MANAGING RISK

شركة البترول الوطنية الكويتية
KNPC

KNPC Clean Fuels Project (CFP) 2020 FEED Update Phase

Environmental Impact Statement (EIS)

Report, Rev 2

Report for KNPC

prepared by DNV

Fluor Document No. P6000CFP-000-10R-106_A

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MANAGING RISK

KNPC Clean Fuels Project (CFP) 2020
Feed Update Phase
Environmental Impact Statement EIS (Rev 2)
for

KNPC

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Contents

NON- TECHNICAL SUMMARY

BACKGROUND

Kuwait contains an estimated 101.5 billion barrels (bbl) of proven oil reserves, roughly 8% of the world total, and around 1,600 producing oil wells. Currently, Kuwait produces about 2.6 million bbl/d of crude oil. Overall, around two thirds of Kuwaiti oil production comes from the southeast of the country, with about one-fifth from northern Kuwait and about one-tenth from the west.

Kuwait's three domestic refineries currently have a combined capacity of 936,000 bbl/d. The country's largest refinery is Mina Al Ahmadi (MAA), with a capacity of 466,000 bbl/d. The other refineries are Mina Al Abdullah (MAB) (270,500 bbl/d) and Shuaiba (SHU) (200,000 bbl/d). In the long term, total refining capacity is expected to be 1.4 million bbl/d.

Kuwait National Petroleum Company (KNPC), in its continuing commitment to meet changing (and more stringent) environmental requirements and to meet the increased need for clean fuels, is embarking upon an ambitious project, the Clean Fuels Project 2020 (hereafter referred to as CFP), to upgrade and modernize the three existing refineries. CFP will involve major upgrades at Mina Al Ahmadi refinery (MAA) and Mina Abdullah refinery (MAB), while the old processing facilities at Shuaiba refinery (SHU) will be retired.

The Front End Engineering Design (FEED) Phase of the project was completed in June 2008. During FEED, an Environmental Impact Statement (EIS) was submitted by KNPC to the Kuwait Environmental Public Authority (K-EPA).The project is currently under the FEED Update Phase which is intended to meet the new marketing requirements of the Project. Thus, the EIS submitted and presented to K-EPA in 2008 needs to be updated to reflect the new scope of the facilities as per Feed Update Phase requirements. This EIS is an update of the original EIS and covers an assessment of the FEED Update Phase scope of facilities.

THE ENVIRONMENTAL IMPACT STATEMENT

In accordance with the regulatory requirements promulgated by Kuwait's principal environmental regulatory authority, the Kuwait Environment Public Authority (K-EPA), and international 'best practice', Det Norske Veritas (DNV) conducted a full independent EIA process in 2008 for the proposed CFP, following an Initial EIA submitted by Fluor to K-EPA in August 2007. EIA is a process undertaken for certain types of major projects, which are judged likely to have potentially significant environmental effects, it assesses the environmental consequences of a proposed development in advance, with emphasis on the prevention of unacceptable impacts.

The output of the EIA process was an Environmental Impact Statement (EIS), which was prepared by DNV on behalf of Fluor, in accordance with the State of Kuwait Regulations Implemented under Law No. 21 of 1995 as Amended by Law No. 16 of 1996. The EIS also fulfilled KNPC's regulatory and internal procedural (EIA Study procedure SHE-ESHU-03-1407) requirements, as well as the statutory requirements *of K-EPA. This FEED Update Phase EIS has also been prepared in accordance with the above requirements and procedures.*

This updated EIS sets out DNV's 3rd-party assessment of the potential environmental effects during the construction, subsequent operation and final decommissioning of the CFP. It is supported by an Environmental Baseline Study (EBS) conducted by DNV in conjunction with two Kuwaiti technical providers, Kuwait Institute for Scientific Research (KISR) and Wataniya Environmental Services (WES) in 2007. The EBS provides an existing environmental 'baseline' of the CFP site and its surroundings allowing DNV to assess any potential impacts posed by the project. WES also provided some assistance with the development of part of this EIS. Public consultation was not within the scope of the CFP EIA.

PROJECT DESCRIPTION

CFP involves modifications at KNPC's three (3) existing refineries: MAA, MAB, and SHU. The MAA and MAB refineries will undergo major upgrades whilst the processing facilities at SHU will be retired. The outcome of this will be the integration of the KNPC Refining System into one merchant Refining Complex with Full Conversion operation with highest Light Ends Products Yields and minimum Fuel Oil production.

The CFP, which is currently under the Front-End Engineering and Design (FEED) Update stage managed by Fluor, will result in a reduction in the overall refining capacity of the three refineries from the current operating levels of 936,000 bbl/d to 800,000 bbl/d. The changes are expected to reduce impact on the environment from the refinery activities. The project will integrate the new and existing process units along with storage, infrastructure, oil movement and shipping. A variety of new Utilities and Offsite (U&O) facilities will be provided.

Environmental Measures Incorporated in CFP

KNPC's objective is that the CFP 2020 will incorporate best environmental practices such as Best Available Control Technologies (BACT) and environmental mitigation measures deemed necessary, so as to meet or exceed all relevant K-EPA emissions criteria. The CFP has been designed to mitigate all environmental impacts, and numerous environmental measures / BACT have been incorporated. BACT is incorporated into the following areas:

- *Noise control and abatement*
- *Air emissions abatement*
- *Solid waste management*
- *Management of hazardous chemicals*
- *Wastewater treatment and disposal*
- *Environmental monitoring*

Assessment of Alternative Sites

It is a requirement of the EIA process to consider alternative site locations when assessing a proposed development. CFP will, however, be based at the existing KNPC refineries and not in a grassroots location and thus evaluating alternative site "locations" is not possible. Thus this EIS examined alternatives to the project itself.

Constructing and operating the new petroleum refining and support facilities within the available space at the existing MAA and MAB refineries was considered the most suitable alternative. This is because it is economically viable, will improve regional air quality by providing low sulphur fuels, and will upgrade current refining capabilities, thus enhancing KNPC's competitive standing within the industry

CFP will not only provide Kuwait and export customers with cleaner burning fuels but will also enhance the safety and environmental performance of the MAA and MAB refineries through modernization and incorporation of current best environmental practice, while the older SHU refinery processing units will be decommissioned.

ENVIRONMENTAL BASELINE STUDY

In support of the EIA process, DNV conducted an Environmental Baseline Study (EBS). The EBS was completed to provide a baseline of the existing environment in order to properly assess any potential impacts posed by this project. The EBS field work was undertaken by two specialist local consultants, WES and KISR.

DNV, WES and KISR conducted the following specialized studies as part of the background studies:

- *Soil characteristics*
- *Ambient air quality*
- *Noise*
- *Land use*
- *Demography and socioeconomic aspects*
- *Geology and seismology*
- *Surface Water, groundwater and water use*
- *Terrestrial and aquatic ecology*
- *Meteorology*

The majority of the EBS work was carried out between March 2007 and August 2007. The main environmental issue identified was that existing air quality in the study area often exceeds criteria.

NOISE

The main purpose of the Noise study was to evaluate the potential community noise impact due to the noise emissions from CFP.

This noise assessment considered noise impacts based on available information at this early stage in the design process, and drew the following findings:

- *There are no exceedences of relevant K-EPA standard predicted at any receptor during daytime due to CFP for both construction and operation.*
- *For the construction phase, night time noise levels will not be affected, since construction activities are not performed during the night hours except under very exceptional situations.*
- *For the operations phase, night time noise levels are expected to exceed the relevant K-EPA standards at several locations.*

Based on the above, the following recommendations are made:

- *Construction activities generating significant noise levels should not be carried out during the night time except under very exceptional situations. This is particularly relevant near the beach chalets to the south east of MAB refinery.*
- *In order to fully comply with K-EPA community noise standards, additional noise attenuation using acoustic enclosures should be considered for significant noise emitting sources located close to the fence lines, particularly for CFP works near the eastern part of the CFP at MAB refinery. Details are provided within the body of the report.*
- *Noise monitoring will be necessary during both construction and operation to ensure no significant impact upon receptors.*

AIR QUALITY

Air modelling was conducted to evaluate the impact of the CFP upon the existing poor air quality in the study area. The air modelling results indicate that the air quality impacts associated with the CFP are acceptable for the following reasons:

- *The CFP will decommission the majority of air emission point sources from the SHU refinery (as well as some units at MAA and MAB refineries), most of which have large atmospheric pollutant emission rates. This will help reduce the total pollutants emitted to atmosphere, hence improving the air quality in the area.*
- *After the completion of CFP, the vast majority of long and short term NO_2, SO_2 and TSP concentrations should improve. This is mainly due to the fact that pollutant emissions from sources that are to be decommissioned far exceed the emissions associated with new CFP sources.*
- *Although, air quality in the study area improves as a result of the CFP, air quality criteria are still breached in some areas for some parameters.*
- *Fugitive emissions on site from the tank farms areas satisfy relevant criteria.*
- *CFP emissions during Sulphur Recovery Unit (SRU) emergency upset conditions satisfy relevant criteria.*
- *Based on the design data available, the air modelling results for the emergency scenarios associated with new CFP Flares indicated that all scenarios satisfy the occupational exposure standard for SO_2, apart from the new acid gas flare at MAB (Unit 146).*

  In the absence of any guidelines or criteria from the Kuwaiti regulator for this type of emergency event beyond the refinery fence-lines, the CFP compared maximum ground level concentrations against more stringent US air quality criteria. Maximum ground level sulphur dioxide concentrations beyond the refinery fence-lines generally meet this more stringent criteria (US AEGL-2) apart from emergency scenarios for the flares associated with Units 162, 167, 146, 149 (High Pressure) and Total Power Failure (TPF). The acid gas flare at MAB (Unit 146) will also exceed the US ERPG-2 criterion for sulphur dioxide.

Sensitivity analysis was thus conducted by increasing the flare stack heights for these Units. The revised results indicate that all relevant criteria are met for all cases except the new acid gas flares at MAA and MAB (Units 167 & 146), as well as the TPF Case, which still exceed the AEGL-2 criterion.

Additional, preliminary sensitivity analysis on the aforementioned flare units indicates that with the emission rate of sulphur dioxide halved, the resulting peak ground level concentrations will reduce proportionally. This would result in MAA Unit 167 and the TPF Case meeting the AEGL-2 criterion. MAB Unit 146 would still not meet the AEGL-2 criterion (in order to meet AEGL-2 criterion, the emission rate of sulphur dioxide should be reduced to around 35-40% of its current value).

Consequently, it is recommended that KNPC implement design changes during the EPC phase to reduce the relief loads for the flare systems which have the highest potential impact on the receptors located outside the refinery boundaries.

SOLID WASTE

CFP will produce a variety of solid wastes (hazardous and non-hazardous) during both construction and operational activities. In order to manage waste properly and comply with local and globally recognized waste management practices, a Waste Management Plan (WMP) will be developed by each EPC Contractor in accordance with KNPC policies / procedures as well as K-EPA requirements. Specifically, the WMP will comply with the existing KNPC Procedure for Solid Waste Management (SHE-ESHU-03-1406).

As part of the WMP, a number of mitigating measures will be implemented. These will have the effect of reducing both the amount of waste generated, and the associated impacts on the environment. The greatest potential impact to the environment relates to the storage of hazardous wastes. The impact of the generation, storage, transportation and disposal of non-hazardous and hazardous solid waste during the operation of the CFP facilities is considered to be of small to moderate negative significance. During construction it is considered to be of small negative significance. This is due to the quantities and the nature of the material, the implementation of an Environmental Management System (EMS) and WMP, and the full implementation of all control measures by the EPC contractors as recommended in this report.

HAZARDOUS MATERIALS

The new and modified CFP facilities will handle and / or store a variety of potentially hazardous materials, including finished products, raw materials and catalysts. Hazardous materials being used within the various systems that comprise the CFP will include: water treatment chemicals such as hydrochloric acid, sulphuric acid, caustic, chlorine, catalysts, and water conditioning chemicals such as corrosion inhibitors and oxygen scavengers.

During construction, all hazardous material will be stored and managed in a central location located within each EPC Contractor controlled area. Materials within these *areas will be stored according to compatibility and all flammable materials will be segregated and stored in a flame protected area. All hazardous materials will be contained within temporary or permanent bunding in order to prevent a release to soil and / or groundwater.*

Hazardous materials storage during operation of CFP facilities will either be in fixed tanks (at various bunded locations on the site), in a compressed gas cylinder storage area, or in the new MAB Chemical Storage Warehouse / Catalyst Storage Area. Material Safety Data Sheets (MSDS's) will be made available at the guardhouse, administration building and control room buildings for the refineries. In addition, MSDS's will be accessible at the new chemical storage warehouse building and catalyst storage facility at the MAB refinery for the materials stored in those buildings.

The impact from the storage, use, transportation and disposal of hazardous materials is considered to be of "small negative" significance during construction and of "moderate negative" significance during operation provided that all recommended management measures are followed. It is important that the management systems will, as proposed, comply with K-EPA requirements for the handling, storage and disposal of hazardous materials. Storage of hazardous chemicals will be in accordance with the provisions in Article 30 of the K-EPA regulations.

WASTEWATER

The CFP development will require large volumes of water for cooling tower, boiler feedwater (BFW) make-up, process water, potable water, sanitation and other refinery services. KNPC plan for as much of the CFP's water demand to be met by wastewater recycling and reuse as possible.

There will be two new Wastewater Treatment (WWT) Systems provided as part of CFP:

- *New Wastewater Treatment System at MAB – Unit 156*
- *New Wastewater Treatment System at MAA – Unit 163.*

DNV has assessed the environmental impacts from the collection, treatment and reuse of process and sanitary wastewater effluents generated during both construction and operational phases as having a 'Small Negative Impact'. Overall, it is concluded that the planned new CFP wastewater collection and treatment facilities are state of the art, and constitute best practice and apply a considerable number of BACT elements. The CFP wastewater facilities will be designed, built and operated in such a way as to meet best practice and the applicable K-EPA environmental criteria.

In order to augment the robust approach to addressing and mitigating environmental impacts during the CFP's construction and subsequent operations, this study makes the following additional recommendations:

- *The wastewater discharge monitoring results should be audited by an independent party on a regular basis.*
- *The wastewater, storm water and sanitary wastewater collection / treatment facilities should be made available at the earliest stage possible during construction, and it is recommended that each EPC contractor make this an early priority for the CFP construction.*

TRAFFIC

A preliminary Traffic Impact Assessment (TIA) was conducted in the FEED Stage EIA in 2008. It has not been updated as part of this report because a detailed TIA will be conducted for the Ministry of Interior in the near future prior to the start of construction activities.

The 2008 TIA indicated that the CFP could have a significant impact on local traffic conditions during the construction phase, in particular during the seven month period of peak construction activities. The impact on traffic during operation of CFP facilities was found to be acceptable although the overall volume of traffic is expected to increase.

The long term impact should be positive for traffic around the SHU Refinery due to a substantial reduction in the number of employees at the start of the CFP operational phase.

It is recommended that a comprehensive TIA be conducted during the EPC phase to further study local traffic patterns with the objective of determining the current status of local roadways relative to their design carrying capacity. This information should be used as the basis for development of a comprehensive CFP Traffic Management Plan to ensure impacts are managed acceptably via detailed traffic control measures.

MISCELLANEOUS ISSUES

Socio-economics

The proposed CFP will have positive benefits on the regional employment market and local economy, due to the recruitment of approximately 33,000 construction workers (at peak) and approximately 1,500 additional operational staff. In addition, there are anticipated to be positive benefits due to the effects of supply, maintenance and service contracts to local businesses.

There will be some potential negative social impacts from CFP construction staff. The main concerns relate to the impact of the very large construction employees when not working, with some potential impact upon local residential areas owing to cultural differences, and increased strain upon local facilities, and it is recommended that the EPC contractor should develop a plan to handle the potential negative social impacts from such a large influx of construction workers. To counter this, there will also be potential positive impacts upon the local community via local businesses benefiting from increased trade and commerce.

KNPC's Safety, Health and Environmental practice will likely be enhanced through the upgrading / replacing of aging units. This will generally make the KNPC refineries and their surroundings a safer and cleaner place to live and work.

Assessment of Landscape and Visual Impacts

There are no significant landscape impacts from installation of the CFP facilities and receptors at long distances will consider the refinery in context with the existing industrial developments adjacent to the site. Local observers will be visually impacted by the CFP development, especially on the south-eastern edge of the project and mitigation measures have been proposed to minimise visual impacts, in the form of hording or earth bunds. The impact of the CFP development is minimised due to the development being incorporated within the refinery boundaries.

Groundwater Monitoring and Contaminated Land

In the EBS, it was observed that there was no significant soil contamination identified at MAA and MAB, however, soil hydrocarbon levels were higher at SHU where contamination was identified at one location. The soil in this location will need to be carefully removed and disposed of correctly. It is recommended that an independent Environmental Advisor is regularly on site during construction whilst soil excavations are taking place to ensure that the soil is excavated and disposed of in the correct manner, and to help identify other areas of contamination, if any.

KNPC recently commissioned a comprehensive Groundwater Study, which involved the establishment of 47 groundwater wells around the three existing refineries; the report identified a degree of groundwater contamination below the refineries.

DNV recommend that regular checks for fugitive emissions to ground/groundwater from CFP refinery plant and tanks are included as part of the EMS, and that systematic groundwater monitoring is conducted around the CFP facilities and in the vicinity of the tank farms, and analysed against agreed criteria). The CFP will need to provide a groundwater monitoring well system to detect any groundwater contamination from areas where oil or other hazardous materials are normally handled or stored.

It is additionally recommended that soil and groundwater identified as contaminated in the KISR report and overlapping with the CFP location will require remediation prior to the start of CFP construction.

EMERGENCY RESPONSE

The three KNPC refineries, MAA, MAB and SHU, process, store and distribute large quantities of flammable and toxic materials. An incident, such as fire, explosion or gas release occurring within the CFP facilities may have serious consequences, affecting not only the site and the local environment, but also other industries and the public outside the site boundaries.

KNPC is committed to the safety of its employees, installations and the general public. All applicable safety standards, procedures and best practices are followed during process selection, design, construction and operation. However, even with the best safe working practices, it is recognized that emergency incidents may and do still occur. KNPC has developed and implemented a Major Incident Procedure Plan (MIPP) for its existing refineries. Since the CFP is being constructed and *operated within KNPC's refineries' boundaries, the MIPP will apply to CFP. The MIPP provides a procedural framework for responding to emergency incidents such as fire and flammable / toxic releases, and has been approved by the appropriate Kuwaiti authorities.*

DECOMMISSIONING AND CLOSURE MANAGEMENT PLAN

At some stage in the future, the CFP will reach the end of its operational life. The future decommissioning and closure of the CFP will be a complex process, especially in ensuring that the sites are rehabilitated to K-EPA's requirements such that the sites can either be handed back to government control, or sold for another private sector use.

KNPC will develop a conceptual Decommissioning and Closure Management Plan (DCMP) for the CFP (which will involve consultation with K-EPA) as closure planning progresses. The DCMP will address all the project stages that CFP decommissioning will include, which are likely to be: pre-decommissioning consents and contracts; decommissioning activity obligations; and post-decommissioning responsibilities.

Specific environmental related decommissioning and closure objectives associated with the CFP are predicated around meeting all Kuwaiti legal and regulatory requirements (including K-EPA criteria), and mitigating any impacts (environmental, public health, safety, social) within the 'impact vicinity' of the site.

The final goal of a successful eventual decommissioning of the CFP should be to ensure that the need for post-closure site maintenance is minimised, and any long-term environmental activities are mitigated.

ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

KNPC has developed and implemented a company wide EMS in line with the requirements of the ISO14001:2004 Standard – Apex Manual for Environmental Management System (SHE-ESHU-04-1401). Since the CFP facilities are within KNPC refinery boundaries, this EMS will also apply to them, ensuring a structured approach to the management of project-related environmental issues.

