of public or private roads;
- Use impervious surfaces at refuelling and other fluid transfer areas at plant site;
- Train workers on the correct transfer, handling of fuels and response to spills;
- Provide portable spill containment and clean-up equipment on site and training in the equipment deployment.
- Ensure personnel working at site are trained in the handling and management of wastes.

**ii. Biological Environment**

***Flora***

To mitigate the negative impacts on flora during construction, SORL shall institute the following measures:

- Minimise earth movements at the construction sites;
- Minimise disturbance of vegetation and where necessary, restore with native vegetation after construction in consultation with the Department of Parks and Gardens;
- Use impervious surfaces at refuelling and other fluid transfer areas at construction sites;
- Train workers on the correct transfer, handling of fuels and chemicals;

- Provide portable spill containment and clean-up equipment on site and training in the deployment of the equipment;

***Fauna***
In addition to measures proposed for flora above, the Contractor shall seek the help of the Ghana Wildlife Division of the Forestry Commission to relocate any large reptiles found at the project site during this phase.

**iii. Socio-economic Environment**

***Occupational Health and Safety***
Sentuo Oil Limited has commissioned Luoyang Ruize Petrochemical Engineering Co. of Henan, China to design, construct and supervise the construction and commissioning of the proposed oil refinery (SORL 2020). During this phase, the Contractor will adopt construction methods that ensure the greening of the oil refinery plant area. Generally, The Contractor shall be responsible for ensuring the health and safety of all persons involved in the works, whether directly or indirectly, by providing a safe working environment, suitable protective equipment and effective training, among other measures required by statutory regulations. Also, in order to cope with, and help control the spread of the COVID-19 pandemic, the Contractor shall observe all recommended protocols during the construction phase.

In practice, the Contractor shall implement construction principles that adapt to local conditions, ensure safety and protect the environment. Specifically, the Contractor in consultation with SORL shall:

- Appoint an Environmental Health and Safety (EHS) Officer;
- Provide Personal Protective Equipment (PPE) and training on safety procedures;
- Provide First Aid posts and display safety / precautionary measures at selected points on the project site to guide movement and activities of workers and visitors;
- Train selected workers as first aid givers and provide adequate first aid kits at the construction areas to treat minor ailments and cuts. However, major cases will be referred to the Tema General Hospital;
- Train drivers at the site to understand road traffic regulations;
- Enforce speed limits of 50 km/hr. in built-up areas and 10-30 km/hr. at the project site;
- Ensure that movement of heavy-duty trucks and equipment to site or storage areas are carried out in phases and regulated to control the number of trucks and reduce the risk of accidents;
- Ensure that all equipment to be used are in good condition and undergo scheduled regular maintenance to minimise of accidents.

***Public Health and Safety***
The Contractor in consultation with SORL shall:

- Analyse traffic flows and prepare a management plan to ensure that transport of equipment is carried out during low peak periods and to minimise congestion at the construction site;
- Institute adequate traffic management measures to caution the public and to create safety awareness;

- Engage flagmen to man all major intersections to assist with passage of trucks conveying materials and equipment to and from the construction site and storage areas;
- Maintain security personnel who are trained to respect the human rights of the public at the construction site;
- Provide workers and security personnel toilet facilities during the construction period;
- Use indicator linings / reflective warning notices or wire mesh to prevent falls into uncovered trenches or deep excavations;
- Ensure that all the drivers to be engaged possess the requisite qualifications;
- Enclose the project site and strictly control admission of job seekers to discourage idling and irresponsible behaviour;
- Observe all recommended protocols to control the spread of the COVID-19 pandemic.

***Local Traffic***

Mitigation measures proposed for the potential negative impacts on Occupational Health and Safety and Public Health and Safety above will be the same for the potential negative impacts on local traffic in the construction phase.

***Land Use***

To mitigate the negative impacts on land use during construction, SORL shall:

- Rationalize the movement of construction vehicles efficiently to minimise congestion in the project area including use of alternative routes;
- Ensure the regular maintenance of vehicle engines and construction equipment to reduce emissions
- Spray the road construction sites with water to reduce the amount of dust in the air;
- Enforce mitigation measures already proposed for waste management in this phase;

***Regulatory Requirements***

To ensure that construction activities for the oil refinery infrastructure are implemented as scheduled, SORL shall:

- Be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652, National Petroleum Act, 2005 (Act 691), GHPA Law, PNDC 160 , the Labour Act 651, 2003 and Labour Regulations, 2007 (L.I. 1833);
- Apply for and obtain all the relevant permits including those pertaining to the Local Government Act, 1993, (Act 462), Ghana National Fire Service Act, 1997 (Act 537) and the Water Use Regulations, 2001 (L.I. 1692);
- Ensure local content and local participation, with respect to employment of workers and general procurement according to the Petroleum (Exploration and Production) Act, 2016 (Act 919), Petroleum (Local Content and Local Participation) Regulations, 2013. Labour Act 651, 2003 and Labour Regulations, 2007 (L.I. 1833);

***Relevant Stakeholders***

To minimise social conflicts and delays in construction schedules, SORL shall consult with all relevant local and administrative stakeholders with respect to all construction-related activities that may directly or indirectly affect the general public, especially, nearby residents and businesses.

### *8.2.3 Operations Phase*

In the operations phase, the processing plant, its sub-components and ancillary facilities will be used to distil 1.5 million tons of crude oil per year in Phase 1 and a total of 3.0 million tons in Phase 2 into various products. The raw materials and finished products will be transported to and from the refinery in trucks and stored in tank farms on site. Potential negative impacts will be associated with the transportation, handling and storage of raw materials and finished products as well as with wastewater discharges, solid waste disposal and gaseous emissions. These will affect air and surface water quality, occupational and public health and safety and regulatory requirements, among others. Mitigation measures are proposed below.

**i. Physical Environment**

***Air Quality***

In the operations phase, various gaseous emissions and airborne particulates would be generated from refinery operations, ancillary units, storage tanks and vehicular operations with significant impact on air quality. In addition to mitigation measures proposed for the construction phase, other specific general air quality control measures to be instituted by SORL include (SORL, 2020):

- *Venting and flaring*

Venting and flaring will be used as part of routine operational measures to safely dispose of vapours emitted by the process plant under normal production, accidents, shutdown and emergency situations. A flare management plan will be used to monitor both pollutant concentrations at the ground level and the total quantity of pollutants released annually and to control flare volumes;

- *Emission control of combustion of flue gases from heating furnaces*

In order to reduce the emission of nitrogen oxides from flue gas combustion, low nitrogen burners will be used in the heating furnace;

- *Control of exhaust gas emissions*

The hydrocarbon gas released from the safety valves of each unit will be discharged into the flare system; the gas discharged during accidents and the purge gas that is produced when the system is first started and stopped will also be discharged into the flare system;

- *Control of fugitive emissions*

For fugitive gas emissions control, Vapour Recovery Units, would be used as much as possible instead of open venting or flaring. To reduce the fugitive emissions of hydrocarbon gases, light oil products will be stored in floating roof tanks, and liquefied petroleum gas in spherical tanks;

- *Minimization of SOx emissions*

This will be done through desulphurization of fuels, or by directing the use of high-sulphur fuels to units equipped with SOx emission controls;

- *Treatment of hydrogen sulphide gas*

The gas discharged from each unit will be desulphurized by a gas desulphurization unit, and the purified dry gas used as refinery fuel gas. The hydrogen sulphide will be sent to a sulphuric acid unit to produce sulphuric acid. To prevent fugitive hydrogen sulphide from being directly discharged into the environment, an acid gas flare system will be used;

- *Control of Greenhouse Gas (GHG) emissions*

Aggregate GHG emissions (e.g., $CO_2$, $CH_4$) shall be quantified annually in accordance with internationally recognized methodologies. Appropriate fuel gas systems and flares, and power/waste heat recovery units will be used to minimize GHG emissions. The overall objective would be to reduce GHG emissions and evaluate cost-effective options for reducing emissions that are technically feasible (IFC, 2016);

- *Control of particulate emissions*

High-efficiency air pollution control devices (e.g., bag filters, electrostatic precipitators, scrubbers, third-stage cyclones) will be installed on potentially large sources of particulate matter emissions such as the FCCU regeneration unit. These technologies along with NOx and SOx emissions control technologies (e.g., wet gas scrubbers) will be employed to additionally control $PM_{2.5}$. A combination of these techniques is expected to achieve >99 percent abatement of particulate matter. Measures to control particulates may also contribute to control of metal emissions from the refinery (IFC, 2016).

During normal operations, the non-condensable gas generated at the top of the distillation tower will be adsorbed by activated carbon and discharged to the factory vent pipe network to reduce the emission of atmospheric pollutants. When plant operations are stopped for maintenance, the rich gas and safety valve overpressure relief gas will be discharged into the venting main pipe and sent to the main plant venting system for treatment and discharge.

***Noise***

Mitigation measures to be instituted by SORL for noise in the operations phase include:

- Use of low-noise equipment, such as low-noise pumps and air-cooler fans;
- Use of sound absorption processes indoors as needed for large compressors, fans and other high-noise equipment;
- Installation of mufflers at steam vents, air vents and induced draft fan inlets;
- Use of low-noise burners for heating furnaces;
- Greening of the plant boundary in such a way as to reduce the impact of noise.

***Drainage***

Stormwater from the refinery plant area and outside the project site, will be drained through the drainage system provided for the purpose and discharged into the outlet of the lagoon to avoid problems with flooding in the area, including the Heavy Industrial Area. The drains will be frequently monitored and maintained to ensure their functionality throughout the life of the refinery.

***Erosion and Soils***

In the operations phase, SORL shall minimise the occurrence of exposed surfaces through greening of the general refinery area, in collaboration with the Department of Parks and Gardens. According to SORL (2020), greening will, among others, be based on adapting to local conditions, reducing erosion and noise, ensuring safety and beautifying the environment. According to the general layout plan, production characteristics, pipe network layout, fire safety, environmental characteristics, and local soil and climatic conditions, plant types and other factors, a choice of green plants with anti-pollution, purification, noise reduction or dust retention ability will be made for greening of areas of the refinery site. In the front of the plant and in auxiliary facilities such as transformer and sewage treatment areas, tall trees will be used. Between the production area and

the surrounding roads, lawns and flowers will be used. Lawn greening will be used between fire roads and fire dikes but there will be no greening in the fire dike. The greening style will ensure blending with the surrounding environment, buildings and other structures to maintain the aesthetic value of the project area.

***Surface Water Quality***

In addition to mitigation measures for impacts on surface water quality described for the construction phase, the following measures for the operations phase shall be implemented.