The implementation of the EMS will commence during the initial stages of construction and will develop as the CFP becomes fully operational.

1.0 Introduction

1.1 Background

Kuwait contains an estimated 101.5 billion barrels (bbl) of proven oil reserves, roughly 8 % of the world total, and around 1,600 producing oil wells. Currently, Kuwait produces about 2.6 million barrels/d of crude oil. Overall, around two thirds of Kuwaiti oil production comes from the southeast of the country, with about one-fifth from northern Kuwait and about one-tenth from the west.

Kuwait's three domestic refineries have a combined capacity of roughly 936,000 bbl/d. The country's largest refinery is Mina Al Ahmadi, with a capacity of 466,000 bbl/d. The other refineries are Mina Al Abdullah (270,500 bbl/d) and Shuaiba (200,000 bbl/d). Kuwait National Petroleum Company (KNPC) continues to plan significant expansion of its production capacity aiming to reach a long-term total refining capacity of 1.4 million barrels/d.

KNPC, in its continuing commitment to meet changing (and more stringent) environmental requirements and to meet the increased need for clean fuels, is embarking upon an ambitious project, the Clean Fuels Project 2020 or CFP, to upgrade the three existing refineries. These requirements will be implemented by the year 2015.

1.2 Outline of Clean Fuels Project 2020

The CFP involves modifications at KNPC's three (3) existing refineries: Mina Al Ahmadi (MAA), Mina Abdullah (MAB), and Shuaiba (SHU). The MAA and MAB refineries will undergo major upgrades while the processing facilities at SHU will be retired. The outcome of this will be the integration of the KNPC Refining System into one merchant Refining Complex with Full Conversion operation with highest Light Ends Products Yields and minimum Fuel Oil production.

The CFP will result in a reduction in the overall refining capacity of the three refineries from the current operating levels of 936,000 bbl/d to 800,000 bbl/d. The changes are expected to reduce impact on the environment from the refinery activities. The CFP will integrate the new and existing process units along with storage, infrastructure, oil movement and shipping. A variety of new Utilities and Offsite (U&O) facilities will be provided.

The Front End Engineering Design (FEED) Phase of the project was completed in June 2008. During the latter stages of FEED Phase development, a variety of changes surfaced as a result revised marketing parameters which necessitated further Front End Engineering Design development under a new FEED Update Phase. The project is currently under the FEED Update Phase which is intended to meet the new marketing requirements, demands and specifications for transport fuels while integrating the operating capability of the MAA and MAB refineries with optimum utilization of KNPC's existing infrastructure.

1.3 Environmental Impact Assessment

In accordance with the regulatory requirements promulgated by Kuwait's principal environmental regulatory authority, the Kuwait Environment Public Authority (K-EPA), and international 'best practice', Det Norske Veritas (DNV) conducted a full independent Environmental Impact Assessment (EIA) process for the proposed CFP during FEED in 2008. An Initial EIA was completed by Fluor (the CFP Project Management Consultant contractor) in August 2007. EIA is a process undertaken for certain types of major projects which are judged likely to have potentially significant environmental effects. It assesses the environmental consequences of a proposed development in advance, with emphasis on the prevention of unacceptable impacts. The output of the EIA process was an Environmental Impact Statement (EIS), which was prepared by DNV on behalf of Fluor.

The project is currently under the FEED Update Phase which provides changes to the FEED Phase engineering design intended to meet the new marketing requirements of the Project. Thus, the EIS submitted and presented to K-EPA in 2008 needs to be updated to reflect the new scope of the facilities as per Feed Update Phase requirements. This EIS is an update of the original EIS (June 2008) which encompasses the FEED Update Phase scope of facilities.

The EIS was prepared in accordance with the State of Kuwait Regulations Implemented under Law No. 21 of 1995 as Amended by Law No. 16 of 1996. The EIS also fulfilled KNPC's regulatory and internal procedural (EIA Study procedure SHE-ESHU-03-1407) requirements, as well as the statutory requirements of K-EPA.

The EIS sets out DNV's 3rd-party assessment of the potential environmental effects during the construction and subsequent operation of the CFP, and also provides a framework for a decommissioning, closure, clean-up and reinstatement plan.

This EIS is supported by an Environmental Baseline Study (EBS) conducted in 2007/8 by DNV in conjunction with two Kuwaiti technical providers, Kuwait Institute for Scientific Research (KISR) and Wataniya Environmental Services (WES). The EBS provides an existing environmental 'baseline' of the CFP site and its surroundings allowing DNV to assess any potential impacts posed by the project. WES also assisted with the development of part of this EIS. Public consultation was not within the scope of the CFP EIA.

1.4 Key Objectives

The key objectives of this EIA process include:

- Establishing and reviewing the existing environmental conditions pertaining to the CFP site and surrounding area;
- Identifying and assessing the potential environmental impacts of the proposed CFP development which might arise during construction and operation, and providing a framework for a CFP decommissioning plan;
- Assessing KNPC planned measures to mitigate any adverse environmental impacts;

- Assessing the provision of measuring, monitoring and sampling and associated capabilities to ensure that the CFP operates a robust system of environmental management and controls;
- Making additional recommendations, as appropriate, on what further measures could be taken to address such impacts, such that environmental impacts are reduced, managed and considered acceptable.

1.5 Principal Environmental Impacts

The potential environmental impacts associated with the CFP include both short-term environmental impacts, which will generally result from various construction activities, and potential longer-term environmental impacts associated with operation of the CFP facilities. Both types of environmental impacts are examined within the body of this report.

KNPC intends that the CFP will incorporate the optimum level of Best Available Control Technologies (BACT) and associated environmental mitigation measures deemed necessary, so as to meet or exceed all relevant K-EPA emissions criteria. In particular, BACT will be incorporated to address the following:

- air emissions abatement;
- wastewater collection, treatment, reuse and disposal;
- solid waste management, minimization and disposal;
- noise control and abatement;
- odour abatement
- protection of Kuwait's coastal and marine environment; and
- environmental monitoring.

1.6 Environmental Impact Statement (EIS): Structure

This EIS is a comprehensive and detailed document which describes the potential environmental impacts, associated with the CFP's construction and operation, and takes into consideration the baseline environmental conditions (via the EBS) at the project site. It also describes the key facilities for the CFP, including the principal emissions and discharge points, plus the management and control systems, which will be implemented to mitigate any adverse environmental impacts. This EIS also provides a framework for the decommissioning of the CFP.

In summary, the EIS is set out for maximum clarity according to the following structure:

- Non-Technical Summary: an outline of the CFP, the EIA process, the EIS, and findings;
- Description of the CFP: including both its construction, design, principal processes and associated facilities;
- Environmental Measures incorporated in the CFP Design: a summary of all the appropriate BACT and environmental mitigation measures deemed necessary, so as to meet or exceed all relevant K-EPA emissions criteria;

- Assessment of Project Alternatives: it is a requirement of the EIA process to consider alternatives and their respective environmental impacts / benefits, including the 'no development' option;
- Environmental Baseline Study: in support of the EIA process, the EBS provides a baseline of the existing environment at the site and surrounding area in order to assess any potential impacts;
- Impact Assessment Methodology: applying DNV's EIA 'impact matrix' methodology to the CFP, to assess potentially significant environmental impacts during construction and operation;
- Noise: including environmental noise predictions, and reduction measures, for the CFP;
- Air Quality during Construction: focusing on air quality and associated air pollutant emissions from the CFP during its construction;
- Air Quality during Operation: focusing on ambient air quality and associated air pollutant emissions from the CFP once operational.
- Waste: focusing on solid waste generated during the CFP's construction and operations, and setting out the Solid Waste Management Plan;
- Chemical Hazards Management: covers the use and management of potentially hazardous materials;
- Wastewater: including process / industrial, sanitary wastewater and stormwater generation, an evaluation of wastewater minimization / reuse / treatment and recycling, and assessment of final discharges;
- Preliminary Traffic Impact Assessment: describes the effects of vehicles related to CFP construction and operation on traffic in the surrounding area. It should be noted that the figures and data used in this Chapter are from the FEED Phase. A comprehensive Traffic Impact Assessment to address the design requirements and scope of facilities for FEED Update will be undertaken during the EPC/Detailed Design Phase of the CFP.
- Miscellaneous Issues: covering socio-economic issues, landscape & visual impacts, groundwater contamination and contaminated land issues;
- Emergency Response Plan: setting out KNPC's Major Incident Procedure Plan (MIPP) which will be similarly adopted as the Emergency Response Plan for the CFP;
- Decommissioning and Closure Management Plan Framework: providing the structure for developing a decommissioning, closure, clean-up and reinstatement plan for the CFP site;
- Environmental Management System: KNPC's company-wide EMS, which will be implemented for the CFP facilities;
- Recommendations.

In support, Appendix I (VOC Storage Tank Data) is attached.

2.0 Description of Clean Fuels Project

2.1 General Description of Clean Fuels Project

CFP will provide a major upgrade and expansion of both the MAA and MAB refineries. Accompanying this expansion, KNPC will retire a number of existing inefficient operating units at MAA, MAB and SHU.

A refinery is an organized co-ordinated arrangement of manufacturing processes, which are designed to provide physical and chemical changes of petroleum crude to convert it into useful products. The finished products for CFP include:

Table 2.1 Finished Products of CFP

Local Market Mogas	MAA
Local Market Gas Oil (10 ppm Sulfur)	MAA
Export Mogas	MAA
Petrochemical Naphtha	MAA & MAB
Local Market ATK	MAA
Local Market DPK	MAA
Export ATK	MAA & MAB
Export DPK	MAB
Export JP 5	MAB
Export Gas Oil (10 ppm Sulfur)	MAA & MAB
Fuel Oil Bunker 380	MAA & MAB
Fuel Oil Bunker 180	MAA & MAB
PIC Aromatic Plant Naphtha	MAB
Gas Oil MEW (500 ppm Sulfur)	MAA
Gas Oil Bunker (10 ppm Sulfur)	MAA & MAB
Petrochemical Coke	MAA & MAB
Sulfur	MAA & MAB

The CFP will provide major upgrades to the MAA and MAB refineries and integration of the KNPC Refining System into one merchant Refining Complex with Full Conversion operation with highest Light Ends Products Yields and minimum Fuel Oil production.

The CFP will integrate new and existing process units along with storage, infrastructure, oil movement and shipping leading to the integrated operating capability of MAA and MAB with optimum utilization of existing infrastructure. A variety of new utilities and offsite facilities will be provided. SHU will continue to operate as a tank farm, product storage and export shipping facility, while its old and less environmentally friendly processing units will be retired.

2.2 Key Environmental Issues Typically Associated with Refineries

Refineries are very large and complex sites that manage large amounts of raw materials and products; they are also demanding consumers of energy and water. In their storage and refining processes, refineries generate emissions to the atmosphere, effluents to water bodies, noise and solid waste, all of which may result in impact to the environment. Typical refinery emissions to the environment include:

- **Air emissions:** Air emissions are often the most important environmental issue for oil refineries. Oxides of carbon (CO), nitrogen (NOx) and sulphur (SOx), particulates and volatile organic carbons (VOCs) are the main air pollutants generated.

- **Wastewater:** Water is used extensively in a refinery as process water and for cooling purposes. Its use often contaminates the water with oil products. The main water contaminants are hydrocarbons, sulphides, ammonia, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), phenol, suspended solids and some metals.

- **Waste:** In the context of the large amount of raw material they process, refineries do not typically generate substantial quantities of waste. Wastes generated by refineries are dominated by sludges, non-specific refinery waste (domestic, demolition, etc.), and spent chemicals such as acids, amines and catalysts.

- **Noise:** Noise from equipment is another typical emission to the environment. Although not generally a problem, noise levels during construction and operation can be high, but controllable.

Minimizing Impacts

The following methods are usually the most effective methods to minimize the key environmental impacts from refinery operations:

- ***Reduce sulphur oxides (SOx) emissions***: typically generated via combustion of fuels (containing sulphur compounds), amine treating, sour water strippers, tail gas treating units and flares. High efficiency sulphur recovery units significantly reduce the sulphur content of fuels, thus minimizing SOx emissions.

- ***Reduce nitrogen oxides (NOx) emissions***: typically a key environmental issue, particularly from specific processes and activities, notably from energy generation (e.g. furnaces and boilers). Choosing low NOx burners as well as selecting gaseous fuels over liquid fuels with higher nitrogen content are important steps in minimizing the NOx emissions.

- ***Increase refinery energy efficiency***: the principal benefit of improved energy efficiency is a reduction in the emissions of all air pollutants. Techniques to increase energy efficiency within refineries include increasing the energy efficiency of the various processes/activities and enhancing energy integration throughout the refinery.

- ***Reduce VOC emissions***: VOC emissions from refineries come from fugitive sources such as storage tanks, transfer / loading / unloading operations and equipment components. Use of floating roof tanks for volatile products, nitrogen blanketing for equipment, provision of mechanical seals and implementation of a Leak Detection and Repair (LDAR) program are recognized as very effective methods to minimize VOC emissions.

- ***Reduce water contamination:*** Because refineries are extensive consumers of water, they can also generate large quantities of contaminated wastewater. Recycling and reuse of water (such as for utility use and irrigation) reduces water consumption requirements. Wastewater treating facilities are imperative to site operations before discharge.

2.3 CFP Process Description and Key Environmental Emissions

KNPC is currently finalizing the FEED Update stage for the CFP, which will decrease the cumulative capacity of the three refineries from 936 KBPD to 800 KBPD. This is expected to reduce impact on the environment in surrounding areas.

There will be twenty new process units, four revamped process units, twenty new Utilities & Offsite (U&O) units and nine revamped U&O units currently planned at the MAA refinery. Similarly, there will be nineteen new process units, two revamped process units, nineteen new U&O units and six revamped U&O units at the MAB refinery. To balance this, all processing facilities and most utility support units (including utility boilers) at the SHU Refinery will be decommissioned in parallel. Additionally, a Crude Distillation Unit (CDU-3) and Merox Unit (Unit 94) at MAA, as well as a Crude Unit (Unit 01), RCD Unibon Unit (Unit 02) and Hydrogen Unit (Unit 03) at MAB will be retired.

The CFP is being designed, engineered and constructed to assure safety, environmental compliance, reliability, efficient manpower utilization, operability and maintainability.

Figure 2.A, Figure 2.B and Figure 2.C show the preliminary site layout of the CFP within the three refineries. The CFP process flow diagrams for the refineries are illustrated in Figure 2.D and Figure 2.E.

Figure 2.A: MAA Refinery Site Plan (preliminary)

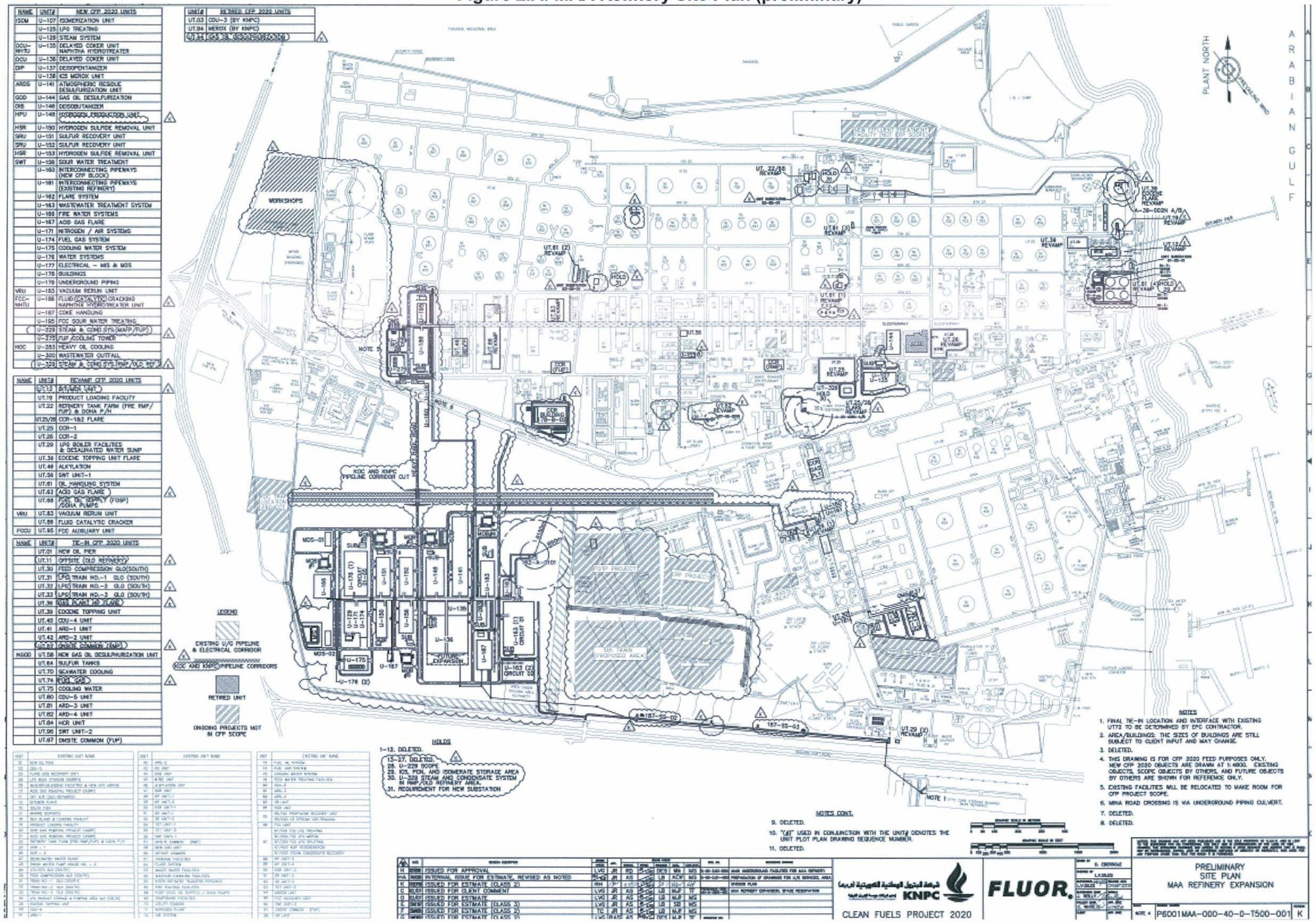


Figure 2.B: MAB Refinery Site Plan (preliminary)

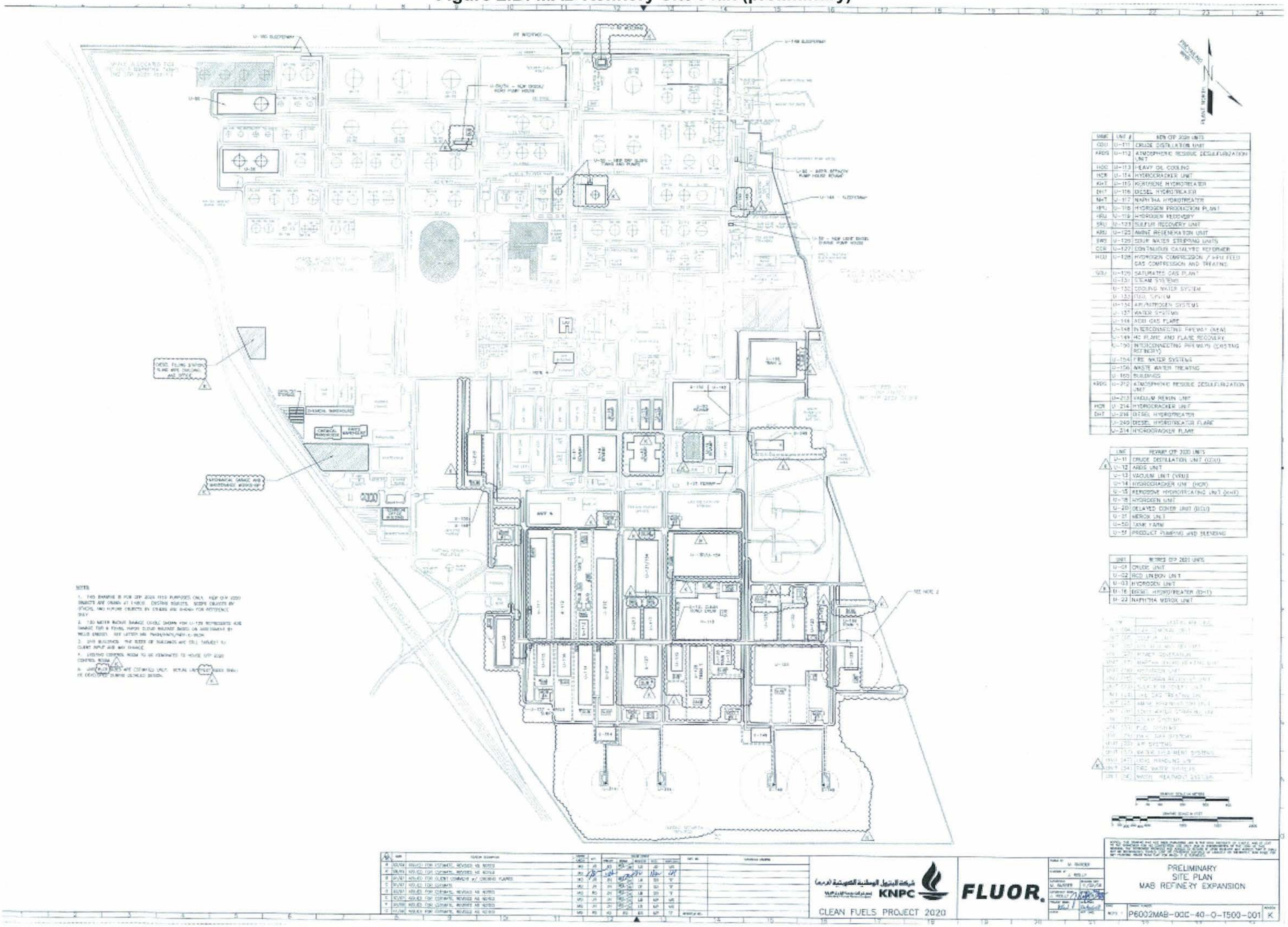


Figure 2.C: SHU Refinery Site Plan (preliminary)

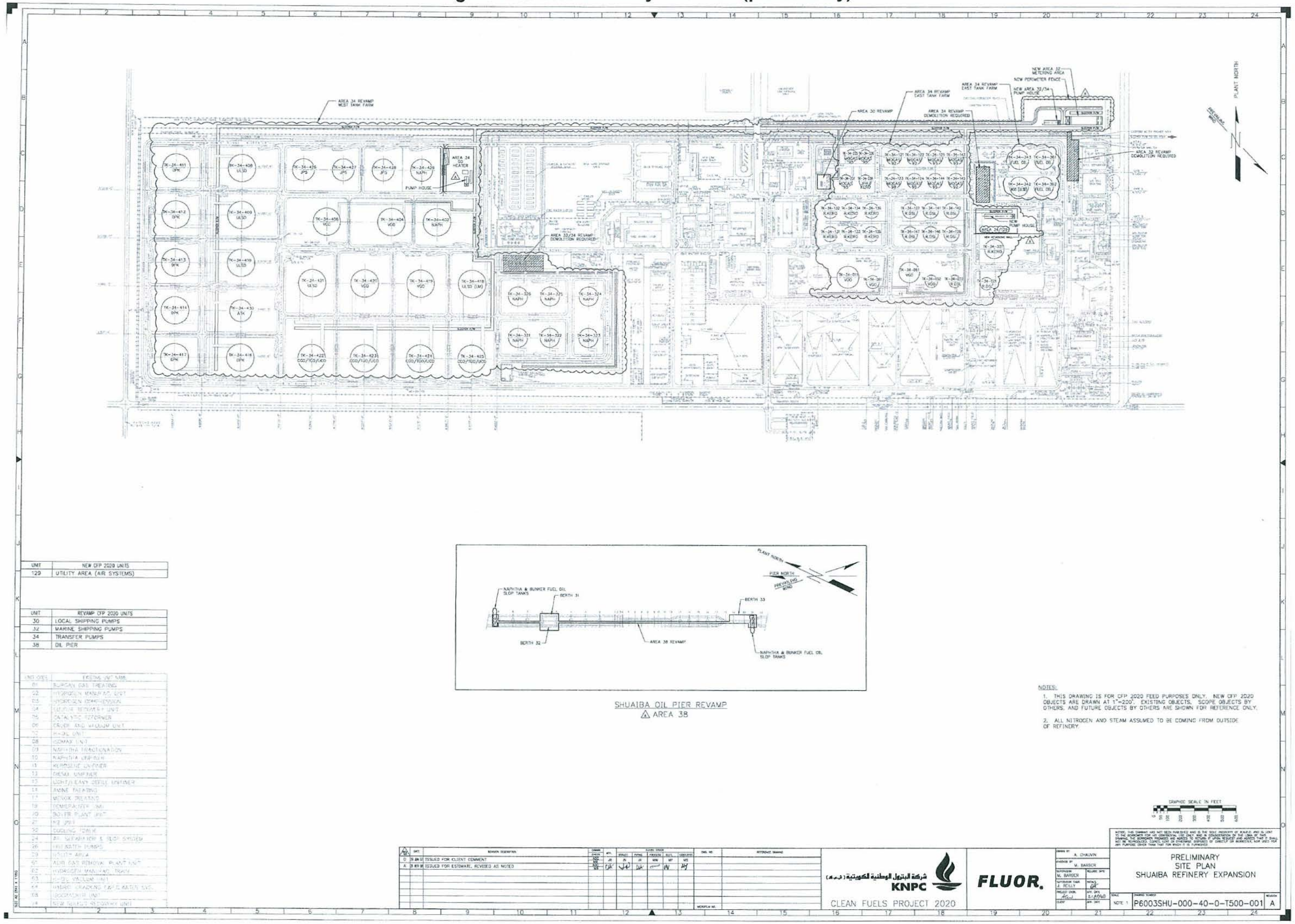


Figure 2.D: MAA Refinery Overall Block Flow Diagram (preliminary)

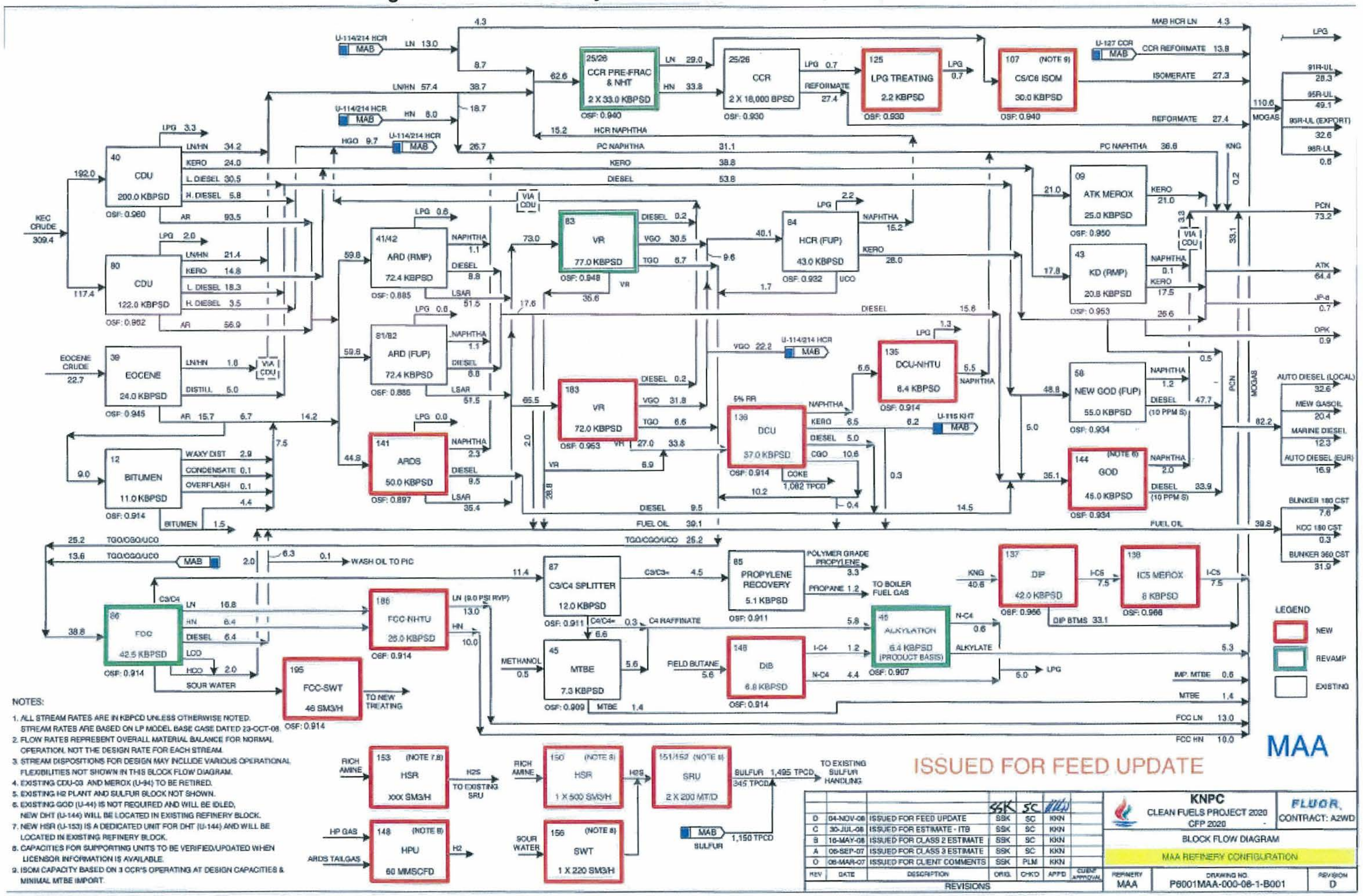
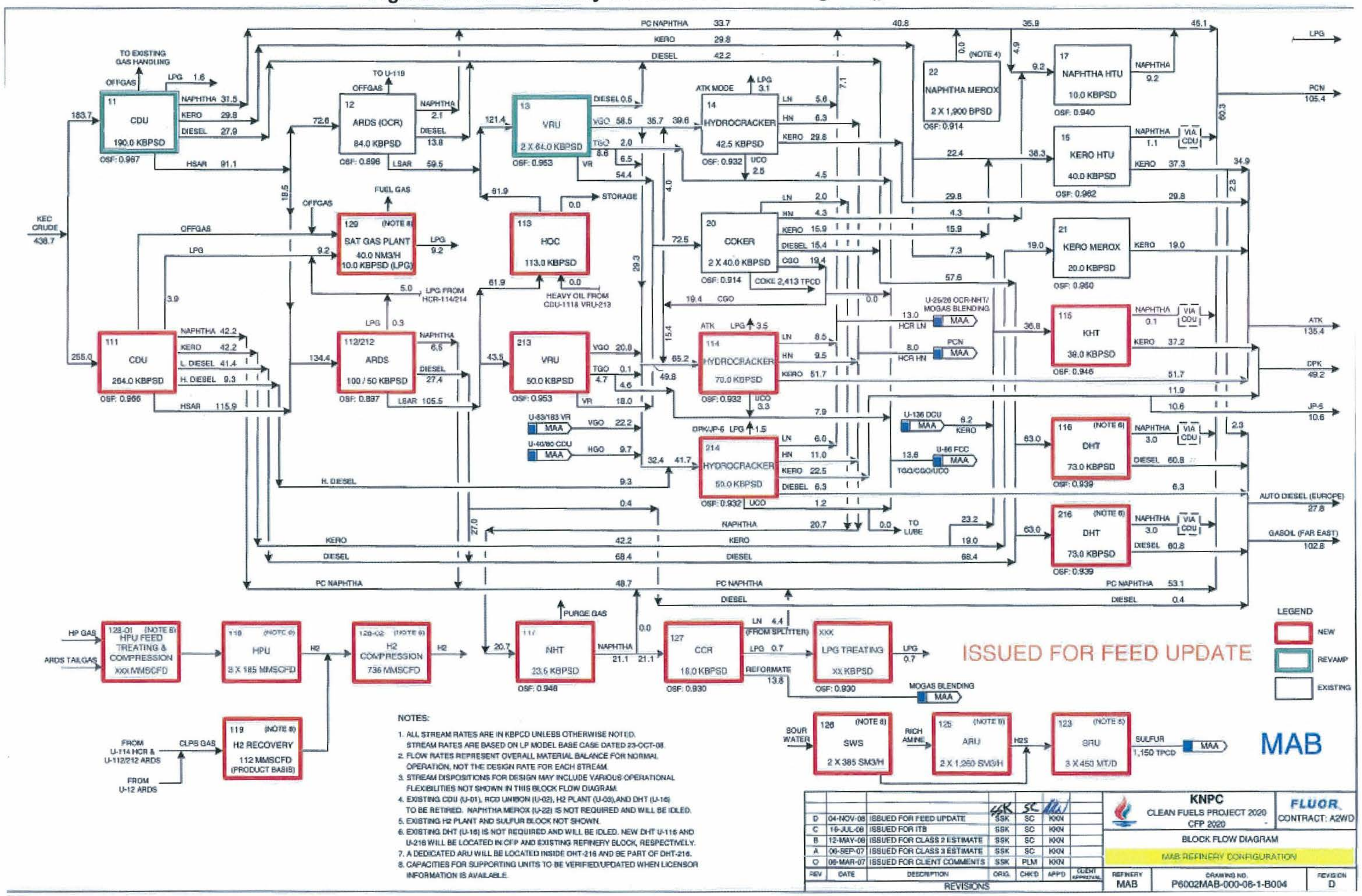


Figure 2.E: MAB Refinery Overall Block Flow Diagram (preliminary)



A brief description of CFP process units is given below. At the end of each unit description, the typical key environmental issues related to each process unit are highlighted.

Note that noise sources (pumps, compressors, forced draft fans, etc.) are typically located throughout a plant and are not highlighted individually in this Chapter, but are considered in detail in Chapter 7. Similarly, fugitive emissions take place from many units and only the key emitters (e.g. large storage tanks) are highlighted here. These volatile emissions are considered in detail in Chapter 9.

2.3.1 MAA Refinery

Twenty new process units are planned for the MAA refinery:

1	Tail Gas Treating Unit (i.e. SCOT Unit)	TGT, Unit 99
2	Isomerisation Unit	ISOM, Unit 107
3	LPG Treating Unit	LPG TU 125
4	Delayed Coker Unit - Naphtha Hydrotreating Unit	DCU-NHTU, Unit 135
5	Delayed Coker Unit	DCU, Unit 136
6	Deisopentanizer	DIP, Unit 137
7	Isopentane IC5 Merox Unit	IC5 Unit 138
8	Atmospheric Residue Desulphurization	ARDS, Unit 141
9	Gas Oil Desulfurization Unit	GOD, Unit 144
10	Deisobutanizer	DIB, Unit 146
11	Hydrogen Production Unit	HPU, Unit 148
12	Hydrogen Sulfide Removal	HSR, Unit 150
13	Sulphur Recovery Unit	SRU, Unit 151
14	Sulphur Recovery Unit	SRU, Unit 152
15	Hydrogen Sulfide Removal	HSR, Unit 153
16	Sour Water Treatment Unit	SWT, Unit 156
17	Vacuum Rerun Unit	VRU, Unit 183
18	Fluid Catalytic Cracking – Naphtha Hydrotreater	FCC-NHTU, Unit 186
19	FCC Sour Water Treating	FCC–SWT, Unit 195
20	Heavy Oil Cooling	HOC, Unit 283

Four revamped process units are planned for the MAA refinery:

1	CCR 1 & 2	Unit 25/26
2	Alkylation	Alky, Unit 46
3	Vacuum Rerun	VR, Unit 83
4	Fluid Catalytic Cracker Unit	FCU, Unit 86

Two process units are planned for retirement at the MAA refinery:

1	Crude Distillation Unit	CDU-3, Unit 03
2	Merox Unit	Unit 94

Twenty new U&O Units are planned for the MAA refinery:

1	Incoming HV Power Supply	Unit 111
2	Site Prep/Roads/Paving/Fencing/Temp Facilities & Electrical	Unit 113
3	Steam System	Unit 129
4	Integrated Control & Safety System (ICSS)/ Enterprise Integration & Communication Systems (EICS)	Unit 159
5	Interconnecting Pipeways (New CFP Block)	Unit 160
6	Interconnecting Pipeways (Existing Refinery)	Unit 161
7	Flare System (hydrocarbon flare)	Unit 162
8	Wastewater Treatment System	WWT, Unit 163
9	Fire Water Systems	Unit 166
10	Acid Gas Flare	Unit 167
11	Nitrogen/Air Systems	Unit 171
12	Fuel Gas System	Unit 174
13	Cooling Water System	Unit 175
14	Water Systems	Unit 176
15	Electrical	Unit 177
16	Buildings	Unit 178
17	Underground Piping	Unit 179
18	Coke Handling	Unit 187
19	Steam and Condensate	Unit 229
20	FUP Cooling Tower	Unit 275

Nine revamped U&O Units are planned for MAA refinery:

1	Product Loading Facility	Unit 19
2	Refinery Tank Farm (pre-RMP/FUP) and DOHA P/H	Unit 22
3	CCR 1&2 Flare	Unit 25/26
4	Eocene Topping Unit Flare	Unit 39
5	Onsite Common (RMP – Interconnecting Piping)	Unit 57
6	Oil Handling System	Unit 61
7	Acid Gas Flare	Unit 62
8	Fuel Oil Supply(FOSP)/DOHA Pumps	Unit 68
9	Onsite Common (Further Upgrade Project)	Unit 97

A number of existing MAA Units will also have tie-in with the CFP, or minor equipment modifications. However, these will not have any significant environmental impact.

2.3.1.1 New MAA Refinery Process Units

Tail Gas Treating Unit (TGT, Unit 99)

A new Shell Claus Offgas Treating (i.e. SCOT) Unit will be provided to reduce the sulphur content of waste gas streams generated by two existing sulphur recovery units (Unit 91 and Unit 92) before these streams are routed to an existing tail gas incinerator. The new SCOT Unit will not generate new air emissions, wastewater effluents or solid waste, but rather, will significantly reduce the concentration of sulphur compounds routed to the existing tail gas incinerator, and thus reduce SO_2 emissions.

Isomerisation Unit (ISOM, Unit 107)

A new C5/C6 Isomerization Unit 107 will process light naphtha from existing CCR Unit 25/26 NHT Section, and will produce isomerate product for the gasoline pool. In the current operation, the light naphtha feed streams are routed to Petrochemical Naphtha (PCN). In the CFP scope, these streams will be routed to the ISOM unit. The new ISOM will be designed to treat 30,000 BPSD of light naphtha and produce isomerate. Key environmental emissions include atmospheric emissions from two fired heaters, and spent caustic waste.

LPG Treating (Unit 125)

The LPG Treating Unit will treat the LPG liquid product from the existing CCRs. Treatment in this unit will reduce the olefins in the LPG liquid product to avoid plugging issues with the gas plant. The design capacity of the LPG Treating Unit is based on the combined LPG production from CCR Unit 25/26 and will be 2,264 BPSD.