- No solid wastes shall be disposed of in the lagoon or project area;
- All water to be discharged into the lagoon from the refinery area shall first be treated to EPA acceptable quality levels in the waste water treatment plant;
- Hydrocarbon and hazardous chemical spillages will be contained, collected and handled according to EPA and industry standard procedures and no spills shall be discharged into the lagoon;

***Groundwater Quality***

Chronic hydrocarbon and hazardous chemical spillages and discharges of refinery effluents could negatively impact groundwater in the operations phase. Mitigation measures are as proposed for surface water quality above and such spills shall not be allowed to infiltrate the soil.

***Waste Disposal / Management***

In addition to those outlined in the construction phase, further measures to mitigate the potential negative impacts of the management of waste generated during operations of the refinery will be implemented as follows:

- Solid waste shall be disposed of by recycling, comprehensive utilization, landfill and incineration according to the nature of the waste to be discharged. All waste catalysts containing precious metals and waste catalysts that must be recovered in connection with patents will be returned to the manufacturers. Wastes with recycling value, such as unqualified polymers will be downgraded for sale. Qualified, EPA-approved companies will be contracted and entrusted to dispose of hazardous solid wastes such as waste catalysts without recovery value through, for example, safe landfill or incineration.
- The project shall basically follow the principle of pollution minimisation, decontamination and diversion, and classification treatment for the various types of waste water generated during the production process as well as re-use (SORL, 2019a);
- Wastewater shall be divided into sulphur-containing water, oil-containing water and domestic wastewater, which will enter different systems. Sulphur-containing waste water (process water) will undergo sour water stripping and be reused as the first option or sent to the sewage water treatment plant; oily water and domestic sewage will be sent directly to the wastewater treatment plant, and most of the effluent reused;
- Due to its hazardous nature, the following process wastewater management practices shall further be implemented (IFC, 2016):
    - Prevention and control of accidental releases of liquids through regular inspections and maintenance of storage and conveyance systems, including stuffing boxes on pumps and valves and other potential leakage points, as well as the implementation of spill response plans;

    - Provision of sufficient capacity for storing process fluids to enable maximum recovery into the process and, as a consequence, avoiding large discharges of process liquids into the oily wastewater drainage system;
    - Design and construction of wastewater and hazardous materials storage containment basins with suitably impervious surfaces to prevent infiltration of contaminated water into soil and groundwater;
    - Segregation of process wastewater from storm water and segregation of wastewater and hazardous materials containment basins; and
    - Implementation of good housekeeping practices, including conducting product transfer activities over paved areas and prompt collection of small spills.
- When a fire occurs in the refinery, the wastewater for firefighting will be drained to the 13,000 $m^3$ accident pool using a pipeline for storage. After the fire is extinguished, the waste water in the pool will be pumped to the sewage treatment plant for treatment and discharge;
- Stormwater in the refinery plant area will be collected and discharged to the wastewater treatment plant. Effluent from the wastewater treatment plant will be recycled as much as possible and any excess discharged to the environment through storm drains constructed at the site.

**ii. Biological Environment**

***Flora***

In the operations phase, although the expected loss of vegetation will be insignificant, the degrading vegetation of the project area will need to be augmented and maintained. SORL shall therefore:

- In collaboration with the Department of Parks and Gardens, landscape the project site and its adjoining areas and maintain a policy of minimum disturbance of vegetation.

As outlined in its feasibility studies (SORL, 2020), the principles underlying the layout of the refinery include organization of greening activities to enhance the natural landscape. The greening of the plant area shall, among others, be based on adapting to local conditions, ensuring safety, and beautifying the environment. SORL shall choose green plants with anti-pollution, purification, noise reduction or dust retention ability for the greening areas of the refinery site.

**iii. Socio-economic Environment**

***Employment and Improvement in Economy***

The possibility that the operations phase could negatively impact the local and national economies through gaseous emissions that could contaminate products in warehouses nearby needs addressing. Hence, SORL shall:

- Ensure that minimal gaseous emissions take place by following the measures proposed above to control the negative impacts of gaseous emissions;
- Monitor the air quality in order to prevent gaseous emission going above permissible levels;

***Occupational Health and Safety***

SORL shall carry out the following measures for mitigation of the potential negative impacts on occupational health and safety. These will be in addition to relevant measures outlined for the construction phase above, including observance of all protocols recommended for the control of the spread of the COVID-19 pandemic.

The proposed oil refinery is designed to operate as a fully closed production and transportation system to prevent the leakage of combustibles. All combustible, flammable and explosive materials are always sealed in various types of equipment and pipelines. Reliable sealing measures are adopted at each connection hence the health and safety of the workers are considered. As mitigation measures SORL shall:

- Develop an Occupational Health and Safety Plan, including requirements for PPE, task risk assessment, mandatory training, audit and monitoring and incident reporting;
- Develop Emergency Response Plans for the different operations;
- Ensure that the workers are provided with adequate PPE including overalls, earplugs, anticorrosive gloves as their particular operations would require;
- Provide non-conductive hand tools rated for the voltage at which live electrical works are performed;
- Place precautionary / warning signs at vantage points around the project site;
- Undertake risk assessments to indicate the avoidance / elimination of hazards associated with manual handling of chemicals;
- Ensure that workers handling fuels, chemicals, machinery and equipment are well trained on the dangers the handlings;
- Issue permits to cover work system of high temperature, risky electrical and works at heights;
- Ensure that all staff working on live equipment or lines are without conductive apparel (watches, bracelets, rings, key chains, necklaces, cloth with conductive thread, etc.);
- Provide barricades and signage for all live electrical equipment;
- Set up flammable / toxic gas alarms to indicate accumulation / dangers in the installation areas, tank and oil loading / unloading operation areas;

In general, good housekeeping practices will be an integral part of the refinery operations to maintain a well laid out working space and avert accidents. For example, as indicated in its Feasibility Study (SORL, 2020). SORL shall:

- Adopt a joint arrangement method as much as possible so that materials can be directly fed between the devices to reduce the installation of intermediate raw material tanks;
- Arrange next to the process plant area, auxiliary production facilities, crude oil tank farms and raw oil tank farms which are closely related to production and centralise facilities with similar properties and functions;

Further to the above, the following specific mitigation measures shall be implemented:

*Prevention / Control of asphyxiating conditions and inhalation hazards (Ambient Air Quality)*

- Design and placement of nitrogen venting systems according to industry standards;
- Installation of an automatic Emergency Shutdown System that can detect and sound an alarm warning of the uncontrolled release of nitrogen (including the presence of oxygen-

deficient atmospheres in working areas), automatically initiate forced ventilation, and shut down equipment to minimize the duration of releases;

- Working areas with the potential for oxygen-deficient atmospheres shall be equipped with area monitoring systems capable of detecting such conditions. Workers also shall be equipped with personal monitoring systems. Both types of monitoring systems shall be equipped with a warning alarm set at 19.5 percent concentration of $O_2$ in the air;
- Implementation of confined space entry procedures according to industry standards and international best practice;
- Protection of workers from exposure to potential inhalation hazards (e.g., $H_2S$, CO, VOCs, PAHs) during routine plant operations. Protection measures to be adopted include worker training, instituting work permit systems, use of PPEs and installation of toxic gas detection systems with alarms (IFC, 2016).

*Noise*

In addition to the measures proposed for the physical environment, the following mitigation measures shall be implemented for occupational health and safety:

- Re-locating noise sources to less sensitive areas as is practicable to take advantage of distance and shielding;
- Inspection workers required to wear noise-proof earmuffs when entering high noise areas;

*Prevention and Control of Fires and Explosions*

There is potential for fires from refinery oil processing and other operations. Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to project workers.

Mitigation measures for the impacts of these hazards are outlined below (IFC, 2016; IFC, 2007; OSHA, 1999).

- Designing, constructing, and operating the refinery according to international standards for the prevention and control of fire and explosion hazards, including provisions for segregation of process, storage, utility, and safe areas;
- Providing early warning systems, such as pressure monitoring of gas and liquid conveyance systems, in addition to smoke and heat detection for fires;
- Evaluation of potential for vapour accumulation in storage tanks and implementation of prevention and control techniques (e.g., nitrogen blanketing for sulphuric acid and bitumen storage);
- Avoiding potential sources of ignition (e.g., by configuring the layout of piping to avoid spills over high-temperature piping, equipment, and/or rotating machines);
- Locating generators that are not properly classified away from process units and hydrocarbon storage tanks;
- Proper location of gas and air compressors to prevent their suctions taking in flammable vapours or corrosive gases;
- Provision of pressure relief valves where the potential exists for overpressure in the refinery processes;
- Automatic monitoring and proper maintenance of hydrocarbon pumps, valves, and lines to avoid leaks;
- Use of bonding to equalize the electrical charge between loading racks and tank trucks;
- Use of grounding at truck loading facilities to prevent flow of stray currents;

- Installation of flame arrestors in loading racks and tank trucks to prevent flashback;
- Providing tanks with automatic overflow control and alarm systems, or establishing manual gauging and checking procedures to control overfills;
- Providing passive fire protection measures within the modelled fire zone that are capable of withstanding the fire temperature for a time sufficient to allow the operator to implement the appropriate fire mitigation strategy;
- Limiting/containing the areas that may be potentially affected by the accidental releases of flammable liquids by;
    - Defining fire zones and equipping them with a drainage system to collect and convey accidental releases of flammable liquids to a safe containment area, including secondary containment of storage tanks;
    - Installing fire/blast partition walls in areas where appropriate separation distances cannot be achieved; and
    - Designing the oily wastewater system to avoid the propagation of fire.
- Equipping the refinery with fire detectors, alarm systems, and fire-fighting equipment;
- Use of fire and emergency alarm systems that are both audible and visible;
- Storing flammables away from ignition sources and oxidizing materials. In addition, flammables storage areas shall:
    - Be remote from entry and exit points into buildings;
    - Be away from ventilation intakes or vents;
    - Have explosion venting;
    - Use spark-proof fixtures;
    - Be equipped with fire extinguishing devices.
- Providing bonding and grounding of, and between, tanks;

Also, safe work practices shall be adopted and appropriate personal protective equipment provided to workers for exposure to hazards related to product sampling, manual gauging, inspection, and maintenance activities including confined space entry.

*Heat*

Safe work practices shall be implemented and appropriate personal protective equipment provided to workers as mitigation measures for exposures to heat hazards.

*Hazardous chemicals*

As indicated in the project description (Chapter 3), a variety of chemicals, additives and catalysts will be stored on site and used during the refinery operations. Improper handling and storage of these chemicals could pose health hazards to workers. In addition, dermal hazards may occur from contacts with acids from the processing units of the refinery.