Delayed Coker Unit - Naphtha Hydrotreating Unit (DCU-NHTU, Unit 135)

The DCU-NHTU (Unit 135) will be located on the same plot as the DCU Unit 136 and will be integrated with the DCU. The Hydrotreater will process the unstabilized full range naphtha (FRN) stream coming from the Wet Gas Compressor 2nd Stage After-Cooler Surge Drum to meet the Petrochemical Naphtha (PCN) specifications.

Any sour water streams generated by the DCU-NHTU will be integrated with that from the DCU Unit 136 and routed to the Sour Water Treatment Unit (SWT, Unit 156) in the CFP block.

Key environmental emissions from the DCU-NHTU will include:

- Atmospheric emissions from the single gas-fired heater.
- Sour wastewater, which will integrate with that from the DCU Unit 136 and be routed to the SWT (Unit 156) in the CFP block.
- Solid waste (i.e. spent catalyst).

Delayed Coker Unit (DCU, Unit 136)

Delayed Coking is a process by which heavier crude oil fractions are thermally decomposed under conditions of elevated temperature and pressure to produce a mixture of lighter oils. These lighter oils can then be processed further to produce more valuable products and petroleum coke that can be used either as a fuel or in other applications such as the manufacturing of steel or aluminum.

The DCU will have Chemical Injection Systems for anti-foam, polysulfides and antioxidants.

Key environmental emissions from the DCU will include:

- Atmospheric emissions from two gas-fired heaters.
- Particulate emissions and hydrocarbon emissions, which will be released in a batch type process during the removal of coke from the four coke drums (Note: hydrocarbon vapors will be condensed and the liquid pumped to the slop oil system).
- Sour wastewater which will be routed to the new Sour Water Treatment Unit (Unit 156) or Sour Water Stripper.
- Wastewater generated during coke cutting operations which will be recycled back to the coke cutting water tank within the unit where a hydroclone is used to separate coke fines from cutting water.

Deisopentanizer (DIP, Unit 137)

The DIP Unit will treat the Kuwait Natural Gasoline (KNG) stream produced by the MAA Refinery Gas Plant Trains to produce both normal-Pentane (n-Pentane) and Isopentane (IC5).

The DIP Unit relief systems will be routed to the existing Gas Plant HP Flare System. Key environmental emissions from the DIP will include sour water streams, which will be routed to the closest Sour Water Treatment Unit within the MAA Refinery.

There is a fired reboiler heater in this unit which will produce atmospheric emissions.

Isopentane IC5 Merox Unit (IC5, Unit 138)

The IC5 Merox Unit is needed to meet the Sulphur content requirements for the Isopentane product from the DIP Unit (Unit 137). The IC5 Merox unit will remove mercaptans sulphur from the Isopentane product to meet the 2020 Sulphur Specification of 10 ppmw before it is sent to Mogas blending. The new Unit 138 will be a single 100% capacity unit and will include sulphur extraction and caustic regeneration sections. There is no fired equipment in Unit 138. Disulfide separator vent gas will be routed to the DIP Reboiler Heater.

Key environmental emissions from the IC5 Merox Unit will include:

- Steam Condensate, which will be sent to the Wastewater Treatment Unit (Unit 163) via the ODS drain system.
- Spent Caustic, which is handled by the Spent Caustic Disposal System.
- Approximately 250 cubic feet of sand (non-hazardous solid waste from disulfide filter) every five years, which requires landfill disposal.

Atmospheric Residue Desulphurization (ARDS, Unit 141)

CFP will provide a new ARDS Unit at the MAA Refinery, which will be capable of processing 100% Atmospheric Residuum (AR) from the existing crude distillation units and existing Eocene Unit. The process removes sulphur from the hydrocarbon feed stream by treating the feed with hydrogen gas over a noble metal alloy catalyst on a fixed bed reactor.

The primary product of the ARDS Unit is a hydrotreated LSAR with 0.5 wt% sulphur. Other major products are diesel, stabilized naphtha and sour Liquefied Petroleum Gas (LPG).

Key environmental emissions from the ARDS Unit will include:

- Atmospheric emissions from the reactor feed furnace and fractionation feed furnace.
- Sour water which will be sent to a new SWT Unit (Unit 156).
- Solid waste stream (i.e. spent catalyst).

Gas Oil Desulfurisation Unit (GOD, Unit 144)

MAA has two existing GOD Units, GOD-44 (processing heavier diesel stocks) and NGOD-58 (processing predominately straight-run light diesel). GOD-44 cannot meet the CFP processing objectives and will therefore be idled upon completion of CFP. The New Gas Oil Desulphurization Unit (GOD-144) will be capable of producing Ultra Low Sulfur Diesel fuel for export. GOD-144 will process diesel from ARDS-41/42/81/82, ARDS-141, Delayed Coker Unit (DCU) 136, and light diesel from CDU 4 and 5. Heavy diesel from CDU-4 and 5 will be processed in the Hydrocracker (HCR-84). The design capacity of GOD-144 will be 45,000 BPSD.

The primary product of GOD-144 will be Ultra Low Sulfur Diesel (ULSD). The unit also produces Wild Slops (un-stabilized naphtha and kerosene) as a secondary product.

Key environmental emissions from the revamped GOD Unit will include:

- Atmospheric emissions from the reactor charge heater.
- Sour water.
- Solid waste (i.e. various spent catalysts including Nickel-Molybdenum and Cobalt-Molybdenum).

Deisobutanizer (DIB, Unit 146)

The existing DIB at MAA cannot produce the required amount of make-up Isobutane because it cannot handle the necessary feed rate of Field Butane. The current Field Butane feed to the DIB is 2,400 BPSD, but 6,450 BPSD is needed to produce the required amount of make-up Isobutane, and thus a new DIB unit will be installed to operate in parallel with the current DIB unit. The new DIB will be sized to handle 6,800 BPSD.

The main purpose for providing a full-sized DIB is to allow flexibility to operate the Alky Unit when the existing DIB is down for maintenance, or to provide additional Isobutane as required.

Key environmental emissions from the DIB will include:

- Liquid Blow Down routed to storage
- Oily Water Sewer routed to storage (wet slops)

Hydrogen Production Unit (HPU, Unit 148)

The total hydrogen requirement for the new hydroprocessing units is provided from the new HPU, which will provide up to 60 MMSCFD of hydrogen product. The HPU will produce hydrogen from the treatment and compression of high pressure fuel gas and ARDS tail gas. A common feed gas compression/ H_2S scrubbing unit will be provided upstream of the new HPU. The new HPU will utilize steam reforming to generate hydrogen.

The only fired equipment item within the new HPU will be the Reforming Furnace. A variety of catalysts will be required.

Key environmental emissions from the HPU will include:

- Atmospheric emissions from the Reforming Furnace.
- Solid waste (i.e. spent catalysts).
- Liquids collected in the HPU flare knockout drum, which will be routed to the MAA Refinery Wet Slop Oil Header.

Hydrogen Sulfide Removal (HSR, Unit 150)

H_2S is stripped out of Rich Amine (circulating solvent that removes H_2S from refinery gas and product streams) in the HSR and is sent as a concentrated acid gas stream (Lean Amine) to the Sulphur Recovery Unit and Tail Gas Treating Unit. Absorbers in the MAA Refinery will use an aqueous solution containing Methyl-Diethanol Amine (MDEA) to remove H_2S from refinery gas and product streams.

There will be two new HSR Units at the CFP: HSR 150 and HSR 153 (see next page for HSR 153). HSR 150 will have two (2) 60% capacity trains with a design capacity of 250 standard m^3/hour of rich Amine.

Acid gas will be stripped out of the amine solution using kettle reboilers with low pressure steam. The H_2S overhead stream is piped to the SRU (Units 151/152). The Amine Regenerator Overhead System will require a water purge to the Sour Water Stripper (Unit 156).

Key environmental emissions from the HSR will include:

- Oily water (ODS will be provided to collect any oily water generated during steam out of vessels and other equipment during shutdown).
- Solid waste (i.e. spent activated carbon and filter cartridges).

Sulphur Recovery Units (SRUs, Units 151 & 152)

H_2S will be recovered and sent to the new SRUs where it will be converted into elemental Sulphur and exported as a refinery byproduct. Two identical SRUs will be provided. The new SRUs will be designed to process acid gas streams from the new HSR, ARU, SWS and SWT Units. The SRUs will recover at least 99.9 weight percent sulphur from the acid gas feed streams, incinerate the ammonia, and oxidize the residual sulphur to sulphur dioxide before venting it to the atmosphere.

Each SRU train will have a Tail Gas Incinerator, including waste heat recovery for steam optimization and utilization within the unit and for steam export. A dedicated incinerator stack will also be provided for each train.

Key environmental emissions from the SRU will include:

- Atmospheric emissions, primarily SO_2 from the Tail Gas Incinerator within each SRU.
- Solid waste (i.e. spent catalyst, ceramic balls, and filter cartridges)

Hydrogen Sulfide Removal (HSR, Unit 153)

MAA has two existing HSR Units which run at near capacity to support the existing refinery H_2S removal requirements. There is no spare capacity to support new units installed as part of the CFP so two new HSR Units will be provided: HSR 150 and HSR 153.

HSR 153 will service new users in the existing block and will utilize DIPA for compatibility with the existing refinery. It will strip the absorbed H_2S from the rich amine stream from GOD 144, regenerating the amine prior to recirculation. The stripped H_2S is sent as a concentrated acid gas stream to the Sulfur Recovery Unit where it is converted to elemental sulfur to be disposed of as a refinery byproduct. The stripped rich amine is returned as lean amine to the amine absorber in GOD-144.

HSR 153 will have sufficient capacity to process GOD 144 LP sour offgas in addition to 5 MMSCFD of sour gas from the existing refinery.

Key environmental emissions from the HSR will include:

- Oily water (ODS will be provided to collect any oily water generated during steam out of vessels and other equipment during shutdown).
- Solid waste (i.e. spent activated carbon and filter cartridges).

Sour Water Treatment (SWT, Unit 156)

Sour water containing appreciable concentrations of Hydrogen Sulfide (H_2S) and Ammonia (NH_3) is produced from several units. The sour water will be steam stripped in the new SWT to suitable levels of H_2S and NH_3 for additional treatment in the CFP Wastewater Treating Unit (Unit 163).

The SWT will be designed to separate gas, light hydrocarbons, and oil emulsions from the sour water feed before steam stripping to remove the bulk of the H_2S and NH_3 (maximum 20 ppmw and 50 ppmw, respectively). A Caustic Injection System is provided to introduce caustic (NaOH) solution into the Stripper Column as required.

Sour water may also contain phenols, cyanides, chlorides and carbon dioxide. The treated sour water from the Stripper Column will be routed into two headers. One header is for refinery reuse and the other for discharge to the Wastewater Treating (WWT) Unit.

Key environmental emissions from the SWT will include:

- Treated sour water, which is sent to the WWT Unit for additional treatment.
- The H_2S and NH_3 rich acid gas from the Stripper Column, which will be sent to the SRUs (Units 151/152) where H_2S is converted to elemental sulphur.

Vacuum Rerun Unit (VRU, Unit 183)

The VR Unit will have a capacity to process approximately 50,000 BPSD of Low Sulphur Atmospheric Residuum (LSAR) from the ARDS units to yield a variety of products, including DFO, VGO, TGO and VR.

The only fired equipment item within the new VR Unit is the Vacuum Charge Heater.

Key environmental emissions from the VR Unit will include:

- Atmospheric emissions from the gas-fired Vacuum Charge Heater.
- Off-gas from the Ejector System will be routed through an MDEA scrubber prior to being disposed of by burning in the Vacuum Charge Heater.
- Sour water collected in the condensate drums and routed to the SWS Unit.
- Slop oil, which will be collected in the condensate drums.

Fluid Catalytic Cracking – Naphtha Hydrotreater Unit (FCC NHTU, Unit 186)

The new FCC-NHTU will process high sulphur light naphtha (LN) and high sulphur heavy naphtha (HN) streams from the revamped FCC (Unit 86) to produce low sulphur light and heavy naphtha streams with a maximum sulphur content of 10 ppmw. These product streams will then be used as blending components of the gasoline pool. The FCC-NHTU will consist of two major sections: Selective Hydrogenation (SH) Unit and Splitter, and Hydrodesulphurization (HDS).

Key environmental emissions from the FCC NHTU will include:

- Atmospheric emissions from two HDS Reactor Heaters.
- Sour water which will be piped to the existing Sour Water Stripper Unit.
- Solid waste (i.e. spent catalysts generated in both the SH and HDS sections of this unit).

FCC Sour Water Treating Unit (SWT, Unit 195)

A new sour water treatment unit (SWT, Unit 195) will be installed to meet the higher sour water rate based on the revamp of some existing units and the addition of new processing units. It will be designed for 125% of the normal sour water flow rate from FCC Unit 86. The capacity of this unit is 202.5 gpm.

The proposed location of this unit is north of FCC-NHT Unit 186. The existing SWT Unit 95, which is used to treat Unit 86 phenolic sour water, will be made available to process non-phenolic sour water from both the RMP & FUP blocks of process units.

Flexibility will be provided to divert some non-phenolic sour water to SWT Unit 195 via a flow control valve, during times of excess non-phenolic sour water generation.

Key environmental emissions from the SWT will include:

- Stripped Sour water which will be sent to the WWT plant
- Gaseous discharges (Nitrogen and traces of H_2S) from the sour water storage tank

Heavy Oil Cooling Unit (HOC, Unit 283)

HOC Unit 283 will use a tempered diesel recirculation system to cool heavy oil products from the new Vacuum Rerun Unit 183 to an acceptable operating temperature before transfer to storage. In addition, this system will include the capability to cool hot LSAR from the new ARDS Unit 141 before being routed to storage in the event that Unit 183 is shut down.

Apart from slops, there are no major environmental emissions from the HOC Unit.

2.3.1.2 Revamped MAA Refinery Process Units

CCR 1&2 (NHT, Units 25 & 26)

Existing Units 25 & 26 are two identical units that each consist of two major sections: Naphtha Hydrotreater (NHT) and Continuous Catalytic Reformer (CCR). Hydrotreated naphtha is separated into light naphtha and heavy naphtha in a splitter column located in each of the NHTs. The heavy naphtha product from NHT is fed to CCR, as per the existing configuration. The light naphtha product will be rerouted as feed to the new Isomerisation unit 107.

These units have atmospheric emissions from the two existing charge heaters and generate solid waste in the form of spent catalyst. However, the revamp work will not result in any additional emissions impacts.

Alkylation (Alky, Unit 46)

CFP will revamp (i.e. increase capacity of) the existing Alkylation Unit to handle a revised composition and higher feed rate of Methyl Tertiary Butyl Ether (MTBE) C4 Raffinate stream. This revamp will increase Alkylate production required for Mogas blending. A new Deisobutanizer (DIB) Column will be added to increase overall DIB capacity.

CFP will increase capacity of the LPG plants to handle the C_3/C_4 streams from the new and revamped units. Therefore, the amount of Isobutane used as feed to this unit has to be increased in order to meet the required Alkylate specification. The Alkylate produced will be sent to the Mogas pool as an important blending stock which can improve the octane and reduce the consumption of imported MTBE.

Key environmental emissions from the revamped Alky Unit will include:

- Spent acid
- Spent caustic

Vacuum Rerun Unit (VRU, Unit 83).

The existing VRU is an open arts unit that was constructed in 1986 with a design capacity of 77,000 BPSD. The feed for this unit is Low Sulphur Atmospheric Residue (LSAR) with a maximum Sulphur content of 0.7%.

In the pre-revamp operation, the main products of Unit 83 are VGO and VR. The components of VGO are drawn off separately from the column and are only mixed after the heat of the HVGO product has been utilized to preheat the feed to the column. The vacuum residue product that is recovered from the bottom of Unit 83 is used for the production of low sulphur fuel oil.

Unit 83 includes one existing gas fired charge heater (H-83-001). The revamp work will not add any new fired equipment nor will it change the existing fired equipment. There will be no impact to the amount or type of effluents generated including atmospheric emissions as a result of the revamp activities. No solid waste is generated by this unit. Ejector condensate (i.e. sour water) is routed to the Sour Water Stripper and ejector slop oil (i.e. dry slops) is processed by the Dry Slops System.

Fluid Catalytic Cracking Unit (FCC Unit 86)

The existing FCC Unit at the MAA Refinery was initially designed in 1984 for a feed rate of 30,000 BPSD of hydrotreated VGO. The unit was revamped in 1997 to increase capacity to 40,000 BPSD. However, parts of the recommended scope on the unit revamp for the reactor, spent catalyst stripper, and feed distributor system were not implemented.

The revamp scope consists of the following work:

- Upgrade of regenerator system to cold wall design,
- Replacement of the feed distribution system with UOP Optimix device,
- Installation of new fluffing air rings and compressor,
- Upgrade of reactor cyclones,
- Upgrade of the spent catalyst stripper to state of the art technology,
- Any additional equipment upgrades identified during scoping study by UOP.

The revamped design will allow the FCC Unit to handle 42,500 BPSD of a heavier feed blend containing VGO and TGO (Trim Gas Oil), CGO and Unconverted Oil (UCO) from various new and existing process units.

A new electrostatic precipitator (ESP) will be installed to reduce particulate emissions from the existing FCC Unit (Unit 86) at MAA under a separate project, which will result in environmental improvement.

Key environmental emissions from the revamped FCC Unit will include:

- Atmospheric emissions from the existing fired heater.
- Suspended particulates (dust particles) emitted from the FCCU to atmosphere.
- Solid waste (i.e. spent catalyst).

2.3.1.3 Retired MAA Refinery Process Units

Crude Distillation Unit (CDU Unit 03)

The CDU is the first important processing step in a refinery. In this unit, crude oil is heated to elevated temperatures and then it is distilled and various fractions are separated according to their boiling ranges. MAA KEC crude that is currently processed by Unit 03 will be routed to the remaining CDUs (CDU Unit 40 and CDU Unit 80). The retirement of this unit will result in a decrease in atmospheric emissions.

Merox Unit 94

The Merox Unit reduces the sulphur content of kerosene feed from CDUs and is currently treating refinery gasoline product. It does not have any fired equipment or solid waste. Once Unit 94 has been retired, the gasoline product will be treated in the new FCC-NHTU Unit 186. The retirement of this unit will result in a decrease in noise.

2.3.1.4 New MAA Refinery Utility & Offsite Units

Many of these facilities will have minimal environmental impact, as they are not process units, and other than the Steam System, do not have continuously operating fired equipment. Impact during their construction is dealt with in relevant chapters. Below, focus is given to those facilities with potential for impacting the environment.

It is noted that material containing Polychlorinated Biphenyls (PCBs) will not be used in equipment provided by the CFP.

Steam System (Unit 129)

The Steam System will be designed to produce steam and boiler feed water (BFW) to support continuous operation of the new CFP refinery units. The steam is used for driving steam turbines, as a process reactant in the production of Hydrogen, and for heating.

Key environmental emissions from the Steam System will include:

- Oily water, which will be routed via gravity drains to the Accidentally Oil Contaminated (AOC) sewer for appropriate treatment and/or disposal.
- Atmospheric emissions from three Utility Steam Boilers.
- Boiler Blowdown.

Hydrocarbon Flare System (HFS, Unit 162)

The Hydrocarbon Flare System (HFS) represents one of the key safety systems in the CFP. It serves as the final line of protection against catastrophic failure resulting from overpressure of equipment and interconnecting piping. The purpose of the HFS is to provide the means for the safe relief and combustion of potentially explosive and/or toxic fluids. These gases and liquids, which are present as feeds, products, or intermediate streams within the refinery processes, must be flared under unplanned upset conditions.

New CFP flares will all be elevated flares.

A single Flare Gas Recovery Unit (FGRU) will be provided. Functionally, a single FGRU will take suction from the flare header at a point located between the Main KO Drum and Water Seal Pot. The FGRU is designed to recover the combined purge/vent flow from each flare header.