The following mitigation measures shall be implemented for exposure to hazardous chemicals:

- Chemicals shall be handled in accordance with recommended practices and stored in an approved storage area that has been designed for containment and segregation to avoid chemical interactions. They will be identified by their Chemical Abstract Registry Number together with associated quantities, characteristics and toxicities;
- Personnel shall be trained in the correct handling of chemicals and response for spill clean-up and first aid. The project shall implement a Workplace Hazardous Materials Information

System training program for the safe handling and use of chemicals stored and used on-site. (NFLRP, 2007);

- Safe work practices shall be implemented and appropriate personal protective equipment provided to workers.

*Solid Waste and Wastewater Management*

Mitigation measures provided above for the physical environment are applicable here also. In addition, workers coming into contact with waste shall wear appropriate PPEs.

*Operation of Clinic/First Aid Post*

A clinic and first aid post will be located near the front area of the plant, close to the edge that leads to the main road outside the plant. A competent medical institution will be contracted to operate the clinic to support emergencies and occupational health and safety processes.

***Public Health and Safety***

In order to prevent other enterprises and residents around the project site from being affected by atmospheric pollutants due to the refinery operations, the local wind direction, wind speed, dominant wind frequency and topographical factors have been fully considered in the general laying out plan of the project site. In addition, mitigation measures for air quality for the physical environment shall also be applied for public health and safety in the operations phase.

*Noise*

Mitigation measures for noise from refinery operations for the physical environment apply to public health and safety also. In addition, trucks and tankers transporting refinery inputs and products shall be properly maintained and fitted with mufflers to reduce their noise to acceptable levels.

*Vibrations*

Vibrations due mainly to explosions from fires at the refinery could impact adversely on the integrity of buildings and other infrastructure in the environs of the refinery. Fire prevention measures proposed as mitigation for impacts on occupational health and safety above will apply to public health and safety too.

*Runoff, Solid Waste and Wastewater Management*

Mitigation measures described for the physical environment above apply to public health and safety also.

***Resource Use (Water and Electricity*)**

SORL shall supplement its water supply from GWCL from other sources such as an on-site desalination plant. Also, its electricity supply from ECG shall also be supplemented from on-site diesel generators. The aim of these measures is to not deprive other users of adequate access to these resources. This is especially important for treated water supply from the GWCL since its quantity is currently not enough to meet demand in the Tema Municipality and rationing is being implemented to manage the situation.

***Regulatory Requirements***
SORL shall operate the oil refinery taking into consideration the current regulatory requirements in Ghana. Thus, SORL shall:

- Be guided by all the relevant regulations such as the Environmental Assessment Regulations, 1999 L.I. 1652 and the National Petroleum Act, 2005 (Act 691);
- Ensure local content and local participation with respect to employment of workers and general procurement (Petroleum Local Content and Participation Regulations, 2013);
- Comply with those regulations for employment, (Labour Act 651, 2003) and Labour Regulations, 2007 (L.I. 1833), fire prevention (Ghana National Fire Services Act, 1997 (Act 537), and water use (Water Use Regulations, 2001 (L.I. 1692). Others are the Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) and the EPA Environmental Quality Standards for noise, air quality and effluent discharges.

***Relevant Stakeholders***
During the operations phase, SORL shall, using its Communication Plan:

- Maintain cordial relationships with the Tema Mantse who is responsible for the Tema New Town community;
- Consult with all relevant local and administrative stakeholders;

### *8.2.4 Decommissioning and Closure Phase*

During the decommissioning and closure phase, the oil refinery will cease functioning and all structures and equipment will be dismantled to be followed by reclamation of the project site. Most negative interactions will result from dismantling of infrastructural components and waste disposal and will affect air quality, noise levels, surface water quality as well as occupational and public health and safety. Mitigation measures are proposed below.

**i. Physical Environment**

***Ambient Air Quality***
In the decommissioning and closure phase, to control gaseous emissions from vehicles and operations of machinery as well as dust emissions, SORL and its contractors shall:

- Use water bowsers to dampen dusty roads to ensure dust suppression;
- Impose vehicle speed limitation on all unpaved roads and tracks;
- Ensure strict compliance with the maintenance schedule of all vehicles and equipment;
- Comply with the EPA Air Quality Standards;

***Noise***
To protect personnel from being exposed to noise levels above 85dBA, SORL and its contractors shall:

- Ensure that all personnel use the appropriate personal protection equipment;
- Comply with EPA Ambient Noise Standards;

***Drainage***
SORL shall apply the same mitigation measures as for the operations phase as the impacts here are similar to those for drainage in that phase.

***Surface Water Quality***
These impacts will occur under similar conditions as for pollution of surface water in the construction phase. SORL shall therefore use the same mitigation as for the construction phase.

***Waste Disposal / Management***
To ensure safe disposal of waste, SORL and its contractors shall:

- Provide sanitary facilities for workers to prevent open defecation;
- Prohibit dumping or storage of litter/debris, tools and equipment on the sides of access or side roads;
- Use impervious surfaces at refuelling and other fluid transfer areas;
- Train workers on the correct transfer, handling of fuels, chemicals and response to spills;
- Provide portable spill containment and clean-up equipment on site and training in the deployment of the equipment;
- Ensure personnel working at site are trained in the handling and management of wastes.

**ii. Biological Environment**

***Flora***
To mitigate the potential negative impacts on flora, SORL shall mandate each contractor to ensure proper handling of waste. For example, each contractor shall:

- Prohibit dumping or storage of litter/debris, tools and equipment on the sides of access or internal roads;
- Provide portable spill containment and clean-up equipment on site;
- Ensure personnel working at site are trained in the handling and management of wastes.

**iii. Socio-economic Components**

***Occupational and Public Health and Safety***
To mitigate the potential negative impacts on the health of workers and the general public, SORL shall mandate each contractor to apply preventive measures including:

- Using water bowsers to dampen dusty roads and exposed surfaces on site;
- Complying with vehicle speed limits on all unpaved roads and tracks;
- Ensuring strict compliance with the maintenance schedule of all vehicles and equipment;
- Complying with the EPA Air Quality Standards;
- Procuring firefighting equipment and training workers on their use;
- Providing Personal Protective Equipment and training on safety procedures to workers;
- Observing all recommended protocols to control the spread of the COVID-19 pandemic.

***Regulatory Requirements***
SORL shall require all contractors to conduct the decommissioning and closure phase activities taking into consideration the relevant regulatory requirements such as those for employment (Labour Act 651, 2003), fire prevention (Ghana National Fire Services Act, 1997 (Act 537) and the EPA Environmental Quality Standards for noise, air quality and effluent discharges.

# CHAPTER 9 PROVISIONAL ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS

This Chapter presents a Provisional Environmental Management Plan (PEMP) and an Environmental Monitoring Plan (EMP) to be used to manage the activities of the proposed oil refinery for the first 18 months after the issuance of an Environmental Permit to SORL. Regulation 12 of the Environmental Assessment Regulations, 1999 (L.I. 1652), upon which the Draft Terms of Reference were based, stipulates that an Environmental Impact Statement on a proposed undertaking will deal with matters including, a PEMP and proposals to monitor predicted environmental impacts and proposed mitigating measures. The PEMP addresses issues concerned with management of project activities during the project.

It is the intention of SORL to establish and maintain high standards of its project activities in order to prevent or minimise environmental and socio-economic degradation. The PEMP is derived from SORL's Environment and Health and Safety Policies which spell out the firm's commitment to protect the environment and to provide good health and safety at the project site. In order to implement the PEMP, SORL management will have to provide the required financial and human resources as well as establish a relevant environmental management structure. Furthermore, the effectiveness of the implementation hinges on the availability of a well-prepared Emergency Response Plan and Corporate Social Responsibility

## 9.1 Environment, Health and Safety Policies

The awareness, compliance and adherence to these policies are the responsibility of all employees of the project and its contractors and subcontractors. The employees will be duly informed of the environmental management responsibilities through training and supervision.

### *9.1.1 Environment Policy*

*Policy Statement*
The Environment Policy of SORL outlines its commitment to a high standard of environmental performance and continual improvement and implementation of a framework for understanding and managing direct and indirect environmental impacts, risks and opportunities associated with the oil refinery project.

SORL recognises that maintenance of environmental quality is vital to the company's existence, progress, and continued development. SORL is committed to conducting all the oil refinery activities, present and future, in a manner that ensures minimal impact on the environment. Each and every decision made by the technical management shall be focused on designing an environmentally sound and socially responsible project.

*Purpose and Objectives*
The purpose of SORL's Environment Policy is to provide a measurable framework for the performance of its activities with respect to environmental and related issues. The objectives of the Environment Policy are:

- To operate the oil refinery with due consideration for environmental protection, and sustainability by responding to applicable environmental policy compliance requirements;
- To incorporate mitigation measures in its operations in order to reduce adverse environmental and social impacts, natural resources degradation and wastage;

*Strategies*
SORL shall develop strategies to minimise the impact of its activities on the environment through diligent application of appropriate and best available technology and responsible conduct during the relevant phases of the oil refinery project. SORL shall:

- Satisfy national and international environmental legislative requirements and conduct all business in an ethical manner;
- Evaluate, plan, construct, and operate the oil refinery and its facilities according to the approved design specifications;
- Operate the oil refinery in a manner that reduces adverse environmental impacts, especially flooding, and satisfies or exceeds applicable national environmental laws, and standards;
- Apply, in the absence of applicable regulations, cost effective and industry best management strategies and practices to ensure sustainable operations;
- Ensure efficient use of resources such as water, electricity and labour;
- Ensure awareness creation among all workers on environmental issues;
- Require all operations to have site specific emergency response plans;
- Foster communication with stakeholders, the general public and other relevant institutions to enhance understanding of environmental issues affecting the company's activities;
- Assess annually the projected costs of decommissioning and make the necessary final provisions to ensure that there will be sufficient funds to pay for these costs upon closure.

### *9.1.2 Health and Safety Policy*

The Health and Safety Policy of SORL outlines its commitment to treat the safety of its workers as its utmost priority. For this reason, the project activities will be guided by Ghana and the relevant international health and safety regulations and policies. SORL newly employed staff, contractors and subcontractors will be taken through health and safety preventive measures induction. SORL will also outline safety procedures for specific works to ensure minimal incident and accident-free situation during the life span of the oil refinery.

*Policy Statement*
The Health and Safety Policy outlines SORL's commitment to treat the health and safety of its workers as an utmost priority. For this reason, the activities of the oil refinery will be guided by the relevant health and safety regulations and policies of the country. Employees and contractors will be provided with health and safety guidelines prior to starting work. SORL shall also employ regular health and safety preparedness and emergency response plans to verify compliance.