Additionally, under typical refinery operations, gases may be vented or liquids blown down to the flare to maintain a required process operating pressure. It is also common practice to start-up or shutdown a process unit by temporarily venting hydrocarbon gases to the flare until the unit can be properly lined out (start-up) or de-pressured and purged (shutdown). However, for the CFP, refinery operations will implement suitable sequencing of unit startups and shutdown to minimize simultaneous planned flaring from different process units.

The key environmental emissions from the Hydrocarbon Flare System will include:

- Gaseous Emissions – SO_2, CO, NO_2 and Hydrocarbons
- Wet slops

Wastewater Treatment System (WWT, Unit 163)

A new WWT plant will be provided to collect, convey and treat wastewater from the MAA CFP block according to the K-EPA requirements prior to any discharge. Process wastewater streams from the CFP units as well as fire fighting water and rainwater runoff from paved process areas are the main streams treated in the WWT Unit.

The new CFP facilities will incorporate state of the art design to complement upgrades to the existing MAB effluent treatment facility under a separate project (KNPC Effluent Treatment Facility Revamp project). The CFP design will incorporate best environmental engineering practices such as 'Best Available Control Technology' (BACT) to avoid, prevent or mitigate the discharge of harmful emissions so as to meet (or exceed) applicable K-EPA environmental standards.

The main wastewater streams treated in the WWT units are process wastewater streams from the CFP units, such as surplus Stripped Sour Water (SSW), Cooling Tower (CT) blowdown, boiler blowdown, as well as fire fighting water and storm water runoff from paved process areas. Storm water runoff from areas and roadways outside paved process areas is collected in an oil catcher and pumped to the Gulf.

The effluent streams generated and collected from the new CFP process units are segregated at the source and collected in one of following seven drainage systems. Effluents segregated and collected in these drainage systems receive different treatment, depending on the source, type and level of contamination.

- Accidentally Oil Contaminated (AOC)

- Oily Drips System (ODS)
- Chemical Collection and Drainage System
- Dry Slops System
- Outside Battery Limits (OSBL) and Roadway Storm Water Drainage System
- Sanitary and Gray Water Collection
- Sludge Collection and Treatment

The key environmental emission from the WWT System will be the treated wastewater discharge to the Gulf.

Fire Water Systems (Unit 166)

The firewater system facilities include the following major unit components:

- Firewater Tanks, pumps and drivers.
- Biocide Injection Systems.
- Ring-Main System.
- Hydrants, Monitors, Post-Indicating Valves, Hose Reels.
- Foam Extinguishing and Storage Systems.
- Water Spray Systems.
- Sprinkler Systems.

Freshwater is supplied for initial make-up of the firewater tanks. Treated effluent water (utility water) from the waste water treatment plant will be used for normal make-up of firewater tank level.

There are no major environmental emissions from the Fire Water Systems, except in an emergency (contaminated firewater) or when fire water pump drivers (diesel engines) are periodically tested.

Acid Gas Flare (Unit 167)

The new elevated Acid Flare System represents one of the key safety systems in the CFP. It serves as the final line of protection against catastrophic failure resulting from overpressure of equipment and interconnecting piping. The purpose of the Acid Flare System is to provide the means for the safe relief and combustion of potentially explosive and/or toxic fluids containing H_2S. These gases and liquids, which are present as feed products, or intermediate streams within the refinery processes, must be flared under unplanned upset conditions.

Additionally, under typical refinery operations, gases may be vented or liquids blown down to the Acid flare to maintain a required process operating pressure. It is also common practice to start-up or shutdown a process unit by temporarily venting gases to the Acid Gas Flare until the unit can be properly lined out (start-up) or de-pressured and purged (shutdown). However, for the CFP, refinery operations will implement suitable sequencing of unit startups and shutdown to minimize simultaneous planned flaring from different process units.

Key environmental emissions from the Acid Gas Flare will include:

- Gaseous Emissions: SO_2, CO, Hydrocarbon, NO_2.
- Sour water from the flare KO drum pumps.

Nitrogen/Air Systems (Unit 171)

The Nitrogen/Air Systems must supply sufficient compressed air to meet the demands of Instrument Air and Plant Air.

Key environmental emissions from the Nitrogen/Air systems will include:

- Water and oily water from air compressors and air dryer package.
- Solid waste (i.e. spent Desiccant Activated Alumina from air dryer packages).

Fuel Gas System (FGS, Unit 174)

Refinery Fuel Gas for the CFP units is supplied primarily by the Coker. When the Coker is down, imported fuel gas will be the primary makeup source.

The main objectives of the FGS are to:

- Remove H_2S from imported fuel gas and ARDS Fractionator off gas with Fuel Gas Scrubber.
- Collect fuel gas from the refinery off gas and treated imported fuel gas, and distribute to various fired heaters and steam generators throughout the MAA facilities.

Key environmental emissions from the FGS will include:

- Oil drips.
- Solid waste (i.e. cartridges from Amine Sump Filter).

Cooling Water System (CWS, Unit 175)

The objective of the Cooling Water System is to maintain the cooling water circulation rate and temperature in order to remove heat from the process and utility units in the new CFP Units at the MAA Refinery.

The Cooling Water System is a closed circuit water system. The major equipment consists of a cooling tower and cooling water pumps. The cooling water is pumped from the cooling tower basin to various process and utility units to remove the heat loads from the units. The hot returning cooling water then enters the cooling tower where the heat is dissipated to the atmosphere.

A small stream of cooling water is directed to blow-down to control the concentration of dissolved solids in the circulating cooling water. Desalinated water is used as make up to the cooling tower basin to replenish the water losses primarily due to evaporation and blow-down. Fresh water is used as back up to the desalinated water. Chemical feed systems are provided to condition the cooling water quality for proper operation.

Key environmental emissions from the Cooling Water System will include:

- Blowdown from cooling water pumps.
- Backwash from side stream filter.

Coke Handling Unit (Unit 187)

A new Coke Handling Unit (Unit 187) in the MAA plant will be provided to transport the coke from the new Delayed Coker Unit (Unit 136) to the existing Coke Storage Building (BD-72-101). In the event of a downstream upset or if the existing Coke Storage Building is full, the Coke Handling Unit can divert the coke to a new Emergency Coke Storage Building which is part of Unit 187.

The new Coke Handling Unit begins at the first coke conveyor inside the new Delayed Coker Unit and extends to the existing Coke Storage Building, BD-72-101, physically tied-in at the existing conveyor BT-72-101. Unit 187 consists of a covered belt conveyance system, ventilation system, deluge system, spray water system, dust collection system, and coke emergency storage and reclaim system.

Key environmental emissions from the Coke Handling Unit will include:

- Dust - To minimize the amount of dust during the transfer of coke, each conveyor transfer chute has a water spray system to suppress the air born dust. The sprayers are switched on automatically when the belts are loaded. Flow rates for each sprayer can be manually adjusted by the operator to meet dust suppression needs. There are also ventilation systems consisting of two inlet air filters and two fans; one fan is operating while the other is on standby. The fans are designed to optimize the air flow for the proper ventilation and displace sufficient volumetric flow to maintain a negative pressure inside the galleries. The negative pressure will prevent any dust emissions from exiting the galleries and transfer towers and entering the surrounding environment.
- Contaminated Water (i.e. water containing coke fines) - Drainage sumps are provided for each transfer tower. These sumps collect the dirty water drains from the coke while being transported or stored and from the spray water system at each tower. The dirty water collected in the sumps is pumped back to the DCU for use as coke cutting water.

2.3.1.5 Revamped MAA Refinery Utilities and Offsite Units

Many of these facilities will have minimal environmental impact, as they are not process units. Impact during their construction is dealt with in relevant chapters. Below, focus is given to those facilities with potential for impacting the environment during operation.

Refinery Tank Farm (pre-refinery Modernization Project RMP, Unit 22)

The tankage facilities will include the following:

- Intermediate product storage.
- Product blending.
- Pumping.
- Finished product storage.

- Product transfer and ship loading.
- Inter-Refinery Transfer (IRT).

Finished and intermediate products are transferred from the processing units to the storage facilities. From storage, intermediate products are pumped to other processing units for finishing or sent to product blenders. Finished products are pumped to the New Oil Pier for ship loading, sent to the local market, or transferred to MAB or SHU. Tankage provides continuous feed capacity to processing units and storage of products/intermediates during unit shutdowns.

Existing storage facilities and pumps will be re-aligned to the operating philosophy for the CFP.

Key environmental impacts will include VOC emissions from the storage, filling and emptying of hydrocarbon tankage.

CCR-1&2 Flare (Units 25/26)

The existing Units 25 & 26 are two identical units each consisting of two major sections: Naphtha Hydrotreater (NHT) and Continuous Catalytic Reformer (CCR). Hydrotreated naphtha is separated into light naphtha and heavy naphtha in a splitter column located in each of the NHTs. The heavy naphtha product from NHT is fed to CCR, as per the existing configuration. A study done in 2008, confirms that the existing major equipment are suitable for the revamp operating conditions and for providing feed definition for the downstream C5/C6 Isom unit. Existing Flare Units 25/26 will be revamped to serve the Units.

Key environmental impacts from the flares will include atmospheric emissions.

Eocene Topping Unit Flare (Unit 39)

The purpose of the revamped elevated Flare Unit 39 is to provide the means for the safe relief and combustion of potentially explosive and/or toxic fluids - it represents one of the key safety systems in the KNPC Clean Fuels Project 2020 (CFP-2020). Additionally, under typical refinery operation, gases may be vented or liquids blown down to the flare system to maintain a required process operating pressure or liquid level.

The flare is designed to receive the relief loads from the Eocene Topping Unit 39, the Bitumen Plant Unit 12 and the new Storage Facilities Unit 61. For design purposes, a liquid rate equivalent to 5 wt% of the gas stream is assumed for sizing the knock-out drum and pump.

Key environmental impacts will include atmospheric emissions.

Flare (Unit 62)

Elevated Flare Unit 62 is to be revamped under the CFP. Key environmental emissions from the flare will include atmospheric emissions during emergency relief. Emissions are expected to be minimal during normal refinery operations.

2.3.2 MAB Refinery

Nineteen new process units are planned for the MAB refinery:

1	Crude Distillation Unit	CDU, Unit 111
2	Atmospheric Residue Desulphurization	ARDS, Unit 112
3	Atmospheric Residue Desulphurization	ARDS, Unit 212
4	Heavy Oil Cooling	HOC, Unit 113
5	Hydrocracker Unit	HCR, Unit 114
6	Kerosene Hydrotreater Unit	KHT, Unit 115
7	Diesel Hydrotreater Unit	DHT, Unit 116
8	Naptha Hydrotreater Unit	NHT, Unit 117
9	Hydrogen Plant	H2 Plant, Unit 118
10	Hydrogen Recovery	HR, Unit 119
11	Sulphur Recovery Unit	SRU, Unit 123
12	Amine Regeneration Unit	ARU, Unit 125
13	Sour Water Stripping Unit	SWS, Unit 126
14	Continuous Catalytic Reformer	CCR, Unit 127
15	Hydrogen Production Unit (HPU) Feed Treating & Compression	HR Unit 128-01 & 128-02
16	Saturates Gas Plant	SGP, Unit 129
17	Vacuum Rerun Unit	VRU, Unit 213
18	Hydrocracker Unit	HCR, Unit 214
19	Diesel Hydrotreater Unit	DHT, Unit 216

Two revamped process units are planned for the MAB refinery:

1	Crude Distillation Unit	CDU, Unit 11
2	Vacuum Unit	VU, Unit 13

Three process units are planned for retirement at the MAB refinery:

1	Crude Distillation Unit	CDU, Unit 01
2	RCD Unibon Unit	Unit 02
3	Hydrogen Unit	H2 Plant, Unit 03

Nineteen new U&O Units are planned for the MAB refinery:

1	Steam System	Unit 131
2	Cooling Water System	Unit 132
3	Fuel System	Unit 133
4	Nitrogen/Air Systems	Unit 134
5	Electrical	Unit 136
6	Water Systems	Unit 137
7	Acid Gas Flare	Unit 146
8	Interconnecting Pipeways (New CFP Block)	Unit 148

9	Hydrocarbon Flare	Unit 149
10	Interconnecting Pipeways (Existing Refinery)	Unit 150
11	Incoming HV Power Supply	Unit 152
12	Fire Water Systems	Unit 154
13	Wastewater Treatment System	Unit 156
14	Integrated Control & Safety System (ICSS)/ Enterprise Integration & Communication Systems (EICS)	Unit 159
15	Buildings	Unit 165
16	Site Prep/Roads/Paving/Fencing/Temp Facilities & Electrical	Unit 166
17	Underground Piping	Unit 179
18	DHT Flare	Unit 249
19	HCR Flare	Unit 314

Six revamped U&O Units are planned for MAB refinery:

1	Utilities and Offsites	Unit 06
2	Interconnecting Pipeways	Unit 48
3	Tank Farm	Unit 50
4	Product Pumping & Blending	Unit 51
5	Pre-RMP Tank Farm	Unit 52
6	Inter Refinery Transfer Lines	Unit 53

A number of existing MAB Units will also have tie-in with the CFP, or minor equipment modifications. However, these will not have any significant environmental impact.

2.3.2.1 New MAB Refinery Process Units

Crude Distillation Unit (CDU, Unit 111)

The new CDU will have a capacity to process 264,000 BPSD of KEC feed, while the remaining 190,000 BPSD of KEC is fed to the existing CDU (Unit 11, which will be revamped under this project). The new CDU will have two main sections: the Crude Tower Section and the Naphtha Stabilizer Section.

Unit 111 produces medium and low pressure off-gases, LPG, Naphtha, Kerosene, Light and Heavy Diesel, and Atmospheric Residue. The Naphtha is a finished product, while all the other streams undergo further processing.

Key environmental emissions from the CDU will include:

- Atmospheric emissions from the two crude heaters.
- Sour waste water which will be routed to the SWS Unit for treatment.
- Desalter Effluent Water, which will be routed to WWT (Unit 156).

Atmospheric Residue Desulphurization (ARDS, Unit 112 & Unit 212)

CFP will provide two new ARDS Units at the MAB Refinery, which will be designed to process 100% High Sulphur Atmospheric Residuum (HSAR) from the new CDU (Unit 111). The process removes sulphur from the hydrocarbon feed stream by treating the feed with hydrogen gas over a noble metal alloy catalyst of a fixed bed reactor. Unit 112 will consist of two identical trains. Unit 212 will have a single train. The primary product of the ARDS Units is a hydrotreated LSAR with 0.5 wt% sulphur. Other major products are diesel, stabilized naphtha and sour Liquefied Petroleum Gas (LPG).

This process and associated emissions are further described in the process unit in MAA (ARDS, Unit 141).

Key environmental emissions from each ARDS Unit will include:

- Atmospheric emissions from the reactor feed furnace(s) and fractionation feed furnace.
- Sour water sent to centralized Sour Water Treating (SWT) unit
- Solid waste stream (i.e. spent catalyst).

Heavy Oil Cooling (HOC, Unit 113)

Apart from slops, there are no major environmental emissions from the HOC Unit.

Hydrocracker (HCR, Unit 114)

A new HCR Unit will be provided to convert VGO, TGO, and CGO to lighter products. It will produce sour LPG light naphtha, heavy naphtha, kerosene, diesel (when operating in Distillate mode), and a small amount of unconverted oil (UCO). Kerosene is the primary intended product.

Key environmental emissions will include:

- Atmospheric emissions from three gas fired heaters.
- Solid waste (i.e. spent catalyst)
- Sour water will be sent to the new Sour Water Stripping Unit (Unit 126).

Kerosene Hydrotreater (KHT, Unit 115)

The new KHT will be fuel-gas fired and will produce Dual Purpose Kerosene (DPK). The unit will be designed to process a flow of straight run (SR) kerosene and coker kerosene. The MAB Refinery currently has an existing 100 ppmw Sulphur Kerosene Hydrotreater (KHTU-15). The specification for hydrotreated kerosene from the new KHT will be a maximum of 7 ppmw sulphur as required for blending into the Ultra Low Sulphur Diesel (ULSD) pool.

The new KHT will consist of two sections: a Reactor Section and a Product Stripper Section. The KHT feedstock will be reacted over a catalyst bed in a Hydrogen-rich environment at elevated temperature. The process reduces the Sulphur content and improves the smoke point as required to meet ATF specifications.

Key environmental emissions from the CDU will include:

- Atmospheric emissions from one gas fired charge heater.
- Sour water, which will be sent for treatment to the new SWS (Unit 126).
- Solid waste (i.e. spent catalyst).

Diesel Hydrotreater (DHT, Unit 116 & Unit 216)

As part of the CFP-2020, two new DHT Units (Unit 116 and Unit 216) will be installed capable of processing 73 KBPSD and producing Ultra Low Sulfur Diesel (ULSD) fuel for export. Unit 116 will be retained within the new CFP Refinery Block whereas Unit 216 will be located within the existing MAB Refinery area to allow for the continued production of ULSD during CFP shutdowns.

Both Units will be designed to process an identical feed slate consisting of light straight (SR) diesel, ARDS diesel and coker diesel to satisfy ULSD Product Quality Specifications while also meeting a minimum catalyst run length of 30 months. All unit feedstocks are derived from 100% KEC. Unit-216 will be provided with a dedicated amine regeneration unit to minimize impact to the existing refinery facilities.

Key environmental emissions from each DHT will include:

- Atmospheric emissions from gas fired charge heater.
- Sour wastewater, which will be sent for treatment to a SWS.
- Solid waste (i.e. spent catalyst).

Naphtha Hydrotreater (NHT, Unit 117)

A new NHT will be provided to produce hydrotreated/desulphurized full range Naphtha. The new NHT will be directly coupled to a new downstream CCR.

The quality of the hydrotreated naphtha product from the new NHT contains a maximum sulphur level of <0.5 ppmw, a maximum nitrogen level of <0.5 ppmw, and have a bromine index < 100 (nil olefins).

The NHT feedstock will be reacted over a catalyst bed in a Hydrogen-rich environment at elevated temperature. The process will de-sulphurize the heavy Naphtha to meet CFP specifications.

Key environmental emissions from the NHT will include:

- Atmospheric emission from one gas fired charge heater.
- Sour wastewater, which will be sent for treatment to the new SWS.
- Solid waste (i.e. spent catalyst).

Hydrogen Plant (H2 Plant, Unit 118)

CFP will include a new H2 Plant to provide the Hydrogen required for the new hydroprocessing units in the refinery. The new Hydrogen Plant will consist of three Hydrogen Production Trains.

The new H2 Plant will utilize steam reforming to generate Hydrogen. The Reformer Furnace will normally be fired using H2 Plant PSA tail gas. This fuel will be supplemented by refinery fuel gas when necessary.

Key environmental emissions from the H2 Plant will include:

- Oily water generated during steam-out of vessels and other equipment during shutdown which will be collected by an Oil Drip Sewer (ODS).
- Atmospheric emissions from three tubular reformer furnaces.
- Solid waste (i.e. spent catalyst)

Hydrogen Recovery (HR, Unit 119)

The Cold Low Pressure Separator (CLPS) off-gas streams from the ARDS (Units 112 and 212) and HCR (Unit 114) contain sufficient Hydrogen to justify recovery through Hydrogen Recovery. The recycle gas purges from the KHT, DHT and HCR will also be fed to HR for Hydrogen recovery.

The new HR will have two main sections: the Amine System and the PSA Unit. The Amine System will be composed of two absorbers; the first one removes Ammonia from the feed gas using wash water, and the second removes H_2S from the feed gas using Amine solution (45% MDEA)

Key environmental emissions from the HR Unit will include:

- Sour water from water wash knock-out.
- Solid waste (i.e. sieve packing).