*Purpose and Objective*
The policy on health and safety outlines the commitment of SORL's management and workers to health and safety issues. It aims to remove or reduce the risks to the health, safety and welfare of all workers, contractors and visitors, and anyone else who may be affected by the company's operations at the oil refinery site. Its objective is to get committed to conducting all its activities

in a manner that is safe and not injurious to health so as to meet the health and safety performance expectations of SORL's stakeholders

*Strategies*
SORL shall:

- Establish and maintain safety culture where safety is a core value;
- Comply with all applicable laws and regulations and apply industry standards and best practices where laws and regulations do not exist or are considered insufficient;
- Provide and enforce the use of PPEs and other safety measures to ensure good hygiene practices in the refinery;
- Prohibit use of alcohol and drugs during working hours;
- Set, measure, and review health and safety objectives and targets and provide training and resources that will enable SORL to meet the objectives and targets;
- Observe all recommended protocols to control the spread of the COVID-19 pandemic;
- Integrate health and safety management into SORL's planned activities by identifying hazards and managing risks to "as low as reasonably practicable" levels;
- Maintain and regularly test an emergency response management plan to ensure the safety of personnel, protection of the environment, safeguarding and protection of assets;
- Ensure that all SORL personnel and contractors are aware of the health and safety policy, understand their responsibilities to report hazards and incidents in their work areas;
- Strive for continual improvement in health and safety performance through monitoring, audit and review processes.

## 9.2 Provisional Environmental Management Plan

- Promote environmental management and communicate the aims and goals of the PEMP among the employees of SORL;
- Ensure that all workers, subcontractors and others involved in the project meet legal and other requirements with regards to environmental management;
- Address concerns and issues raised in the EIA's stakeholder consultation process and those that will likely continue to arise during the life of the oil refinery;
- Provide a framework for implementing the project's environmental commitments (i.e. mitigation measures identified in the EIA);
- Prepare and maintain records of the oil refinery project's environmental performance (i.e. monitoring, audits and non-compliance tracking) to provide a feedback for continual improvement in SORL's environmental performance;
- Ensure that appropriate recovery preparedness is in place in the event of emergencies during project implementation.

The Provisional Environmental Management Plan (PEMP) will help to address specific environmental and social issues, risks and impacts of the project. Based on the environmental impacts identified under Chapter 7.0, and mitigation measures for significant impact, a provisional environmental management plan (Table 9-1.1) is prepared for implementation.

**Table 9-1.1 Provisional Environmental Management Plan**

| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| **Ambient Air Quality** | Dust and gaseous emissions | Suppress dust on all unpaved access roads with water and dust suppressant<br>Ensure that site preparation and clearing are not conducted in the peak of the dry season;<br>Cover loose soil/cement load with tarpaulins to reduce fugitive dust generation during movement to and from site;<br>Regularly clean exhaust pipeline of vehicles to remove any surface particulate material build-up;<br>Implement controlled speed limit programme for both company and contractor vehicles;<br>High-efficiency air pollution control devices (e.g., bag filters, electrostatic precipitators, scrubbers, third-stage cyclones) will be installed on potentially large sources of particulate matter and emissions from construction machinery and equipment.<br>Maintenance of all work equipment at optimal operating conditions according to the manufactures' specifications;<br>Flare management plan to be prepared to be used to monitor flare concentration and volumes;<br>Use of low nitrogen burners in the heating furnace to reduce the emission of nitrogen oxides from flue gas combustion;<br>Use of Vapour Recovery Unit and storage of light oil products in floating roof tanks, and liquefied petroleum gas | Pre-construction, Construction, Operations and Decommissioning & Closure | EHS Liaison Committee ,EHS Department and Contractor | Monthly monitoring of TSP, $PM_{10}$ and $PM_{2.5}$ at all monitoring sites;<br>Speed tracking of company /contractor vehicles. | To satisfy the EPA limits/guidelines for air quality;<br>SORL speed limits of 50 km/hr. in built-up areas and 10-30 km/hr. at the project site.<br><br>EPA standards for gaseous emissions |

| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| | | in spherical tanks are the actions for fugitive gas emissions control;<br>Minimization of SOx emissions through desulphurization of fuels, or by directing the use of high-sulphur fuels to units equipped with SOx emission controls;<br>Use of an acid gas flare system to prevent fugitive hydrogen sulphide from being directly discharged into the environment;<br>Appropriate fuel gas systems and flares, and power/waste heat recovery units used to minimize GHG emissions;<br>Control of particulate emissions | | | | |
| **Soil Erosion and Drainage** | Soil compaction and erosion and flooding | Ensuring that the heavy-duty trucks and equipment to be used are properly maintained on schedule to prevent oil / diesel leakages into the soils;<br>Ensuring that efficient water and waste management practices are adopted<br>Limited land clearing to minimise exposure of soils to erosion.<br>Use of types of heavy-duty trucks and equipment that will not overburden the soils;<br>Drainage system to be constructed suitable to evacuate the volumes of water that drain the area during the rainy season<br>Drains at the project site not be blocked. | Pre-construction, Construction and Operations | EHS Liaison Committee, EHS Department, Contractor | Field inspections | |
| **Noise and Vibration** | Noise and vibration from haul trucks and equipment | Use of construction vehicles and equipment with low noise and vibration capacity;<br>Use of well-maintained equipment and screen or muffle noisy systems; | Construction / Operations | EHS Liaison Committee and EHS Department | Regular noise monitoring at selected monitoring sites | Noise levels within EPA standards for ambient sensitive receptors such as |

| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| | use during the oil refinery process | Ensuring that all personnel wear appropriate Personal Protection Equipment (PPE) such as ear plugs in areas of high noise;<br>Use of low-noise equipment, such as low-noise pumps and air-cooler fans;<br>Use of sound absorption processing indoors as needed for large compressors, fans and other high-noise equipment;<br>Installation of mufflers at steam vents, air vents and induced draft fan inlets;<br>Use of low-noise burners for heating furnaces;<br>Greening of the plant boundary in such a way as to reduce the noise impact | | | Response to complaints from nearby industries and community. | nearby industries and local community |
| **Surface Water Quality** | Pollution of surface water body / Chemu lagoon from discharge of sediment, leaked oil and fuel laden runoff water | Training workers on the correct transfer, handling of fuels, chemicals and response to spills;<br>Providing portable spill containment and clean-up equipment on site;<br>Training in the deployment of equipment;<br>Avoiding or covering exposed surfaces from land clearing and excavations to prevent loose sediment from being transported by surface runoff into surface waters;<br>Use of impervious surfaces for refueling and other fluid transfer areas to prevent their discharge into surface waters;<br>Avoiding disposal of solid wastes into the lagoon or project area;<br>Only treated waste water to be discharged into the lagoon from the refinery area; | Construction / Operations | EHS Department, EHS Liaison Committee and Contractor | Regular monitoring of surface water quality | Water quality compliance with EPA effluent discharge standards;<br>EPA and industry standard discharge procedures |

| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| | | Hydrocarbon and hazardous chemical spillages to be contained, collected and handled according to EPA and industry standard procedures and no spills shall be discharged into the lagoon | | | | |
| **Waste Disposal / Management** | Poor solid waste and wastewater management pollute surface water | *Solid Waste*<br>Providing waste bins with covers at vantage points at the project site for collection of solid waste;<br>Contracting a Waste Management company in collaboration with TMA and KKMA, to collect solid waste;<br>Providing sanitary facilities at the temporary work camp and around the project site;<br>Prohibiting dumping or storage of litter/debris, tools, etc. on the sides of public or private roads;<br>Use of impervious surfaces at refuelling and other fluid transfer areas at plant site;<br>Training workers on the correct transfer, handling of fuels and response to spills;<br>Providing portable spill containment and clean-up equipment on site and training in the equipment deployment.<br>Training of personnel working at site in the handling and management of wastes.<br>Solid waste during operations disposed of by recycling,<br>Comprehensive utilization, landfilling and incineration according to the nature of the waste; | Construction and Operations | EHS Department, EHS Liaison Committee and Contractor | Scheduled health examinations of workers;<br>Monitoring of surface water quality;<br>Quarterly waste audits. | Medical standards for good health and water quality compliance with EPA standards. |

| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| | | All waste catalysts containing precious metals and waste catalysts will returned to the manufacturers.<br>Wastes with recycling value, such as unqualified polymers will downgraded for sale.<br>Hazardous solid wastes such as waste catalysts without recovery value disposed of through EPA-approved companies in safe landfill or by incineration.<br>The principle of pollution minimisation, decontamination and diversion, and classification treatment adopted for the various types of wastewater generated during production process and re-use.<br><br>*Wastewater*<br>Sulphur-containing wastewater (process water) to undergo sour water stripping and be reused as the first option or sent to the sewage water treatment plant;<br>Oily water and domestic sewage sent directly to the wastewater treatment plant, and most of the effluent reused;<br>Hazardous process wastewater management practices as described in mitigation measures Section 8.3.2 to be further implemented. | | | | |
| **Flora** | Loss of vegetation in the project area | Earth movements at the construction sites minimised;<br>Disturbance of vegetation minimised and restored with native vegetation after construction;<br>Use of impervious surfaces at refuelling and other fluid transfer areas at construction sites; | Construction | EHS Department, EHS Liaison Committee and Contractor | Field inspection | Greening of project site |