Sulphur Recovery Unit (SRU, Unit 123)

H_2S will be recovered and sent to the new SRU where it will be converted into elemental Sulphur and exported as a refinery byproduct. Unit 123 will be designed to process acid gas streams from the new Amine Regeneration Units and the new Sour Water Stripper Units. It will recover at least 99.9 weight percent sulphur from the acid gas feed streams, incinerate the ammonia, and oxidize the residual sulphur to sulphur dioxide before venting it to the atmosphere.

Unit 123 will be comprised of three 450 MT/day trains. The three plants will be designed as 3-35% units. Normally all three plants will be in operation. Each train will have a Tail Gas Incinerator, including waste heat recovery for steam optimization and utilization within the unit and for steam export. A dedicated incinerator stack will also be provided for each train.

Key environmental emissions from the SRU will include:

- Atmospheric emissions, primarily SO_2 from the Tail Gas Incinerator within each SRU.
- Solid waste (i.e. spent catalyst, ceramic balls, and filter cartridges)

Amine Regeneration Unit (ARU, Unit 125)

A new ARU will be provided to strip H_2S from the amine solution. The ARU will consist of two 70% trains, each with a design capacity of 1100 m^3/hour. These trains will receive rich amine and supply lean amine to the new Amine Absorbers/Contactors. The H_2S that is stripped out will be sent as a concentrated acid gas stream to the SRU.

The ARU design will include provision for injecting corrosion inhibitor into the Amine System.

Key environmental emissions from the ARU will include:

- Liquid hydrocarbons (i.e. wet slops from Flare KO Drum).
- Solid waste (i.e. mechanical filter cartridges and spent activated carbon filters).
- H2S acid gas stream (to SRU)

Sour Water Stripper (SWS, Unit 126)

Sour water containing appreciable concentrations of H_2S and NH_3 is produced from several units. The sour water is steam stripped to suitable levels of H_2S and NH_3 for additional treatment in the WWT Unit (Unit 156). A significant volume of stripped water will be reused in the CDU and ARDS Units, with smaller volumes required by the KHT, DHT and NHT.

The SWS will consist of two plants, each with a design capacity of 300 m^3/hour. Each plant provides 75% of the needed flow rate and both plants will normally be operated simultaneously.

The SWS will be designed to separate non-aqueous gas, light hydrocarbons, and oil emulsions from the sour water feed before steam stripping to remove the bulk of the H_2S and NH_3. Sour water may also contain phenols, cyanides, and carbon dioxide.

Key environmental emissions from the SWS will include:

- Oily water drains: collected liquid hydrocarbons in the Sour Water Feed Drum will be separated and pumped to the Hydrocarbon Flare KO Drum.
- Stripped sour water to wastewater treatment (WWT Unit 156).

Continuous Catalytic Reformer (CCR, Unit 127)

A new CCR will be provided and coupled with the new NHT (Unit 117) to process a flow rate of up to 18,000 BPSD of hydrotreated Full Range Naphtha (FRN) from the NHT. The CCR will include a Naphtha Splitter Section followed by a Reformer Section.

Products from the CCR include Reformate, Light Naphtha, LPG and Net Gas Byproducts. The byproducts include Debutanizer overhead gas, which will be sent to the Fuel Gas System and spent Caustic from catalyst regeneration, which will be sent to the Water Treatment Unit for neutralization.

Hydrogen required for start-up of the new CCR will be sourced from the new HPU (Unit 118), new HRU (Unit 119), and the new membrane unit, which treats the Hydrogen-rich ARDS purge stream.

Key environmental emissions from the CCR will include:

- Atmospheric emission from five gas fired heaters (two stacks).
- Solid waste (i.e. spent CCR catalyst).
- Spent caustic (to WWT plant)

Hydrogen Production Unit Feed Treating & Compression (HPU, Unit 128-01)

CFP will include a new HPU Feed Treating & Compression Unit to treat / remove H_2S, as well as CO_2 and NH_3 from the feed gas stream in an Amine Absorber.

Key environmental emissions from the HPU Feed Treating and Compression will include sour water, which will be sent for treatment to the new SWS (Unit 126).

Hydrogen Compression (HC, Unit 128-02)

CFP will include a new HC Unit to provide the Hydrogen required for the new hydroprocessing units in the refinery. The total Hydrogen product will be compressed in the new, centralized HC facility to supply the requirements of the hydrotreating units. The major components of the new HC will include multi-stage reciprocating Hydrogen Compressors, various suction drums and discharge coolers.

Key environmental emissions from the HC may include generation of intermittent liquid wastewater stream consisting of hydrocarbons with sour water, from the suction drums.

Saturates Gas Plant (SGP, Unit 129)

The new SGP will process the off-gas streams produced in the new CDU and the planned New Refinery Project hydroprocessing units; the sour LPG produced in the new ARDS, the new Hydrocracker, and the new CDU; as well as sweet LPG produced by the new CCR. The SGP will have a capacity to process 35 MMSCFD of off-gas and 12,000 BPSD of LPG.

The SGP will produce treated refinery off-gas (100 ppmv H_2S maximum; 50 ppmv per design basis) and an LPG-rich stream (less than 20 ppmw H_2S).

Lean Amine solution will be used in two separate Amine Scrubbers: a Refinery Off-gas Amine Scrubber and an LPG Amine Contactor. These will remove H_2S from the refinery off-gas and the sour LPG liquid.

Key environmental emissions from the SGP will include:

- Water Wash Coalescer - supplier to recommend disposal options during EPC.
- Rich Amine Filter

Vacuum Rerun Unit (VRU, Unit 213)

The VR Unit will process Low Sulphur Atmospheric Residuum (LSAR) from the ARDS units to yield a variety of products, including DFO, VGO, TGO and VR.

The only fired equipment item within the new VR Unit will be the Vacuum Charge Heater. Off-gas from the Ejector System will be routed through an MDEA scrubber prior to being disposed of by burning in the Vacuum Charge Heater.

Key environmental emissions from the VR Unit will include:

- Atmospheric emissions from the gas-fired Vacuum Charge Heater.
- Sour water collected in the condensate drums and routed to SWS Unit.
- Slop oil, which will be collected in the condensate drums.

Hydrocracker Unit (HCR, Unit 214)

The main objective of the HCR Unit 214, a 50,000 BPSD Unit, is to convert heavy vacuum gas oil (VGO), trim gas oil (TGO), and heavy SR diesel to lighter products meeting specifications of LPG, naphtha, kerosene and diesel. Unconverted Oil (UCO) will also be produced as by-product or as lube oil base stock (LOBS). The feed to the unit can be supplied directly from the upstream Vacuum Rerun (VRU), Crude Distillation (CDU), and Delayed Coker (DCU) units for maximum hot feed available, and supplemented with cold feed from storage.

Unit 214 shall consist of two stages, with a common fractionation system, to separate the products. Each stage is provided with independent feed/effluent heat exchanges, feed heaters, product separators, and a gas recycle system. The unit shall be able to operate with the first or second stage online, while the other stage is down.

Key environmental emissions will include:

- Atmospheric emissions from three gas fired heaters.
- Solid waste (i.e. spent catalyst)
- Sour water will be sent to the new Sour Water Stripping Unit (Unit 126).

Diesel Hydrotreating Unit (DHT, Unit 216)

See details for Unit 116 above.

2.3.2.2 Revamped MAB Refinery Process Units

Crude Distillation Unit (CDU, Unit 11)

For CFP, the existing CDU (Unit 11) will continue to process Kuwait Export Crude (KEC) in parallel with the new CDU (Unit 111). The capacity of the existing CDU will remain at 190,000 BPSD, however the unit will be upgraded to produce a heavier diesel cut and improve the reliability and safety of the unit.

Heater firing for the CDU Charge Heater will be 100% fuel gas with back-up from the fuel oil system. CFP will provide the following modifications and enhancements:

- New Heavy Diesel Side Stripper,
- Spare Flashed Crude Pump,
- Crude Tower Modifications,
- Kerosene Product Water Cooler Modifications,
- ATM Residue / Flashed Crude Exchanger Modifications, and
- New Temperature Control Station.

The revamp works will not change or impact emissions. Key environmental emissions from the revamped CDU will remain as:

- Atmospheric emissions from heater
- Sour water which will be routed to the SWS
- Desalter effluent which is routed to the WWT
- Dry and wet slops which are collected and routed to storage

Vacuum Unit (VU, Unit 13)

The existing VU consists of two trains originally designed to process Low-Sulphur Atmospheric Residue (LSAR). The products from the VU are Light Vacuum Gas Oil (LVGO), Heavy Vacuum Gas Oil (HVGO), and Vacuum Residue (VR).

The CFP revamp will decrease the throughput of each of the two existing trains in order to maximize the overall gas oil product yield.

Key environmental emissions from the revamped VRU will not change with the revamp. The revamp work will not impact the two existing gas fired heaters. There is no solid waste generated by this unit. Sour water is collected in the condensate drums and routed to the SWS.

2.3.2.3 Retired MAB Refinery Process Units

Retirement of some MAB refinery process units will result in environmental benefit, as the following will cease:

- Atmospheric emissions from the crude heaters and furnace.
- Solid waste (i.e. spent catalysts).
- Liquids collected in the HPU flare knockout drum.

2.3.2.4 New MAB Refinery Utility and Offsite Units

Nineteen new U&O Units are planned for the MAB refinery. Many of these facilities will have minimal environmental impact, as many are not process units. Impact during their construction is dealt with in relevant chapters. Below, focus is given to those facilities with potential for impacting the environment during operation.

Steam System (Unit 131)

The Steam System will be designed to produce steam and Boiler Feed Water (BFW) to support continuous operation of the new CFP refinery units. The steam is used for driving steam turbines, as a process reactant in the production of Hydrogen, and for heating.

Key environmental emissions from the Steam System will include:

- Oily water, which will be routed via gravity drains to the Accidentally Oil Contaminated (AOC) sewer for appropriate treatment and/or disposal.
- Atmospheric emissions from six Utility Steam Boilers.
- Boiler Blowdown.

Cooling Water System (Unit 132)

The objective of the Cooling Water System is to maintain the cooling water circulation rate and temperature in order to remove heat from the process and utility units in the new CFP Units at the MAB Refinery.

The Cooling Water System is a closed circuit water system. The major equipment consists of a cooling tower and cooling water pumps. The cooling water is pumped from the cooling tower basin to various process and utility units to remove the heat loads from the units. The hot returning cooling water then enters the cooling tower where the heat is dissipated to the atmosphere.

A small stream of cooling water is directed to blow-down to control the concentration of dissolved solids in the circulating cooling water. Desalinated water is used as make up to the cooling tower basin to replenish the water losses primarily due to evaporation and blow-down. Fresh water is used as back up to the desalinated water. Chemical feed systems are provided to condition the cooling water quality for proper operation.

Key environmental emissions from the Cooling Water System will include:

- Blowdown from cooling water pumps.
- Backwash from side stream filter.

Fuel Gas System (Unit 133)

Refinery Fuel Gas for the CFP units is supplied primarily by the Coker. When the Coker is down, imported fuel gas will be the primary makeup source.

The main objectives of the FGS are to:

- Remove H_2S from imported fuel gas and ARDS Fractionator off gas with Fuel Gas Scrubber.
- Collect fuel gas from refinery off gas and treated imported fuel gas, and distribute to various fired heaters and steam generators throughout MAB.

Key environmental emissions from the FGS will include:

- Oil drips.
- Solid waste (i.e. cartridges from Amine Sump Filter).

Nitrogen/Air Systems (Unit 134)

The Nitrogen/Air Systems must supply sufficient compressed air to meet the demands of Instrument Air and Plant Air.

Key environmental emissions from the Nitrogen/Air systems will include:

- Water and oily water from air compressors and air dryer package.
- Solid waste (i.e. spent Desiccant Activated Alumina from air dryer packages).

Unit 137 Water Systems

There are a number of new water systems onsite, such as desalinated water, potable water, fresh water, demineralised water and cooling water. These new systems will have a number of environmental issues associated with them such as:

- Noise from pumps etc
- Waste generated(e.g. resins)
- Resource use

Acid Gas Flare (Unit 146)

The Acid Gas Flare Unit 146 is a new elevated flare and represents one of the key safety systems in the CFP. It serves as the final line of protection against catastrophic failure resulting from overpressure of equipment and interconnecting piping. The purpose of the Acid Gas Flare is to provide the means for the safe relief and combustion of potentially explosive and/or toxic fluids containing H2S. These gases and liquids, which are present as feeds, products, or intermediate streams within the refinery processes, must be flared under unplanned upset conditions.

Additionally, under typical refinery operations, gases may be vented or liquids blown down to the Acid Gas Flare to maintain a required process operating pressure. It is also common practice to start-up or shutdown a process unit by temporarily venting gases to the Acid Gas Flare until the unit can be properly lined out (start-up) or de-pressured and purged (shutdown). However, for the CFP, refinery operations will implement suitable sequencing of unit startups and shutdown to minimize simultaneous planned flaring from different process units.

Key environmental emissions from the Acid Gas Flare will include:

- Gaseous emissions: SO_2, CO, Hydrocarbon, NO_2.
- Sour water from the flare KO drum pumps.

Hydrocarbon Flare System (HFS, Unit 149)

The Hydrocarbon Flare System (HFS) represents one of the key safety systems in the CFP. It serves as the final line of protection against catastrophic failure resulting from overpressure of equipment and interconnecting piping. The purpose of the HFS is to provide the means for the safe relief and combustion of potentially explosive and/or toxic fluids. These gases and liquids, which are present as feeds, products, or intermediate streams within the refinery processes, must be flared under unplanned upset conditions.

All CFP flares are elevated flares. The new hydrocarbon flare system for MAB includes a High Pressure HP Flare and a Low Pressure LP Flare.

A single Flare Gas Recovery Unit (FGRU) will be provided. Functionally, a single FGRU will take suction from the flare header at a point located between the Main KO

Drum and Water Seal Pot. The FGRU is designed to recover the combined purge/vent flow from each flare header.

Additionally, under typical refinery operations, gases may be vented or liquids blown down to the flare to maintain a required process operating pressure. It is also common practice to start-up or shutdown a process unit by temporarily venting hydrocarbon gases to the flare until the unit can be properly lined out (start-up) or de-pressured and purged (shutdown). However, for the CFP, refinery operations will implement suitable sequencing of unit startups and shutdown to minimize simultaneous planned flaring from different process units.

Key environmental emissions from the Hydrocarbon Flare System will include:

- Gaseous emissions – SO_2, CO, NO_2 and Hydrocarbons
- Wet slops

Fire Water Systems (Unit 154)

The firewater system facilities include the following major unit components:

- Firewater Tanks, pumps and drivers.
- Biocide Injection Systems.
- Ring-Main System.
- Hydrants, Monitors, Post-Indicating Valves, Hose Reels.
- Foam Extinguishing and Storage Systems.
- Water Spray Systems.
- Sprinkler Systems.

Freshwater is supplied for initial make-up of the firewater tanks. Treated effluent water (utility water) from the waste water treatment plant will be used for normal make-up of firewater tank level.

There are no major environmental emissions from the Fire Water Systems, except in an emergency or when fire water pump drivers (two diesel engines) are periodically tested.

Wastewater Treatment System (WWT, Unit 156)

A new WWT System will be provided to collect, convey and treat wastewater from the MAB CFP block according to the K-EPA requirements prior to any discharge. Process wastewater streams from the CFP units as well as fire fighting water and rainwater runoff from paved process areas are the main streams treated in the WWT Unit.

The new CFP facilities will incorporate state of the art design to complement upgrades to the existing MAB effluent treatment facility under a separate project (KNPC Effluent Treatment Facility Revamp project). The CFP design will incorporate best environmental engineering practices such as 'Best Available Control Technology' (BACT) to avoid, prevent or mitigate the discharge of harmful emissions so as to meet (or exceed) applicable K-EPA environmental standards.

The main wastewater streams treated in the WWT units are process wastewater streams from the CFP units, such as surplus Stripped Sour Water (SSW), Cooling Tower (CT) blowdown, boiler blowdown, as well as fire fighting water and storm water runoff from paved process areas. Storm water runoff from areas and roadways outside paved process areas is collected in an oil catcher and pumped to the Gulf.

The effluent streams generated and collected from the new CFP process units are segregated at the source and collected in one of following seven drainage systems. Effluents segregated and collected in these drainage systems receive different treatment, depending on the source, type and level of contamination.

- Accidentally Oil Contaminated (AOC) drainage system
- Oil Drips System (ODS) Drainage and Biological Treatment System
- Chemical Collection and Drainage System (DCH)
- Dry Slops System (DS)
- Outside Battery Limit (OSBL) and Roadway Rainwater Drainage System
- Sanitary and Grey Water Collection System
- Sludge Collection and Treatment System

Oily solids from the oil separators in the CFP ODS System will be routed to the oily sludge centrifuges for dewatering, and the resulting dewatered cake will be incinerated in a fluidized bed incinerator. This incinerator will be designed with adequate capacity to also incinerate oily sludge streams from the rest of the MAB Refinery, MAA Refinery and open market.

Key environmental emissions from the WWT System will be:

- Treated wastewater discharge
- Incinerator ash (disposed to landfill).
- Atmospheric discharges from sludge incinerator stack

DHT Flare (Unit 249) & HCR Flares (Unit 314)

New elevated flare units will also be provided at Units 249 and 314 (High Pressure and Low Pressure).

They will serve as the final line of protection against catastrophic failure resulting from overpressure of equipment and interconnecting piping. Under normal operating conditions, emissions from the flares are not significant, consisting only combustion products from pilot gas and purge gas.

Miscellaneous New Uitlities & Offsite Units

New Utility and Offsite Units are also provided at Units 136, 148, 150, 159, 165 and 166, although they do not have significant environmental aspects associated with them.

2.3.2.5 Revamped MAB Refinery Utilities & Offsite Units

Many of these facilities will have minimal environmental impact, as they are not process units. Impact during their construction is dealt with in relevant chapters. Below, focus is given to those facilities with potential for impacting the environment during operation.

Tank Farm (Unit 50)

The existing Tank Farm at the MAB Refinery receives, stores, blends and transfers feed, intermediate, product and finished product streams from source units and sends them to the process units, ship loading facilities or to pipelines. For CFP, existing tankage will be reallocated to meet distribution requirements.

Key environmental impacts will include VOC emissions from the storage, filling and emptying of hydrocarbon tankage.

Pre-RMP Tank Farm (Unit 52)

There are three types of residual stocks held in dedicated storage for the refinery. They include Sour Atmospheric Residual (SAR), Low Sulphur Atmospheric Residue (LSAR) and Low Sulphur Fuel Oil (LSFO). Dedicated storage tanks and piping are maintained for each of the three commodities although residual storage tanks can be used interchangeably depending on the current mode of refinery operation.

Key environmental emissions from the Pre-RMP Tank Farm will include VOC emissions.

2.3.3 SHU Refinery

The process units planned for retirement at SHU are:

1	Burgan Gas Treating	Unit 01
2	Hydrogen Manufacturing	Unit 02
3	Hydrogen Compression	Unit 03
4	Sulphur Recovery	Unit 04
5	Catalytic Reformer	Unit 05
6	Crude and Vacuum	Unit 06
7	H-Oil	Unit 07
8	Isomax	Unit 08
9	Naphtha Fractionation	Unit 09
10	Naphtha Unifier	Unit 10
11	Kerosene Unifier	Unit 11
12	Diesel Unifier	Unit 12
13	Light / Heavy Defile Unifier	Unit 13
14	Amine Treating	Unit 14
15	Merox Treating	Unit 17
16	Acid Gas Removal Plant	Unit 61
17	Hydrogen Manufacturing Train	Unit 62
18	H-Oil Vacuum	Unit 63
19	Hydrocracking Exp. C. Water Sys.	Unit 64
20	Isocracker	Unit 68
21	New Sulphur Recovery	Unit 74

In addition, the utility steam boilers at SHU will be decommissioned. Although the retirement of these SHU facilities are not part of the CFP scope, their decommissioning will be conducted in parallel with the commissioning of the CFP facilities. The retirements of these units will significantly improve environmental conditions in the area surrounding the SHU refinery, because they are some of KNPC's oldest and least efficient operating facilities.