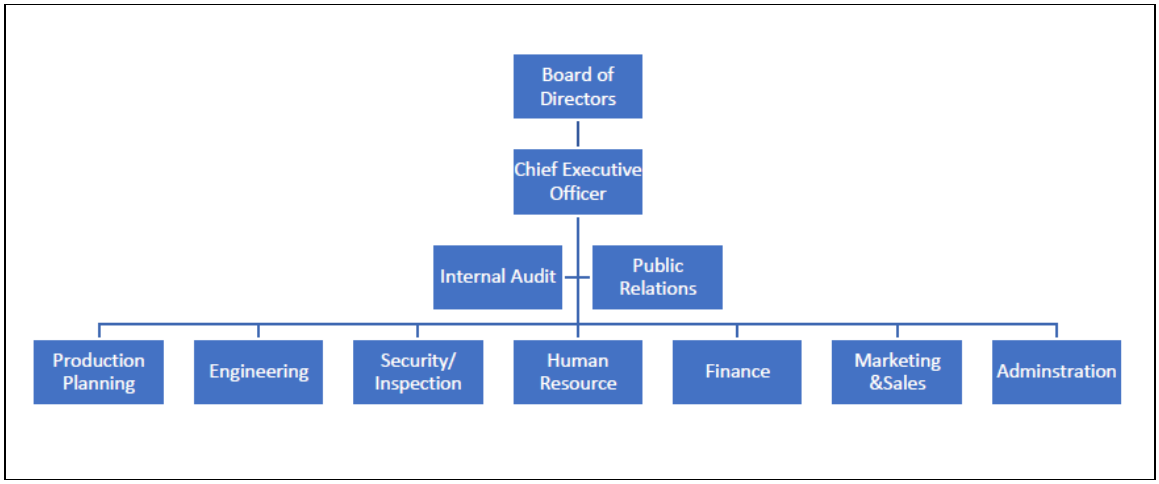
| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| | | Workers to be trained on the correct transfer, handling of fuels and chemicals;<br>Portable spill containment and clean-up equipment provided on site. | | | | |
| **Fauna** | Loss of fauna in project area | Contact Ghana Wildlife Division of the Forestry Commission to relocate any large reptiles found at project site. | Construction | EHS Department and Contractor | | |
| **Regulatory Requirements** | Inability to comply with regulatory requirements on time | Complying with relevant regulatory requirements on timely basis | Pre-construction, Construction, Operations and Decommission & Closure | SORL Management and Public Relations and Communication Committee | Checking of permits required for compliance of the laws and regulations | Availability of required permits |
| **Employment and Economy** | Improved local and national economy | Employing skilled labour from the country;<br>Training selected community residents to work in the oil refinery.<br>Implementing SORL's Corporate Social Responsibility Programme with the nearby community;<br>Paying taxes and royalties to the central and local government authorities;<br>Sourcing of local suppliers and sub-contractor. | Pre-construction, Construction, Operations and Decommissioning & Closure | Public Relations and Communication Committee and , Human Resource Department EHS Liaison Committee, and Contractor | Regular review of employee data.<br>Monitoring of employment process to ensure that it is in line with SORL's CSR programmes. | Compliance with Ghanaian labour laws and implementation of Corporate Social Responsibility. |
| **Relevant Stakeholders** | Inadequate information flow or communication on the project | Communication and awareness creation on project progress based on SORLs Communication Plan;<br>Holding regular scheduled meetings with stakeholders | Pre-construction, Construction, Operations and Decommission & Closure. | Public Relations and Communication Committee and HR Department | Assessment of stakeholder meeting and revision of Communication Plan | Amicable relationship with stakeholders |

| Environmental and Socio-economic Component | Impact Issue | Action | Project Phase | Responsible Entity | Monitoring Mechanisms | Performance Standards |
|---|---|---|---|---|---|---|
| **Public Health and Safety** | Incidents / accidents leading to injuries, ill health and death | Conducting traffic flows analysis and preparing a management plan to ensure that transport of equipment is carried out during low peak periods;<br>Observing all COVID-19 pandemic protocols;<br>Instituting adequate traffic management measures to caution the public and to create safety awareness;<br>Engaging flagmen to man all major intersections to assist with passage of trucks conveying materials and equipment to and from the project site;<br>Workers and security personnel to be provided toilet facilities during the construction period;<br>Use of indicator linings / reflective warning notices or wire mesh to prevent falls into uncovered trenches or deep excavations;<br>Drivers to be engaged possess the requisite qualifications;<br>Project site enclosed to strictly control admission of job seekers.<br>Carrying out communication on project activities, awareness creation on sexually transmitted infections, HIV/AIDs, malaria for employees, contractors and local community;<br>Actions to minimise the adverse impact of noise and vibrations (from explosions) affecting the ear membranes as covered under occupational health and safety and waste management also applicable. | Construction, Operations and Decommission & Closure | Contractor, EHS Department, EHS Liaison Committee and HR Department | Daily checks on the works of the Flagmen, indicator linings / reflective warning notices or wire mesh at the project site;<br>Audit of aware creation and communication activities with stakeholders and public. | Reports on the conduct of communication and awareness creation |

## 9.3 Environmental Management Resources and Organisation

As earlier stated, each and every decision made by SORL's management shall be focused on designing and implementing an environmentally sound and socially responsible project. In order to ensure that specific environmental and social issues, risks and other adverse impacts are adequately addressed, SORL will provide the requisite resources and organisations / structures (units, committees etc.) to implement, maintain and improve the PEMP. Similarly, the key contractors will be required to demonstrate to SORL's satisfaction that they have appropriate resources and organisational structure to meet the environmental socio-economic protection commitments of the project.

Thus, SORL will provide adequate financial allocations for implementing the provisional environmental management plan of the project. Responsibilities and accountabilities for the implementing the provisional environmental management plan will be assigned to personnel, department and committees. The oil refinery project will be organised on functional lines (SORL, 2020) as shown in the proposed organizational chart (Figure 9-1.1). The operational departments of SORL comprise the Production Planning, Engineering, Security & Inspection, Human Resource, Finance, Marketing and Sales and Administration.




**Source: SORL, 2020b**

**Figure 9-1.1 Organisational Chart of SORL**

### *9.3.1 Environment, Health and Safety Management Structure*

The company will set up an Environmental Health and Safety (EHS) Department under an appropriate Department determined by the CEO for the purpose of implementation of the PEMP. The personnel to be included in the EHS Department are the Health, Safety and Environment Officer, who will be the Head and report to the CEO. Under him/her will be two (2) assistants i) Environment Officer (General environment, water quality, waste management, etc.) and ii) Health and Safety Officer

The Head of the EHS Department shall have the overall responsibility for the formulation, implementation, monitoring and evaluation of Environmental Health and Safety issues of the project. The functions of the Head of the EHS will include:

- Leading the implementation of the environment, health and safety policies of the project, including technical and non-technical operations;
- Liaising with the Chief Executive Officer to ensure all required PPEs and other EHS logistics are provided for the project;
- Liaising with regulatory institutions such as EPA, NPA, TMA and KKMA;
- Prompting all departments to ensure adherence to implementation of EHS procedures;
- Keeping records and reporting all incidents and accidents and illness;
- Organising and coordinating EHS training and awareness programme for all workers.

### *9.3.2 Environment, Health and Safety Liaison Committee*

In addition to the EHS Department, SORL shall establish the Environment, Health and Safety Liaison Committee in collaboration with the Contractor - Luoyang Ruize Petrochemical Engineering Co. of Henan, China. The Head of EHS Department and representatives from the departments shown in Figure 9-1.1 will be members of this Committee with the Head of the EHS as Chairman. The Committee will ensure that SORL's actions conform to the Environment, Health and Safety policies. The functions of the Committee shall include:

- Updating SORL's Environment, Health and Safety Policies;
- Drawing up programmes and procedures for the EHS management of the project during the pre-construction, construction and operations phases of the project;
- Holding monthly meetings to discuss and deliberate on environment, health, safety as well as security issues;
- Carrying out construction inspections and audits monthly and review the performance of the contractor and subcontractors during the construction works;
- Implementing the environmental permit conditions and mitigation, monitoring and management measures in the EIS;
- Carrying out disciplinary actions against workers who do not comply with the environment, health and safety protection procedures.
- Preparing and providing appropriate EHS awareness creation programmes for the workers;
- Reviewing the objectives and targets for EHS performance and improvement;
- Assigning responsibility and authority for implementation activities;
- Lobbying management to provide adequate resources needed to implement the policies;
- Equipping personnel through training to acquire the required knowledge and skills to effectively apply the EHS systems and standards;

### *9.3.3 Public Relations and Communication Committee*

In all the project phases, it is imperative that SORL maintains cordial relationships with the Tema Mantse who is responsible for the Tema New Town community. Also it is important to keep in touch with all relevant local and administrative stakeholders and disseminate information about the project to forestall any stakeholder agitation. SORL will therefore put in place a Public Relations and Communication Committee to ensure thorough communication with the public. Furthermore this Committee will:

- Prepare and implement appropriate EHS communication plan for updating stakeholders, businesses close to the project area, Tema New Town community residents and other relevant public entities on the progress of the project;
- Partner with communities and governments throughout the life of the project to ensure mutually beneficial outcomes that contribute to environmental sustainability;
- Create and maintain cross-functional collaboration and ownership across the entire organisation to achieve the company's sustainability and external relations goals;
- Connect internal and external stakeholders with the company through proactive, transparent and engaging vital communications from time to time.

### *9.3.4 Framework for Emergency Response Plan*

SORL is committed to the safety of its employees, installations and the public. All applicable safety standards, procedures and best practices will be followed during process selection, design, construction and operation of the various facilities. However, even with the best safe working practices, emergency incidents may occur. Therefore, as part of the overall Provisional Environmental Management Plan, SORL shall develop an Emergency Response Plan (ERP) as a comprehensive document for management of incidents / accidents that may occur in the proposed oil refinery area. The ERP will establish critical aspects of incident /accident management including notification, incident management, organisation and responsibilities. The Emergency Response Plan is aimed at addressing potential accidental / incidental occurrences during all phases of the project. The goal of the ERP is to minimise hazards to workers, residents of Tema New Town (the only nearby community), the public and the general environment.

The specific objectives of the emergency response plan are to:

- Identify all stakeholders and their roles;
- Identify the key persons to be involved and clearly define their roles and the procedures that must be followed during an emergency;
- Identify all the likely emergency scenarios associated with the construction and operations phases and provide effective response procedures for each identified emergency scenario;
- Save human life and minimize damage to equipment, property and the general environment;
- Identify training needs of personnel and resources required to ensure emergency preparedness at the site;
- Establish notification procedures and communication arrangements;
- Establish evacuation procedures;
- Provide clean-up and remediation arrangements;
- Put in place emergency response plan review arrangements;
- Develop budget for the implementation of the ERP.

The ERP will be disclosed to all potentially impacted industries and people in the Tema Heavy Industrial Area and the neighbouring local community (Tema New Town). All authorised hard copies of the ERP document must have the signatures of the review and approval authorities. Authorised electronic copies of the document will have the approval date and the date printed as a footer on every page. SORL will request all contractors and sub-contractors on the proposed

project to prepare and submit for approval a contingency plan for emergency situations and possible incidents.

Management will report, as appropriate, emergencies / accidents / incidents to relevant stakeholders / regulatory bodies such as the TMA, KKMA, EPA, the National Petroleum Authority, Ghana National Fire Service (GNFS), NADMO and Ghana Police Service. The EHS Unit would be required to ensure that procedures are revised to reflect changes in personnel, facilities or desired action. It is expected that details of particular actions required in the various emergency plans would be reproduced in easy-to-read type and posted at areas where they are required. SORL will provide controls and recovery measures to effectively manage emergency situations / risks at the project site. The Emergency Response Procedures will be activated to ensure no loss of life, protection of the environment, availability of manpower, equipment and funds for the emergency, maintenance of good record keeping and dissemination of accurate information concerning emergencies to the workers, public and government.

### *9.3.5 Corporate Social Responsibility*

SORL will design and commit to a Corporate Social Responsibility (CSR) programme which cascades the project life.

SORL shall be committed to:

- Respecting the Universal Declaration of Human Rights in business operations;
- Respecting social, economic and cultural rights of local people;
- Adopting policies, standards, and operating practices that ensure ongoing improvement in environmental, health and safety issues;
- Sharing success by partnering with stakeholders in appropriate community development programmes;
- Consulting with stakeholders in matters that affect them;
- Striving to communicate performance in an accurate, transparent and timely manner;
- Implementing its Social Responsibility Policy in conjunction with Environment, Health, and Safety Policies since these issues can affect the communities in which they operate.

As part of the company's CSR, SORL will work with TMA and KKMA to prioritize and invest in areas of community development in support of the Medium-Term Development Plans of the two assemblies. SORL's investment in these areas and Tema New Town will act as a boost to the capacity of TMA and KKMA to deliver on their respective development mandates.

## 9.4 Provisional Environmental Monitoring Plan / Programme

The environmental monitoring plan is designed as a strategy for collecting the necessary data on implementation of mitigation measures to assess their effectiveness in managing the identified potential impacts of the refinery activities. Also the appropriate monitoring plan/programme will be used to verify whether predictions of environmental and socio-economic impacts in the EIS were accurate and that unforeseen impacts are detected early enough to allow corrective measures to be taken before significant damage occurs. Relevant records will be kept to ensure compliance

with mitigation measures recommended in the EIS. The records will also be used to prepare various post-EIS reports as required by EPA.

The objectives of the environmental monitoring plan/programme are to:

- Evaluate the effect on key baseline indicators due to project implementation;
- Evaluate the performance of mitigation measures proposed;
- Suggest improvements in the management plans, if required;
- Satisfy or comply with statutory / permit conditions and community obligations.

### *9.4.1 Pre-Construction Phase Monitoring*

In the pre-construction phase, there will be no significant negative impacts associated with the biological environment. Regulatory requirements will be the most affected socio-economic component while land access and inspection are the activities that would generate significant negative impacts affecting drainage and erosion in particular. Mitigation measures are proposed below.

#### *i Physical Environment*

***Soil Erosion and Drainage***

The EHS Liaison Committee and the EHS Department will monitor the activities of the Contractor to ensure that only limited land clearing takes place to minimise exposure of soils to erosion and the drains that go through the project site are not be blocked or otherwise disturbed to avoid flooding situations.

#### *ii. Socio-economic Components*

***Occupational and Public Health and Safety***

The Environment, Health and Safety (EHS) Officer of SORL, in collaboration with the EHS Liaison Committee and the responsible contractor, will monitor the implementation of SORL's Emergency Response Plan and provide updates in his quarterly reports. The EHS Officer and the contractor will document incidents involving risks and threats to health and safety of workers. The Public Relations and Communication Committee as a way of monitoring possible social conflict prepare quarterly reports on the status information dissemination on the scope and schedule of the proposed oil refinery project to the various interested stakeholders. Other areas to be monitored include operational safety procedures and use of PPEs. Accidents will be recorded in an incident report book and included in the quarterly report of the EHS Officer.

***Compliance with Regulations and Acquisition of Permits***

The head of Public Relations and Communication Committee in collaboration with the CEO of SORL will provide updates on compliance with relevant regulations and applications for various permits and their approval by the relevant authorities through quarterly reports.

### *9.4.2 Construction Phase Monitoring*

In the construction phase, mitigation measures have been proposed for adverse impacts associated with the physical and biological environments and the socio-economic components. The key adverse potential impacts for which mitigation measures have been proposed relate to air quality, drainage, soils and erosion, occupational and public health and safety and regulatory requirements. These measures form the basis of monitoring activities presented below. Baseline studies on water and air quality and noise levels conducted prior to the commencement of project activities will guide compliance with environmental quality parameters to be monitored.

#### *i Physical Environment*

***Air Quality***
The EHS Officers will monitor dust particulate as an indicator of ambient air quality at some selected areas of the refinery. The EHS Officer will monitor the ambient air quality using the same parameters and stations as used for the baseline study. This will be conducted on a quarterly basis.

***Soil Erosion and Drainage***
The EHS Officers will monitor land clearing, construction works and soil erosion at the project site to ensure that works are carried out in a manner to preserve the general topography, drainage and soils of the project site.

#### *iii Socio-economic Components Monitoring*

***Regulatory Requirements***
The EHS officer of SORL will monitor the activities of the contractor to ensure that their construction activities are carried within the realm of the relevant laws and regulations and standards such as Environmental Assessment Regulations, 1999 (L.I. 1652), EPA Environmental Standards on air quality, noise level and effluent discharge into natural water bodies, Labour Regulations, 2007 (L.I. 1833) and Local Content and Local Participation with regards to employment and general procurement consideration for the Petroleum Subsector.

***Occupational Health and Safety***
The Environmental Health and Safety (EHS) Officer of SORL, in collaboration with the responsible contractor, will monitor the implementation of SORL's Emergency Response Plan and provide updates in his quarterly reports. The EHS Officer and the contractor will document incidents involving risks and threats to health and safety of workers and assess the effectiveness of traffic management procedures. Areas to be monitored include operational safety procedures, use of protective clothing and documentation of incidents. Accidents will be recorded in an incident report book and included in the quarterly report of the EHS Officer.

SORL will organize and support periodic monitoring of the health of all categories of workers. The health monitoring will be conducted on annual basis. The environmental, health and safety information and data collected during the monitoring exercise will be submitted to EPA in monthly and Annual Environmental Reports.

***Noise and Vibration***
SORL will conduct noise and vibration monitoring as part of its responsibilities under the provisional environmental management plan to determine compliance with EPA's noise standards. The EHS Officer will monitor noise and vibration levels using the same parameters and stations as used for the baseline study. This will be conducted on a quarterly basis.

***Soil Erosion and Drainage(Flooding)***
The EHS Officers will continue, as in pre-construction phase, to monitor land clearing, construction works and soil erosion at the project site to ensure that works are carried out in a manner to preserve the general topography, drainage and soils of the project site.

***Surface Water Quality***
The EHS Officer will monitor the quality of surface water using the same parameters and stations as used for the baseline study. This will be conducted twice a year in the dry and wet seasons.

***Waste Disposal / Management Monitoring***
The responsible contractor will monitor the generation of all waste types weekly to ensure proper collection and storage prior to collection and disposal by an accredited waste management firm to be contracted by SORL. In collaboration with the contractor, the EHS Officer will record and document all wastes generated in the course of work in a Monthly Waste Report, which shall be used to track / monitor wastes generated from the refinery site.

***ii Biological Environment***

***Flora Monitoring***
The EHS Officer of SORL will monitor the vegetation clearance during the construction to ensure that works carried out within defined perimeters and only when necessary. Also, the monitoring will cover the vegetation clearing works to ensure that vegetation clearing is kept to the minimum necessary. The EHS Officer shall record his observations weekly during the period of vegetation clearance and present quarterly reports.

***iii Socio-economic Components Monitoring***

***Regulatory Requirements***
The EHS Officer of SORL will monitor the activities of the contractors to ensure that their construction activities are carried out within the realm of the relevant laws and regulations and standards such as Environmental Assessment Regulations, 1999 (L.I. 1652), EPA Environmental Standards on air quality, noise level and effluent discharge into natural water bodies, Labour Regulations, 2007 (L.I. 1833) and Local Content and Local Participation with regards to employment and general procurement consideration for the Petroleum Sub-sector.

***Occupational Health and Safety***
The Environmental Health and Safety (EHS) Officer of SORL, in collaboration with the responsible contractor and the EHS Liaison Committee will monitor the implementation of SORL's Emergency Response Plan and provide updates in his quarterly reports. The EHS Officer and the contractor will document incidents involving risks and threats to health and safety of

workers and assess the effectiveness of traffic management procedures. Areas to be monitored include operational safety procedures, use of PPEs and documentation of incidents. Accidents will be recorded in an incident report book and included in the quarterly report of the EHS Officer.

SORL will organize and support periodic monitoring of the health of all categories of workers. The health monitoring will be conducted on annual basis. The environmental, health and safety information and data collected during the monitoring exercise will be submitted to EPA in monthly and Annual Environmental Reports.

***Local Traffic***
The Environmental Health and Safety (EHS) Officer will monitor the movement of the vehicular traffic and update SORL management to take the precautionary measures to avoid the risk of truck breakdowns, accidents, increased noise levels, dust and gas inhalations

***Land Use***
Construction activities will be monitored by the EHS Officer and the contractor will be cautioned to avoid increased traffic on the VALCO and nearby heavy industrial roads Also the waste management activities of the contractor will be monitored to avoid improper disposal of wastes.

***Public Health and Safety***
The EHS Officer will carry out monthly monitoring of traffic impacts and management measures. The monitoring will also cover the use of PPEs, the number of traffic incidents and accidents involving project vehicles /vessels, number of drivers undertaking training, and vehicle/vessel maintenance logs.

### *9.4.3 Operations Phase Monitoring*

In the operations phase, mitigation measures have been proposed to control or reduce the negative impacts will be associated with the transportation, handling and storage of raw materials and finished products as well as with wastewater discharges, solid waste disposal and gaseous emissions. These will affect air and surface water quality, occupational and public health and safety and regulatory requirements, among others.

#### *i Physical Environment*

***Air Quality***
During the operations phase, ambient air quality monitoring will be the same as recommended for the construction phase. In addition, SORL will monitor the frequency of equipment maintenance and check the compliance of all contractors with the manufacturer's operation and maintenance procedures of all equipment in use at the refinery project.

***Noise and Vibration***
As specified under the construction phase, SORL will conduct noise and vibration monitoring as part of its responsibilities under the provisional environmental management plan to determine compliance with EPA's noise and vibration standards. The EHS Officer will monitor noise and

vibration levels using the same parameters and stations as used for the baseline study. This will be conducted on a quarterly basis.

***Soils Erosion and Drainage***
SORL will monitor the project site for possible impacts regarding soil contamination with leaked oil, compaction, erosion and flooding. The drainage system will be monitored for any blockage and flooding.

***Surface Water Quality***
The quality of the effluent to be discharged after treatment will be monitored to ensure that the effluent discharged into the project drainage system or Chemu comply with EPA standards on water quality

During the phase the EHS Officer will continue to monitor the quality of surface water using the relevant parameters and defined stations. This will be conducted twice a year in the dry and wet seasons.

***Solid Waste Disposal / Management***
The EHS Officer will monitor the generation of all waste types weekly to ensure proper collection and storage prior to collection and disposal by an accredited waste management firm to be contracted by SORL. The EHS Officer will record and document all wastes generated in the course of work in a Monthly Waste Report, which shall be used to track / monitor wastes generated from the resort operations

***ii Biological Environment***

***Flora Monitoring***
SORL will monitor annually its efforts geared towards augmenting and maintaining the degrading vegetation existing in the project area.