Six Retained/Revamped Tank Farm Units are planned for SHU:

1	Local Ship Pumps	Unit 30
2	Marine Shipping Pumps	Unit 32
3	Shuaiba Harbor	Unit 33
4	Transfer Pumps	Unit 34
5	Shuaiba Oil Pier	Unit 38
6	Inter Refinery Transfer Pipe	Unit 65

One new U&O Units are planned for the SHU refinery:

1	Utility Area Air System	Unit 129

2.4 CFP Construction

The CFP will have ten EPC contractors: three EPC Contractors at MAA, five EPC Contractors at MAB, one EPC Contractor for SHU and one EPC buildings Contractor (responsible for both MAA and MAB).

There will be three other major contracts: a high voltage contract and two early works contractors (one in MAA and one in MAB). The buildings and high voltage contractors will have activity in both MAA & MAB.

The overall construction window for the CFP is 45 months with the preparatory works being 10 months long and the effective construction duration being 35 months.

2.4.1 Preparatory works

The initial preparatory works at the CFP will involve the following:

- Demolition of buildings
- Removal of existing utilities
- Clearing/grubbing
- Cut and fill
- Installation of major underground headers in the E-W pipe rack corridors
- Installation of main permanent roads
- Installation of construction roads
- Installation of gates and fencing
- Installation of site support buildings (guardhouses, visitor centre, central medical facility, site office at MAB, etc).

At the same time, a full range of temporary utilities will need to be provided throughout the construction phase – i.e. power, water, sanitation, telecoms etc. such as:

- *Construction power supply*: It is estimated that 6.25MW will be required at MAA for construction purposes. 11.8 MW will be required at MAB, and 6 MW will be required at SHU.
- *CFP site lighting*: Area lighting will be installed at the construction entrances.
- *Water supply*: Site temporary water will be provided to the EPC contractors via a water tie-in point. EPC's will be responsible for routing the water to their networks.
- *Sanitary system*: Specific details on the collection of sanitary waste were not available at the time of writing of this EIA, however each EPC Contractor is responsible to adhere to Project and Regulatory Requirements.
- *Temporary site drainage*: to ensure efficient construction, the CFP site will need to be effectively drained. Conceptually, the EPC contractor will contain storm water on site using existing drainage channels/ditches.

Water Quality will be monitored by the EPC Contractor and, if it meets K-EPA water quality standards, it will be discharged via existing storm water discharge outlets at MAA or MAB. If the water quality does not meet K-EPA standards, it will be treated, by the EPC contractor, prior to discharge. There will be no new discharge outlets provided during construction. Existing refinery wastewater treatment facilities will not be used for treatment of construction drainage.

The site will be rough graded and sloped to allow the controlled runoff of surface water. Engineering has optimized the site elevation to balance the cut and fill requirements and thus the current estimated excess material is minimal. It is estimated that there with be 129,106 m^3 of stripped topsoil at MAA and 259,028 m^3 at MAB. The net, after balancing cut and fill, will be -6,500 m^3 of cut at MAA (shortage) and 67,000 m^3 of cut at MAB (surplus).

2.4.2 Construction

Impacts during construction are discussed in the various chapters in this report. The construction lay down areas are shown in Figure 13B in Chapter 13.

The following two figures 2.F and 2.G provide:

- a provisional master schedule for the CFP construction which demonstrates how the various CFP construction activities, from contracts being awarded to commissioning and start-up, fit together
- Two curves showing planned progress and manpower from June 2010 to May 2015.

Figure 2.F: Provisional Master Construction Schedule

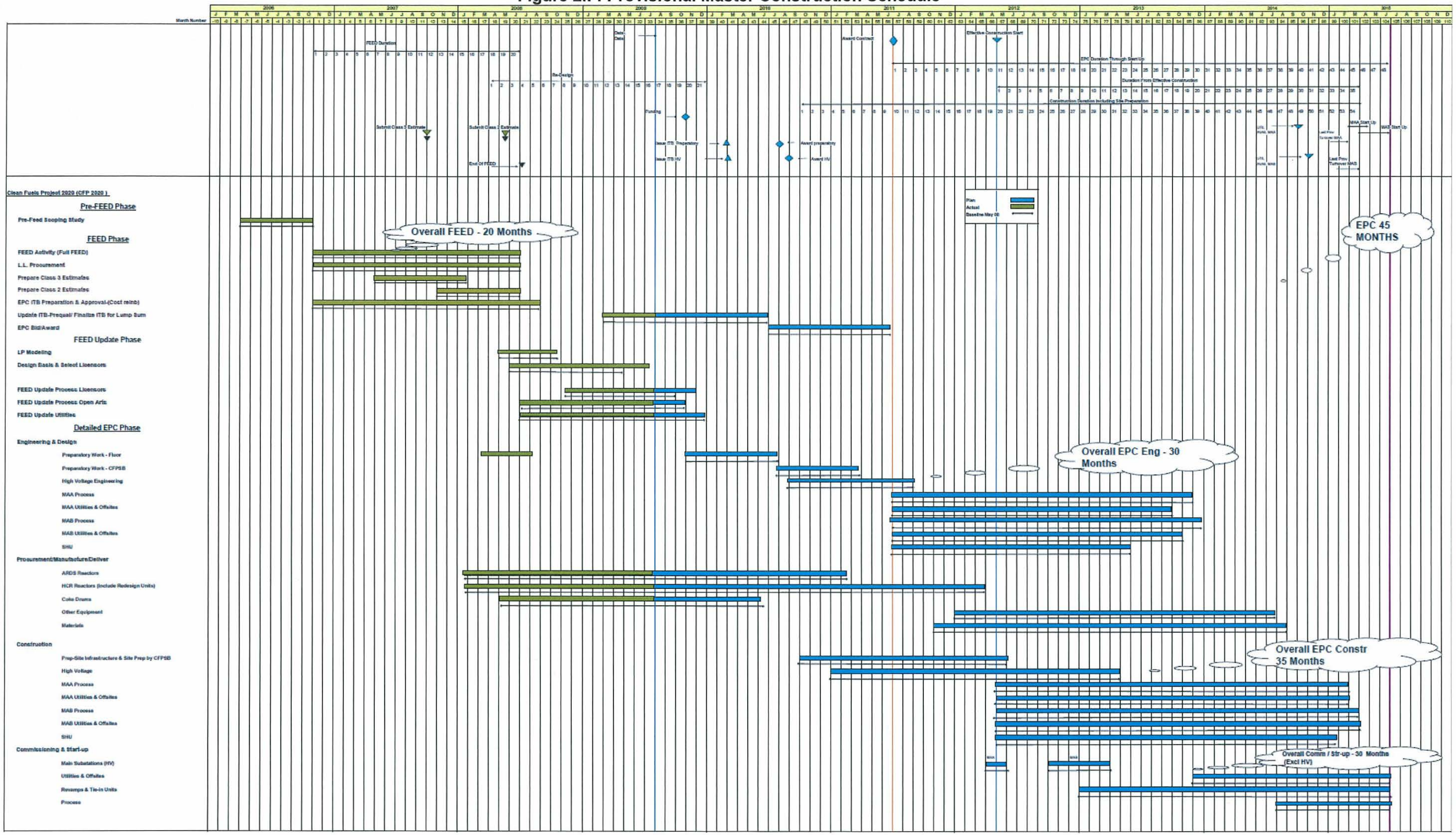
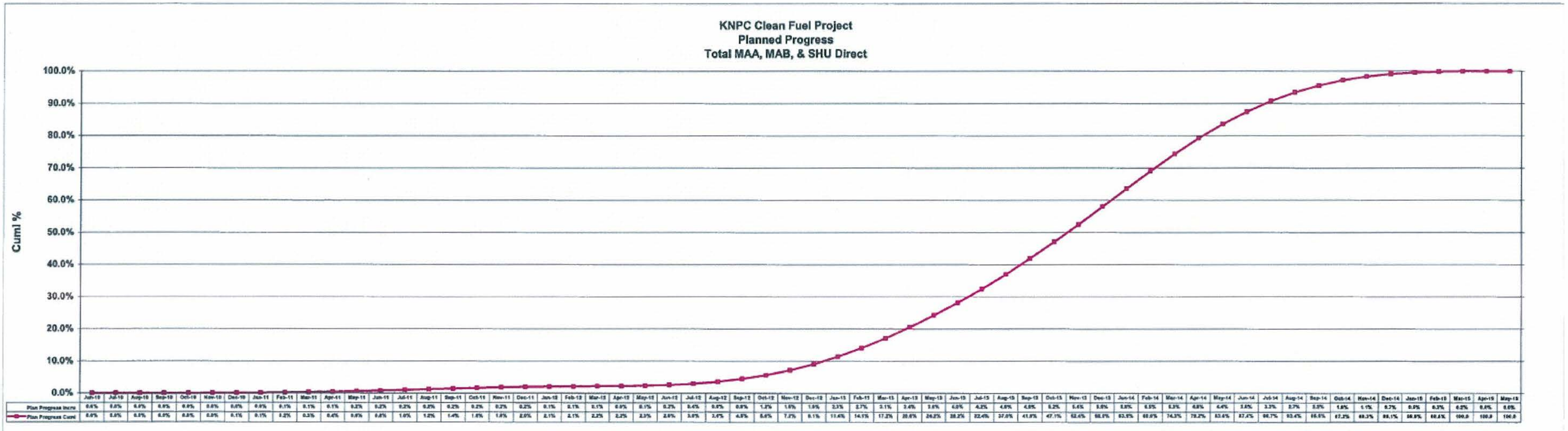
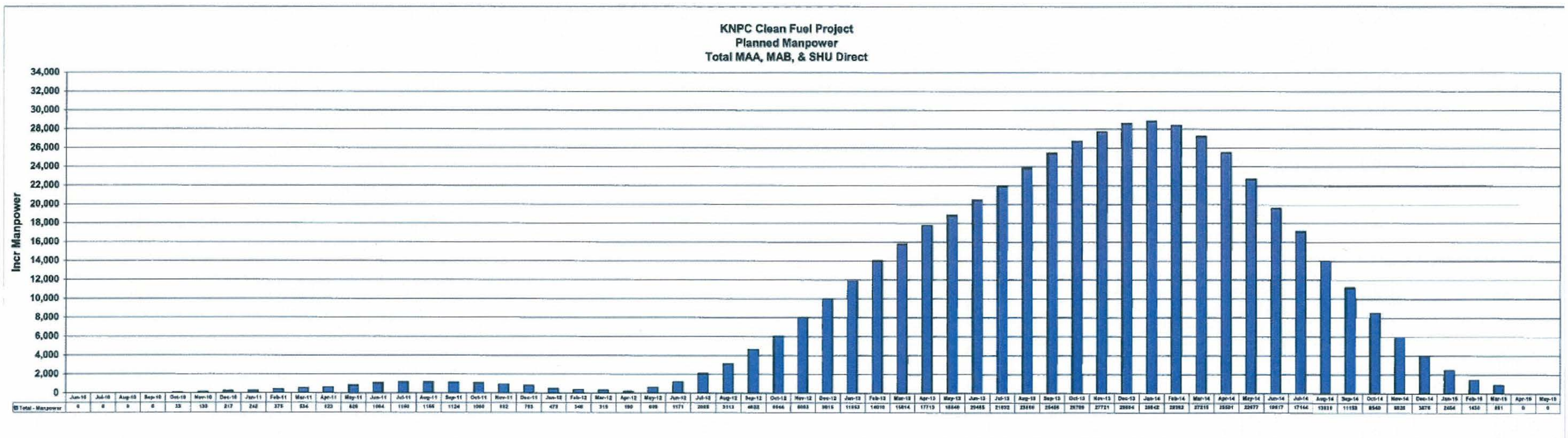


Figure 2.G: Total MAA, MAB & SHU Direct Progress and Manpower





3.0 Environmental Measures Incorporated within CFP Design

The CFP is a project that involves modifications at KNPC's three existing refineries and is not in grass root locations. There will thus be a dual approach to the environmental design philosophy of the CFP as it is not always possible to treat both new and revamped facilities in the same way with respect to environmental management. Existing facilities undergoing revamp are already being managed in accordance with their design and existing KNPC HSE Practices and Procedures. New facilities will be subject to current state of the art practices in environmental design which will be at least as stringent and protective as the practices now in place for the facilities being revamped. All three of the refineries have been certified to the ISO 14001 Environmental Management System (EMS) and thus the facilities will be designed and operated in accordance with the EMS of these refineries.

KNPC's objective is that the CFP will incorporate appropriate Best Available Control Technologies (BACT) and environmental mitigation measures deemed necessary, so as to meet or exceed all relevant K-EPA regulatory criteria. The CFP has been designed to mitigate environmental impact, and numerous 'environmental best practice measures' / BACT have been incorporated. These are discussed within the relevant parts of this EIS but are summarized below for ease of reference. It should be noted that for each chapter of this report, after assessment of impacts has been conducted, additional recommendations are presented, as appropriate, to further mitigate impacts.

3.1 Air Emissions Abatement

CFP will have both point and fugitive sources of air contaminants emitting to the atmosphere. The point sources are primarily combustion equipment items consisting of process heaters/furnaces/boilers, incineration systems and flare systems. The fugitive emission sources include storage tanks, equipment components, sulfur handling operations, coke handling operations and wastewater treatment facilities.

Principal environmental measures regarding point source emissions at the CFP will include:

- BACT to limit Oxides of Nitrogen (NOx) emissions: all boilers, heater and furnaces of 100 MMBtu heat capacity or greater will be equipped with Low NOx Burners (LNB) to reduce NOx emissions.
- BACT for Oxides of Sulphur (SOx) emissions: burning of treated refinery fuel gas (not more than 100 ppm H_2S), LPG or low sulfur fuel oil (less than 1.0 weight % sulfur). The Tail Gas Treating Units (TGTUs) will ensure that the SO_2 emissions from the incinerator stack do not exceed 250ppm. SO_2 emissions will be controlled by incorporation of techniques including feedstock hydrodesulphurization.
- A new TGTU (Unit 99) to substantially reduce existing sulphur dioxide emissions from the MAA refinery.
- BACT for stack height: minimum stack height of 61 metres for discharge of air contaminants from equipment located within process units and having a fired duty of 100 MMBtu/hr or greater. Minimum stack height of 65 metres for utility steam boilers. For natural draft heaters, the maximum stack gas

velocity will be 7.6 meters per second and for balanced draft heaters it will be 15.0 meters per second.

- BACT for venting: vents to the atmosphere that may contain hydrocarbons will be flared to remove the hydrocarbon portion to the extent practical.
- New hydrocarbon flare systems incorporating flare gas recovery to minimize flaring activities.
- A new Electrostatic Precipitator (ESP) to reduce the suspended catalyst particles in the flue gas from the regenerator of the existing FCCU (Unit 86) at MAA.

Principal environmental measures to control fugitive emissions from the CFP facilities will include:

- A Leak Detection and Repair Programme (LDAR) will be in place during operation of the facilities.
- BACT for H_2S emissions: all sour water streams will be treated to ensure compliance with applicable K-EPA discharge criteria. All process vents having hazardous concentrations of sour gas will be routed to either a recovery system or a control device. Ambient H_2S monitors will be placed in those areas of the CFP having the greatest potential for H_2S fugitive emissions.
- BACT for Suspended Particulate Matter (SPM) emissions: the coke handling systems will be designed to minimize and control suspended particulate emissions. The coke handling system will be enclosed and the air extraction vents will be filtered.
- BACT for VOC emissions: the following techniques will be included:
    - Relief valves routed to flare
    - Open-ended valves equipped with cap, plug, blind flange or second valve
    - Pumps incorporating double mechanical seals
    - Reciprocating compressors designed with cylinder packing case venting to flare system
    - Centrifugal compressors provided with dry gas seals and nitrogen buffer gas venting to flare system
    - Closed process drains and effluent sumps. Vents to atmosphere will be via an appropriate control device
    - Unless otherwise specified or directed by K-EPA regulation, Shell DEP or KNPC Procedure, US EPA'S Petroleum Refinery Wastewater Systems Rule (40 CFR 60, Subpart QQQ) will be used as a design guideline for controlling VOC emissions from wastewater treatment systems, which will be enclosed where equipment is in contact with hydrocarbons or odorous compounds, where feasible.
    - Liquid sample points will be designed to minimize hydrocarbon or product loss to the drainage system.
    - Closed loop sampling will be used wherever practical to minimize operator exposure and minimize emissions during sample purging.
- Controlling storage tank emissions via measures including: double seals or vapor recovery systems and pole wipers for floating roof tanks.

3.2 Wastewater Treatment / Reuse / Disposal

CFP will require large volumes of water for cooling, boiler feedwater (BFW) make-up, process water, potable water, sanitation and other refinery services. KNPC's planned approach is to reduce the CFP's water demand requirements by wastewater recycling and reuse to the extent possible.

Minimization of wastewater generation at the source and by reuse, as well as segregation, collection and treatment of similar wastewater streams are the main principles used in the design of the cost effective and environmentally friendly wastewater treatment system. The new Wastewater Treatment systems will collect, convey and treat wastewater according to the K-EPA requirements prior to any discharge.

There will be two new Wastewater Treatment (WWT) Systems provided as part of the CFP:

- New Wastewater Treatment System at MAB – Unit 156
- New Wastewater Treatment System at MAA – Unit 163.

These new CFP facilities will incorporate state of the art design to complement upgrades to the existing MAB effluent treatment facility under a separate project (KNPC Effluent Treatment Facility Revamp project). The CFP design will incorporate best environmental engineering practices such as BACT to avoid, prevent or mitigate the release of all harmful discharges so as to meet (or exceed) applicable K-EPA environmental standards.

3.3 Hazardous Materials Management

Principal environmental measures regarding the management of Hazardous Materials at the CFP include:

- Collecting and maintaining MSDS forms for all hazardous materials intended for use during operation of the CFP.
- Appropriate labelling of hazardous material storage containers.
- Secondary containment for all new storage tanks in hazardous materials service.
- A system for leak detection will be in place serving the new hydrocarbon and hazardous materials storage tanks whose contents are liquid at ambient conditions.
- Fenced off designated hazardous material storage areas with spill containment systems and limited controlled access.
- Surface impoundments in the Wastewater Treatment System used to hold or store hazardous materials will incorporate appropriate secondary containment and leak detection systems.

3.4 Solid Waste Management

Principal environmental measures regarding solid waste generation at the CFP will include:

- Minimizing waste generation through optimizing operations, ensuring reclamation, recycling, and recovery of precious metals from spent catalysts.
- Analyzing, categorizing and segregating solid wastes.
- A Waste Transport Manifest requirement for all waste transported offsite for treatment or disposal. All landfill sites used will be designed and licensed to accept the specific hazardous and non-hazardous type wastes.
- Designated areas for temporary storage of all solid waste generated with waste being stored in appropriate containers.
- Installation of equipment for the handling, treatment and minimization of industrial sludge generation.
- Handling of spent catalysts as hazardous waste unless analyzed to be non-hazardous in accordance with K-EPA criteria.