***iii Socio-economic Components***

***Regulatory Requirements***
The EHS officer of SORL will monitor the activities during the phase, to ensure that all the operational activities are carried within the realms of the relevant laws and regulations and standards such as Environmental Assessment Regulations, 1999 (L.I. 1652), EPA Environmental Standards on air quality, noise level and effluent discharge into natural water bodies, Labour Regulations, 2007 (L.I. 1833) and Local Content and Local Participation with regards to employment and general procurement consideration for the Petroleum Sub-sector.

***Occupational and Public Health and Safety***
Monitoring activities will be the same as recommended for the construction phase except for incidents of fire, risk of asphyxiation and hazardous chemicals. The monitoring of fire hazards and explosion will involve carrying out routine weekly inspections of all the electrical installations for early detection of faulty cables or connections. It will also involve monitoring sources of possible

gas leakages to ensure no malfunction or occurrence of asphyxiation conditions. In addition, regular inspections of fire detection and fire-fighting facilities will be undertaken.

SORL will also record monthly, the number of health and safety accidents/incidents and conduct a daily check on employees' use of personnel protective equipment. On annual basis, SORL will undertake health examination of all workers and conduct health and safety audits.

For the benefit of general public, SORL will monitor the enforcement of mandatory speed limits of 50 km/hr in built-up areas and 10-30 km/hr at the project site as a way to minimize the incidence of road accidents.

### *9.4.4 Decommissioning and Closure Phase*

#### *i Physical Environment*

***Air Quality***

During the decommissioning and closure phase, ambient air quality monitoring will be the same as recommended for the construction phase. In addition, SORL will monitor the frequency of vehicles and equipment maintenance and check the compliance of all contractors with the manufacturer's operation and maintenance procedures of all equipment in use during the phase.

***Noise and Vibration***

As specified under the construction phase, SORL will continue to conduct noise monitoring in the phase to determine compliance with EPA's noise standards. The EHS Officer will monitor noise and vibration levels using the same parameters and stations as used for the baseline study. This will be conducted on a quarterly basis.

***Surface Water Quality***

The quality of the effluent to be discharge after treatment will continue to be monitored to ensure that the effluent discharged into the project drainage system or the Chemu Lagoon comply with EPA standards on water quality.

Also during the phase, the EHS Officer will continue to monitor the quality of surface water and groundwater as in the operations phase, using the same parameters and stations as used for the baseline study.

***Waste Disposal / Management***

The EHS Officer will monitor the generation of all waste types weekly to ensure proper collection and storage prior to collection and disposal by an accredited waste management firm to be contracted by SORL. The EHS Officer will record and document all wastes generated in the course of work in a Monthly Waste Report, which shall be used to track / monitor wastes generated from the resort operations.

The disposal of dismantled equipment and plant, civil infrastructure, engineering workshop, and refinery area utilities and facilities will be monitored for compliance with the requirements of EPA

### *iii Biological Environment*

***Flora Monitoring***
SORL will continue to monitor quarterly its efforts geared towards augmenting and maintaining the degrading vegetation existing in the project area.

### *iii Socio-economic Components*

***Occupational and Public Health and Safety***
Monitoring activities will be the same as recommended for the construction phase. The monitoring of fire hazards and explosion will involve carrying out routine weekly inspections of all the electrical installations for early detection of faulty cables or connections during the decommissioning and closure phase.

SORL will also record monthly, the number of health and safety accidents/incidents and conduct a daily check on employees' use of personnel protective equipment. TEDC will undertake health examination of all workers.

For the benefit of general public, SORL will monitor the enforcement of mandatory speed limits of 50 km/hr in built-up areas and 10-30 km/hr at the project site as a way to minimize the incidence of road accidents.

***Regulatory Requirements***
The EHS officer of SORL will continue to monitor the activities during the phase, to ensure that all the decommissioning and closure activities are carried within the realms of the relevant laws and regulations and standards such as Environmental Assessment Regulations, 1999 (L.I. 1652), EPA Environmental Standards on air quality, noise level and effluent discharge into natural water bodies, Labour Regulations, 2007 (L.I. 1833) and Local Content and Local Participation with regards to employment and general procurement consideration for the Petroleum Sub-sector.

## 9.5 Matrix of Proposed Monitoring Plan –
Table 9-5.1 below is the matrix of a proposed monitoring plan for the various project phases and environmental and socio-economic components.

**Table 9-5.1 Monitoring Plan for Project Phases and Environmental Categories**

| Parameter | Parameters to be Monitored | Monitoring Sites | Monitoring Frequency | Responsibility | Estimated Cost /Annum (GH₵) |
|---|---|---|---|---|---|
| ***Pre-construction Phase*** | | | | | |
| *Physical Environment* | | | | | |
| Soil Erosion and Drainage | Activities of the Contractor in land clearing | Oil refinery site | | EHS Officer / Contractor | |
| *Socio-economic Component* | | | | | |

| Parameter | Parameters to be Monitored | Monitoring Sites | Monitoring Frequency | Responsibility | Estimated Cost /Annum (GH₵) |
|---|---|---|---|---|---|
| Occupational and Public Health and Safety | Implementation of SORL's Emergency Response Plan; Recording of accidents / incidents involving risks and threats to health and safety of workers; Status information dissemination on the scope and schedule of work; Use of PPEs. | Oil refinery site / Heavy Industrial Area / Tema New Town community | | EHS Officer / Contractor | |
| Compliance with Regulations and Acquisition of Permits | Status of compliance with relevant regulations and applications for various permits a | | Quarterly | EHS Officer / Contractor | |
| ***Construction Phase**** | | | | | |
| *Physical Environment* | | | | | |
| Air Quality | Dust particulate-TSP, $PM_{10}$ and $PM_{2.5}$ | Oil refinery site at established sampling points | Quarterly | EHS Officer / Contractor | |
| Noise and Vibration | Noise and vibration levels | Oil refinery site at established sampling points | Quarterly | EHS Officer / Contractor | |
| Soil Erosion and Drainage | Land clearing & construction activities of contractor and soil erosion | Project site | Quarterly / Annually | EHS Officer / Contractor | |
| Surface Water Quality | Surface water parameter indicators of quality | Oil refinery site at established sampling points | Quarterly (Wet and Dry Season) | EHS Officer | |
| Waste Disposal/Management | Metallic wastes quantities and types; Garbage volumes; Waste oil quantities; Hazardous waste type and quantities; Construction spoil volumes. | Around the oil refinery plant | Weekly | EHS Officer / Contractor | |
| *Biological Environment* | | | | | |

| Parameter | Parameters to be Monitored | Monitoring Sites | Monitoring Frequency | Responsibility | Estimated Cost /Annum (GH₵) |
|---|---|---|---|---|---|
| Flora | Vegetation clearing activities of the contractor | Land near the oil refinery plant | Weekly | EHS Officer | |
| *Socio-economic Component* | | | | | |
| Regulatory Requirements | Activities of SORL and the contractor for compliance with national regulations and standards | | Quarterly | EHS Officer / Contractor | |
| Local Traffic | Movement of the vehicular traffic to and from refinery area. | Oil refinery site / Heavy Industrial Area | | | |
| Land Use | Construction and waste management activities of the contractor | Oil refinery site | | | |
| Occupational Health and Safety: | Type and frequency of injuries /accidents/incidents /near misses;<br>Availability /Use of PPE's;<br>EHS Training programmes;<br>Scheduled monitoring and maintenance works;<br>Worker grievance mechanism records;<br>Worker training records. | Oil refinery site | Fire-Weekly<br>Accidents – Monthly<br>Health Exams-Annually<br>Traffic - Daily | EHS Officer / Contractor | |
| Public Health and Safety | Traffic impacts and management measures;<br>Availability / Use of PPEs;<br>Number of traffic incidents and accidents involving project vehicles;<br>Number of drivers undertaking training;<br>Vehicle maintenance logs. | Heavy Industrial Area/ Tema New Town community | Monthly | | |
| ***Operations Phase*** | | | | | |
| *Physical Environment* | | | | | |

| Parameter | Parameters to be Monitored | Monitoring Sites | Monitoring Frequency | Responsibility | Estimated Cost /Annum (GH₵) |
|---|---|---|---|---|---|
| Air Quality | Dust Particulate matter ($PM_{10}$, $PM_{2.5}$ and TSP);<br>VOCs, Noxious gases (NOx, COx, SOx);<br>Frequency of vehicles and equipment maintenance;<br>Compliance with manufacturer's equipment operation and maintenance procedures | Project site at established sampling points | Quarterly | EHS Officer / Contractor | |
| Noise and Vibration | Noise and vibration levels | Project site at established sampling points | Quarterly | EHS Officer / Contractor | |
| Soils, Erosion and Drainage (Flooding) | Soil contamination with leaked oil; Soil compaction, erosion and flooding;<br>Drainage system blockage | Oil refinery site | Quarterly | EHS Officer | |
| Surface Water Quality | Surface water parameter indicators of quality | Project site at established sampling points | Quarterly (Wet and Dry Season) | EHS Officer | |
| Waste Disposal/Management | Garbage volumes;<br>Waste oil quantities;<br>Hazardous waste type and quantities. | Around the oil refinery plant | Weekly / Monthly | EHS Officer / Contractor | |
| *Biological Environment* | | | | | |
| Flora | Progress of re-vegetation of degraded sites | Project site | Annually | EHS Officer | |
| *Socio-economic Components* | | | | | |
| Regulatory Requirements | Activities of SORL for compliance with national regulations and standards | | Quarterly | EHS Officer / Contractor | |
| Occupational and Public Health & Safety: | As in construction phase;<br>Incidents of fire; | Oil refinery site / Heavy Industrial Area / Tema | Daily / Weekly / Monthly / Annually | EHS Officer / Contractor | |

| Parameter | Parameters to be Monitored | Monitoring Sites | Monitoring Frequency | Responsibility | Estimated Cost /Annum (GH₵) |
|---|---|---|---|---|---|
| | Risk of asphyxiation and hazardous chemicals;<br>Fire hazards and explosion;<br>Electrical installations and their functioning;<br>Gas leakages;<br>Functioning of fire detection and fire-fighting facilities;<br>Number of health and safety accidents / incidents;<br>Availability and use of PPEs;<br>Speed limit of vehicles;<br>Workers heath condition | New Town community | | | |
| ***Decommissioning and Closure/Post-Closure Phase*** | | | | | |
| *Physical Environment* | | | | | |
| Air Quality | As in construction phase;<br>Frequency of vehicles and equipment maintenance;<br>Manufacturer's operation and maintenance procedures of all equipment; | Project site at established sampling points | Quarterly | EHS Officer / Contractor | |
| Noise and Vibration | Noise and vibration levels | Project site at established sampling points | Quarterly | EHS Officer / Contractor | |
| Surface Water Quality | Surface water parameter indicators of quality | Project site at established sampling points | Quarterly (Wet and Dry Seasons) | EHS Officer | |
| Waste Disposal/Management | Garbage volumes;<br>Waste oil quantities; | Around the oil refinery plant | | EHS Officer / Contractor | |
| *Biological Environment* | | | | | |

| **Parameter** | **Parameters to be Monitored** | **Monitoring Sites** | **Monitoring Frequency** | **Responsibility** | **Estimated Cost /Annum (GH₵)** |
|---|---|---|---|---|---|
| Flora | Progress of re-vegetation of degraded sites | Project site | Quarterly | EHS Officer | |
| *Socio-economic Components* | | | | | |
| Regulatory Requirements | | | Quarterly | EHS Officer / Contractor | |
| Occupational & Public Health and Safety: | As in construction phase;<br>Fire hazards and explosion;<br>Number of health and safety accidents / incidents;<br>Availability and use of PPEs;<br>Speed limit of vehicles;<br>Workers heath condition | Oil refinery site / Heavy Industrial Area / Tema New Town community | Daily / Weekly / Monthly | EHS Officer / Contractor | |

# CHAPTER 10 DECOMMISSIONING AND CLOSURE PLAN

## 10.1 Introduction

Decommissioning is defined as the shutdown of a facility in order to prepare it for complete closure, clean-up and site reinstatement. At the cessation of SORL operation, the oil refinery will be decommissioned in accordance with statutory requirement in force at the time. SORL is required to develop a programme for the oil refinery decommissioning and closure This programme will cover measures to ensure a smooth and environmentally safe oil refinery closure. SORL will develop the programme at a time closer to decommissioning to ensure that all the relevant environmental issues are properly identified and appropriately considered. The implementation of the programme would ensure that the site is rehabilitated to EPA's requirement, thus allowing the site to either be handed back to TDC or be sold for another private sector use. The extent of dismantling, demolition and site clearance will depend upon the future use of the site. There are likely to be three stages to the decommissioning:

- *Pre-decommissioning* consents and contracts: covering the site and structures, plant and processes, municipal and site utilities, fire safety, access and transport, and demolition of buildings etc;
- *Decommissioning* activity obligations: environmental emissions (effluents discharges, air pollution, noise and dust generation, waste disposal, ground/groundwater contamination etc.) and associated health and safety issues;
- *Post decommissioning* responsibilities: These ensure that everything that needs to be known about the decommissioned site is passed on to the new site owners, operators and organisations

SORL will deliver the decommissioning process with a strong focus on safety and environmental responsibility. These elements will be enshrined in the decommissioning plan so as to reduce any risk of significant incident. For the decommissioning process to be effective and to make accurate budgetary projections, SORL will endeavour to have a clear understanding of its decommissioning liabilities and other obligations under applicable Ghanaian legislation.

### *10.1.1 Objectives*

The specific environmentally-related objectives of decommissioning and closure are to:

- Meet all pertinent Ghanaian legal and regulatory requirements and complete the site clean-up and reinstatement in accordance with EPA criteria and standards;
- Protect the public health and safety of local people and the surrounding environment;
- Ensure that all residual and social impacts are acceptable;
- Ensure that the need for long-term site maintenance is removed as much as possible;
- Ensure that post-reinstatement land use is in accordance with national (and other key stakeholder) requirements;
- Dismantle all the refinery structures;
- Dispose of safely hazardous materials, contaminated soils, steel structures and equipment;
- Decontaminate the contaminated soils;
- Restore all the distressed lands with vegetation, where possible.

### *10.1.2 Principles*

The principles of the decommissioning exercise are:

- Planning for decommissioning should begin as early as possible, in fact, ideally, it should be considered in the decision whether to allocate a concession or authorize an operation and should therefore be linked to permitting;
- Due to the long timeframe involved (one or more generations), the legislative requirements need to enable the flexibility to accommodate changes in context, technological developments or stakeholder priorities that may require adjustments in the final closure program.

## 10.2 Preliminary Decommissioning Plan

The description of restoration measures should include the size of the area to be restored as well as concurrent, temporary and final restoration measures to be used and their schedules. For each restoration measure SORL will include:

- Area to be addressed;
- Timing and schedule for executing measures;
- Equipment and structure removal or conversion;
- Remedial measures, including success indicators and contingency measures if initial efforts are unsuccessful;
- Plans for reuse of all or parts of the proposed project;
- Commitment to perform restoration, decommissioning and closure plan if the initial efforts for reuse are unsuccessful.

During the decommissioning and closure phase, SORL will dispose of erosion and sediment contaminating surface water in environmentally friendly manner. The sources of surface water contamination include:

- Spills and fuel leaks during the construction and operations phases of the project;
- Disposal of construction wastes, including potentially hazardous wastes;

During the operations phase, parts of the project area will experience soil contamination by storage and use of hazardous materials and spills and fuel leaks. For the decommissioning and closure of the operations of the refinery, SORL will take the following actions:

- Conduct soil sampling based on types of materials stored or handled;
- Prepare a detail rehabilitation plan to treat contaminated soils to the extent required for subsequent proposed use;
- Prepare a management plan for rehabilitation and decommissioning or proper disposal of hazardous materials such as oils, greases, solvents, caustics and acids, and other materials that may have been left behind;
- Prepare contingency plans for handling and disposal of contaminated materials if discovered during decommissioning;
- Remove and properly dispose of potentially hazardous materials such as asbestos and certain metals from structures prior to demolition.

During the decommissioning and closure phase, any contamination associated with operations of the refinery facilities, vehicle and equipment operations and maintenance will be remediated through the following actions:

- Post signs warning the public of potential dangers associated with the site;
- Develop a plan that shows how on-site facilities and equipment that are no longer needed will be removed and disposed of in a safe manner;
- Develop a plan for the rehabilitation of roads that will not be preserved for post-closure use with bridges, culverts and pipes being removed so that natural stream flow is restored, and the river banks are stabilized with vegetation or by using rip-rap.

SORL will develop a programme that shows how infrastructure will be dismantled and removed, except in cases where this infrastructure is to be preserved for post-closure land use or will be needed for post-closure monitoring, inspection and maintenance. For temporary structures (storage areas, construction employee housing including water, sewage, and power connections, water diversions, erosion control barriers, temporary access roadways), the decommissioning process, would include measures for returning the area to preconstruction features.

SORL will take the following actions:

- Return access roads and the project site to as near natural contours as feasible;
- Revegetate all disturbed areas with plant species appropriate to the site;
- Utilize interim measures for erosion control, dust mitigation, weed infestation, etc. while land is in transition;
- Restoration of terrain and vegetation shall involve the return of access roads and the project site to as near natural contours as feasible.

## CHAPTER 11 CONCLUSION

Sentuo Oil Refinery Limited (SORL) proposes to construct and operate an oil refinery at Tema in the Greater Accra Region of Ghana. The project will be located at the Heavy Industrial Area in Tema and SORL has secured Plot No. IND/HI/21/5 from the Tema Development Corporation (TDC). The proposed oil refinery will process 3 million metric tons of sour crude oil per year into 1.12 million metric tons of gasoline, 1.23 million metric tons of diesel and various amounts of LPG, benzene, aromatics, xylene, sulphuric acid, acrylic, polypropylene, bitumen and fuel oil.

The refinery project will be constructed in two phases, with 1.5 million metric tons crude oil processing capacity for each phase. The main components to be built in the first phase are:

- 1.5 million metric tons / year atmospheric distillation unit;
- 800,000 metric tons / year heavy oil catalytic unit;
- 600,000 metric tons / year diesel hydrogenation unit;
- 300,000 metric tons / year naphtha-methanol-to-gasoline combined unit;
- 400,000 metric tons / year catalytic gasoline selective hydrogenation unit; and
- 60,000 metric tons / year sulphur recovery unit.

Other components of the refinery project include:

- Solid waste, process-water and wastewater treatment facilities;
- Site drainage and stormwater management;
- Raw materials and product storage tank farms;
- Central laboratory;
- Workshop for repair and maintenance of plant equipment;
- Process and potable water reticulation systems;
- Clinic.

In line with Ghana's Environmental Assessment Regulations, 1999 (L.I. 1652), SORL has conducted an Environmental Impact Assessment to obtain an environmental permit to implement the project. Based on the details of project activities and concerns and issues raised during consultations with various stakeholders, in addition to the current environmental and socio-economic baseline information on the project location and its area of influence, potential impacts have been identified.

In general, the project will have positive impacts on the local, regional and national economies in the form of improvement in the supply of petroleum products. With a current national daily demand of 83,000 barrels of crude oil, and production of about 50,000 barrels, the modern refinery will contribute to filling this demand gap and also satisfying international markets. The project will also support employment and generation of income from taxes and levies and business opportunities to contractors and suppliers, among others. In the Greater Accra Region, it will support 350 direct jobs.

However, there are also potential negative impacts that need to be addressed. These include concerns raised during consultations with stakeholders such as the lack of detailed information on the project, possible flooding of the project area because it is part of a wetland, impacts on public

health in the industrial area and Tema New Town and increased congestion in the project area. Measures have been proposed to mitigate the potential negative impacts including the use of a Communication Plan to increase public awareness of the project and development of an Emergency Preparedness Plan to safeguard both occupational and public health. Other mitigation measures have also been included in the project design to control gaseous emissions, risk of fire and explosions as well as control flooding using up-to-date engineering designs backed by good environmental practices. For example, SORL, aware that the project area is part of a wetland that is susceptible to flooding during the rainy season, intends to design and put in place an adequate drainage system that can cater for the water that runs through the entire project area to avoid problems with flooding.

Overall, the proposed oil refinery project, represents for Ghana, a very important development opportunity because it is in line with the policies of the Government of Ghana, which aim to secure a reliable supply of high quality energy services for all sectors of the Ghanaian economy and also to become a major exporter of oil and power. Counting on SORL's appropriate implementation of the Provisional Environmental Management Plan, it can be concluded that the benefits of the project will far outweigh the identified potential adverse impacts.

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## APPENDICES

The Appendices listed below have been compiled in a separate document because of the size of the Main Report.

| | |
|---|---|
| Appendix 1-1.1 | Certificate of Incorporation |
| Appendix 1-1.2 | Certificate to Commence Business |
| Appendix 1-1.3 | Correspondence: Acquisition of Industrial Plot No. IND/HI/21/5 |
| Appendix 1-1.4 | Registration of Project: EPA Form EA 2 |
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| Appendix 6-1.1 | List of Stakeholders Consulted |
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