3.5 Noise Control and Abatement

Principal environmental measures regarding noise abatement for the CFP facilities include:

- Using mufflers/silencers on process vents and steam generation system vents, where feasible.
- Providing high noise sources with sound-reducing enclosures, acoustical insulation, silencers or other engineering methods to minimize noise where necessary.
- Applying noise limits in indoor areas.
- Optimization of high velocity fluid flow in process piping.
- Designing systems with flow velocity no greater than 100 times (in feet per second) the square root of the specific volume of the fluid (cubic feet per pound), where appropriate.
- Use of soft bends and longer pipe length between valves to minimize turbulence at pipe bends and in between valves, where appropriate.
- An absolute work area noise limit of 115 dB(A) and a work area noise limit/equipment noise limit of 85 dB(A).
- The use of permanent warning signs at boundaries of noise restricted areas to indicate mandatory use of hearing protection.

3.6 Odour Abatement

KNPC has embarked upon an Odour Management System with a mission to be "Odour free" in all its operations. Principal environmental measures regarding odour abatement at the CFP include:

- Double mechanical seals for hydrocarbon pumps
- Closed loop sampling systems
- Flare gas recovery unit
- Appropriate sequencing during unit startups to minimize flaring
- Vapor recovery systems or floating roofs with double seal, pole wipers and fittings
- Installing carbon canisters for odour mitigation from tank vents of fixed roof storage tanks, and from drain vents of some oily wastewater vents.
- Provision of procedures for proper regeneration and passivation to reduce odour during catalyst dumping
- Routing water seal on flare drums to a sour water system via wet slop tanks
- Provision of ISO tanks for chemical unloading
- Providing floating skimmers at lagoons
- Ensuring adequate sparing of equipment such as pumps to avoid overflow of sumps.

3.7 Environmental Stewardship

The principal environmental stewardship measures for the CFP facilities include:

- Ensuring compliance with applicable international treaties / protocols
- Avoiding the use of ozone-depleting substances where practical, and prohibiting asbestos containing materials (ACMs) and the use of equipment containing polychlorinated biphenyls (PCBs).
- Operating the CFP with energy efficiency measures to minimize emissions of Green House Gases (GHGs); for example, CO_2.
- Ensuring no chromium-based corrosion inhibitors are used for cooling water treatment
- EMS certification to ISO14001 as soon as possible following start-up.

3.8 Monitoring

Principal environmental monitoring measures covering air, water, groundwater and noise, include:

- Implementation of a fully automated Environmental Information Management System (EIMS), the 100% browser-based *Essential Suite™ EHS and Crisis Management system*. Essential Suite™ facilitates the use of EHS and crisis management data in support of regulatory reporting and performance monitoring, as well as demonstrating how KNPC is exercising its corporate social responsibility. Essential Suite™ is also a core component of KNPC's project action plan to address its long-term sustainability.

- Installing groundwater monitoring wells at both up-gradient and down-gradient locations around process units where oil or other hazardous materials are handled/stored.
- Continuous and intermittent monitoring for various air emission sources (providing readouts in the control room) including:
    - Area/Ambient monitoring
    - Flare system monitoring
    - Continuous emission monitoring (Continuous Emissions Monitoring System - CEMS - installed for new dual-fired or oil-fired combustion sources). CEMS will continuously measure NOx, SOx and Oxygen.
- Monitoring of wastewater effluent flow and quality from the wastewater treatment system.
- An automatic composite sampling package to collect liquid effluent samples prior to discharge.
- Effluent monitoring at the point of discharge from the Wastewater Treatment Systems.
- Periodic noise monitoring from process and utility areas to ensure that K-EPA criteria is met for both the workplace and at the fence line.

4.0 Environmental Comparison of Project Alternatives

It is a requirement of the EIA process to consider alternative site locations when assessing a proposed development. CFP will be constructed at the existing KNPC refineries and not in grass root locations, therefore, evaluating specific alternative site "locations" is not possible. This chapter will instead examine alternatives to the project itself.

The project alternatives currently available are:

1) Do not construct and operate new petroleum refining and support facilities (i.e. no project)
2) Construct and operate new petroleum refining and support facilities in a location outside the existing MAA and MAB refineries
3) Construct and operate new petroleum refining and support facilities within the available space at the existing MAA and MAB refineries

4.1 Alternative 1

As previously described, CFP will expand and upgrade the MAA and MAB refineries by increasing their capacities and increasing conversion of LSFO to higher end products through Bottom of Barrel (BOB) processing utilizing ARDS / Coker / HC technologies. The project is intended to provide the industrial and private sectors of Kuwait and export customers with cleaner burning fuels than those currently available in Kuwait. If the project is not constructed, KNPC will be unable to meet the future market demands for cleaner burning fuels both in Kuwait and abroad and improvements in air quality throughout the region (such as lower ambient SO_2 concentrations) will not progress.

This alternative is considered unacceptable for the following reasons:

- CFP has the key objective of providing low sulphur fuels that will meet the specifications and demands mandated for their continued use in Kuwait in the Year 2020, by the Year 2015. Currently, sulphur dioxide concentrations exceed K-EPA ambient air quality criteria in various locations and regions throughout Kuwait. The availability of low sulphur fuels from CFP will substantially reduce the impacts of sulphur dioxide pollution on public health and the ecology of Kuwait. The production of low sulphur diesel fuels will permit the installation and use of catalytic converters on diesel-powered equipment and vehicles to reduce NOx and CO emissions.
- A significant number of existing petroleum refining units currently being operated by KNPC at MAA, MAB and SHU are inefficient and outdated/obsolete by current industry standards. CFP will optimize conversion capacity by upgrading and modernizing many existing facilities to state-of-the-art design, while retiring obsolete units. New refining units will be provided that fully comply with applicable K-EPA environmental criteria. The project will further allow KNPC to remain competitive within the industry by developing refining operations into an export oriented

integrated merchant refining complex to meet diversified market requirements.

- If the project were not implemented, the following environmental upgrades would not be available:
    - a new Tail Gas Treating Unit (Unit 99) to substantially reduce existing sulphur dioxide emissions from the MAA refinery;
    - a new oily sludge incinerator at MAB that will process and reduce the volume of solid waste from both MAA and MAB;
    - a new electrostatic precipitator to reduce particulate emissions from the existing MAA FCCU (Unit 86).

4.2 Alternative 2

The adoption of Alternative 2, constructing and operating new petroleum refining and support facilities in a location outside the existing MAA and MAB refineries, will:

- Increase costs and jeopardize the project's economic viability. New land acquisitions will be required for both onshore and offshore facilities. Connectivity (i.e. pipelines, cables etc) with existing refining and support units at MAA and MAB will be over longer distances and may be impractical resulting in the need to construct and operate additional units (such as storage, blending shipping facilities).
- Require local infrastructure, which depending upon the selected location may include, but is not limited to roads, marine port facilities, and available support services for construction contractors and KNPC operating personnel.
- Increase environmental impacts to previously undeveloped areas or areas without a strong, existing industrial base. Impacts would be generated by the need to construct and operate additional infrastructure and support units such as storage, blending and shipping facilities. Impacts may include both terrestrial and marine ecological communities and destruction of habitat. When considering alternative locations for the project, consideration must be given to geology, seismic risk, coastal characteristics and available space among other criteria. Marine port facilities are the only available option in Kuwait for loading and unloading sulphur and for export of petroleum products, regardless of whether the refining facilities are located inland or along the coastline.

4.3 Alternative 3

CFP will not only provide Kuwait and export customers with cleaner burning fuels, but will also enhance the safety and environmental performance of the MAA and MAB refineries through modernization and incorporation of current best environmental practices.

Existing air quality for the Shuaiba Industrial Area is currently of concern and pollutant levels at times are known to exceed K-EPA air quality criteria. CFP will employ best environmental practices, including BACT, to control emissions. There will be some additional load placed on the environment due to the construction of new units and expansions of existing facilities at the MAA and MAB refineries.

However, much of this load on the region is expected to be offset to a significant extent by the retirement of all process units at the SHU refinery as well as by the retirement of some process units at MAA and MAB.

Hence, the overall environmental impact of the new and modified CFP facilities is expected to be acceptable to K-EPA.

Alternative 3 is the selected alternative for CFP. Utilizing existing space within the MAA and MAB refineries for construction and operation of new petroleum refining units has clear cut advantages over Alternative 2 that include:

- Minimizing project costs and economic viability. Adequate space is available within the MAA and MAB refineries for construction of the planned CFP facilities. There is no requirement for new land acquisitions. Distances for connections (pipelines, cables etc.) between new and existing units including existing tankage is minimized. Costs are also minimized by the ability of the project to utilize existing infrastructure as well as storage, blending and shipping facilities.
- Taking advantage of existing local infrastructure including but not limited to roads, port facilities (no new port facilities are required for this alternative), and available support services for construction contractors and KNPC operating personnel.
- Minimizing environmental impacts by constructing and operating the project within an area that is designated for industrial development. Since infrastructure as well as storage, blending and shipping facilities are available to be utilized for CFP; the need for similar new facilities and their associated environmental impacts is minimized or eliminated. Existing waste treatment and disposal facilities are located within relatively close proximity of MAA and MAB minimizing the distance over which such wastes need to be handled and transported.

Alternative 3 is selected because it is economically viable, will improve regional air quality by providing low sulphur fuels, and will upgrade current refining capabilities, thus enhancing KNPC's competitive standing within the industry.

5.0 Environmental Baseline Study

In support of the EIA process, DNV was commissioned by Fluor to conduct an Environmental Baseline Study (EBS). The EBS work at the CFP site was conducted in accordance with the requirements and standards for the State of Kuwait promulgated as Regulations Implemented under Law No. 21 of 1995 as Amended by Law No. 16 of 1996.

The EBS was conducted during 2007 for the purpose of providing a baseline of the existing environment in order to properly assess any potential impacts posed by this project.

As an independent foundation operating worldwide, DNV is committed to involving local specialists to ensure that they will benefit from any developments in their own country and to draw on their experience of local environments and conditions. As a result, a large part of the EBS work was subcontracted out to two local technical specialists, Kuwait Institute for Scientific Research (KISR) and Wataniya Environmental Services (WES). This, along with the execution plan, was agreed upon with KNPC prior to the commencement of the EBS.

DNV, KISR and WES conducted the following specialized studies as part of the background investigation for the EBS, which were then used to develop the EIS:

- Soil Characteristics
- Ambient Air Quality
- Noise
- Land Use
- Demography and Socioeconomic Aspects
- Geology and Seismology
- Surface Water, Groundwater and Water Use
- Terrestrial and Aquatic Ecology
- Meteorology

The majority of the EBS work was carried out between March and August 2007, and all EBS reports are supported by suitable and accurate maps and graphics wherever possible.

The full KNPC CFP EBS report is provided in a separate report. Additional information from a separate KNPC groundwater study is summarised in Chapter 14.

A summary of the key issues identified in the EBS are highlighted below:

- The project sites for the CFP are in developed zones, and the major CFP upgrades and expansions occur within the existing refineries' industrial site boundaries. The immediate surrounding areas are a mix of industrial, residential and open land.
- Thirty-nine soil samples were collected around the perimeter and near the centre of the study area, and analysed. Results generally indicate no contamination problems, although minor TPH contamination was identified at

MAA and MAB; hydrocarbon levels were higher at SHU, where TPH contamination was identified at sampling location S39.

- KNPC groundwater study (2009) indicates that groundwater onsite is contaminated in some areas with parameters such as TPH, phenol and coliforms.
- KNPC HSE air monitoring data was analysed in conjunction with the air monitoring data collected by the EBS Study Team, and results indicate the following:
    - Results often exceed K-EPA / Ministry of Oil air quality criteria for NO_2, NMHC and suspended particulate matter (SPM).
    - Fewer violations were also observed for SO_2, O_3 and PM_{10} (compared with SPM, NO_2 and NMHC).
    - There are very infrequent exceedences of the K-EPA/MO criteria for NH_3 and H_2S at some locations.
- Twenty noise sampling sites were located at various points throughout the study area. All locations meet daytime K-EPA noise criteria, although some of the locations exceed night time criteria (depending on which K-EPA criteria is used in the comparison).
- A review of existing KNPC HSE Noise Monitoring Data showed that some measurements onsite exceeded 85 dB (A), the permissible exposure limit. In areas where limits were exceeded, however, special measures are implemented to ensure proper hearing protection of personnel.
- There is no significant seismic activity currently reported in the area.
- The topography of the study area is flat and sandy with the soils having high porosity and permeability.
- The sites show a negligible existence and distribution of natural drainage systems and there are no important natural reserves/natural sensitive areas in the vicinity.
- The coastline is sandy and muddy and has been altered by man in the study area. Sea water quality is reported to be relatively poor owing to the many industrial activities in the area.
- There is no suitable habitat to encourage a wide diversity of flora and fauna in the area.
- Kuwait has two main seasons, summer and winter. The seasonal temperatures vary widely, with summer temperatures often reach above 45°C during July and August, while temperatures during winter can drop to below 3°C during the night. The rainy season extends from October to May. The long term average annual rainfall for the whole country was approximately 176 mm, but in recent years rainfall has decreased to an average of between 106 - 134 mm/year. Dust and sandstorms are common throughout the year. The wind generally blows from the northwest.

6.0 Environmental Assessment Methodology

This section outlines DNV's *Matrix for Assessment of Non-Quantifiable Impacts* methodology, which is applied across the sections of this EIA that are not quantifiable. Where impacts are quantifiable, results of assessment are, in general, simply compared against relevant numerical criteria to establish significance.

DNV's *Matrix for Assessment of Non-Quantifiable Impacts* methodology meets World Bank requirements, and has been successfully applied to similar types of projects in various parts of the world including the KNPC New Refinery Project. This approach avoids the EIA becoming an over-documented report, and produces deliverables which distinguish the important aspects and are easier to understand.

Environmental aspects that cannot be quantified are described and subjected to a technical evaluation of the type of effect, its scope, and its consequences, and the environmental significance is then simply illustrated.

The main objective of the 'Matrix for Assessment of Non-Quantifiable Impacts', is to distinguish those critical impacts from those that are less important. This is done by considering the effect of an impact in the area in which it is occurring (i.e. its 'value' or 'sensitivity'), and combining it with the 'scope of the effect', to arrive at the 'total impact'.

The assessment methodology applies DNV's EIA matrix together with Impact Assessment Forms (see Figure 6A overleaf) to summarise the scale of an environmental impact. In outline, the methodology is as follows:

Step	Procedure
1	**General description of the area (situation and characteristics):** *Evaluation of the value / sensitivity*: Step 1 is categorising the area being assessed in terms of 'value' or 'sensitivity'. This is, so far as possible, based on official data or statements: e.g. 'this area is of relative low importance to national fisheries compared with other areas," etc and information compiled in the Environmental Baseline Study (EBS).
2	**Description of the extent of effect:** *Evaluation of extent:* The extent of effect from the planned activity should be based on scientific documentation, or, if not available, based on expert and objective evaluation (based on knowledge/experience of the type of projects/activities and similar environments, and technology). The scale of this effect is then evaluated objectively, ranging from very negative to very positive.
3	**Establishing total impact per 'category' (e.g. Environment)** By combining Steps 1 and 2 in the impact matrix (see Figure 6A overleaf), the total impact can be identified. This gives a relatively narrow area indicating the magnitude of the impact. *Total (environmental) impact*: Combining the outputs from Steps 1 and 2, provides a graphical view of the total impact: This ranges from a very large negative impact to a very positive impact.

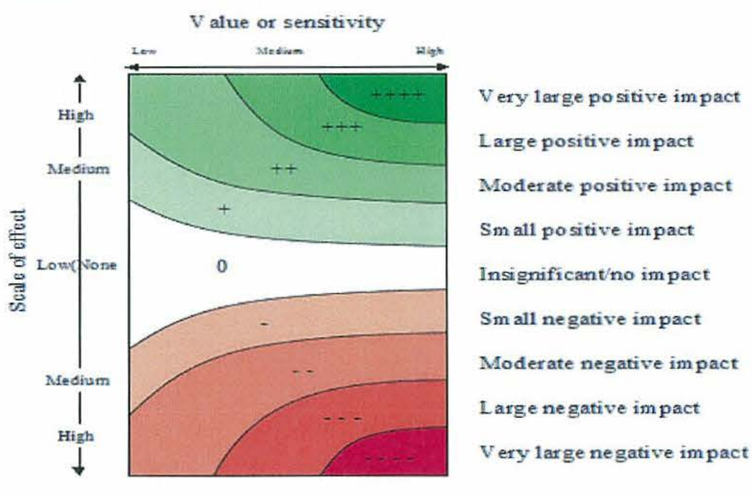
The same magnitude of effect may then result in a different impact depending on the value or sensitivity of the impacted environmental component. This is considered a sound basis for assessing and presenting the environmental impacts associated with the CFP. Each impact is then assessed and documented according to the above system. The results of this exercise are extracted and presented in this EIS report, enabling focus on the most important impacts.

The process also ensures transparency, because it is simple to go backwards and identify why the impact was assessed as it was, and to study the premises and assumptions on which its assessment was based. It also gives the flexibility to change one factor, if new information arrives, and so provides a simple clear methodology to assess any updated impacts.

Figure 6A Impact Assessment Form

Impact Assessment Form

Category: [e.g. ENVIRONMENT or SOCIETY] **Consequence evaluation for:** [issue: e.g. wastewater management during NRP operations]	
1. General description of the area (situation and characteristics):	
Description of the basis for evaluating 'value' or 'sensitivity' of an area. What are the facts, literature sources or statements this is based upon?. Indicate further factors considered more important than other arriving at this conclusion. **Evaluation of the value:** Small Medium Large |X------------|-------------|	
2. Description of the extent of effect	**3. Total (environmental) impact**
Description of the scientific information and data that the assessment is based on. Describe further how it is interpreted in this context. Describe what has been given highest priority, and why? Document why the assessment conclude on the extent of effect. **Evaluation of extent:** Very neg. Medium neg. Little/no Medium pos. Very pos. |---------------|---------------X--|---------------|------------------|	Combine 1) and 2) in the impact matrix. The total impact is then identified and stated here. E.g. 'Small Negative Impact'



7.0 Noise

7.1 Introduction

7.1.1 General Approach

A noise impact assessment study for CFP has been carried out as part of the EIA. The main purpose of this study is to evaluate the potential community noise impact due to the noise emissions from the activities associated with the CFP. Toward this, predictive computational modelling is used to quantitatively estimate the sound pressure level (SPL) at various discrete receptors located near the ground level, especially including the sensitive noise receptors identified in the Environmental Baseline Study EBS.

Considering that CFP facilities are located at three geographically distinct sites, *viz.*, Mina Al-Ahmadi (MAA), Mina Al-Abdullah (MAB) and Shuaiba (SHU), separate modelling runs were performed for each site. Similarly, since the noise emission sources are distinctly different for each phase of the project, separate modelling runs were performed for the Construction Phase and the Operations Phase at each site.

The background values (existing noise levels) were added to the predicted SPL values and the net values were compared with regulatory standards for community noise levels issued by K-EPA.

7.1.2 Model Description

Predictor Type 7810 Ver 6.20 software developed by Brüel & Kjær is used for noise modelling in this study. Predictor is one of the most efficient multi-purpose Windows-based software packages available for calculating environmental noise. Predictor complies with the European Union's (EU) Environmental Noise Directive (2002/49/EC) and is in accordance with Guidelines on Revised Interim Computation Methods (2003/613/EC) and the European Commission's Assessment of Exposure to Noise Working Group's Good Practice. Among the various algorithms available, the modelling algorithm conforming to the international standard ISO 9613 is used in this study, including the following:

- ISO 9613-1 Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere
- ISO 9613-2 Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation
- VDI 2571 Schallabstrahlung von industriebauten: German method used to calculate the directivity of point sources for noise emitting facades and roofs
- Commission Recommendation 6 August 2003: 2003/613/EC "Guidelines on the revised interim computation methods for industrial noise, aircraft noise and railway noise, and related emission data"

The following inputs to the model are required:

- Noise Sources: Noise sources can be either point sources or line sources. Line sources are basically a series of point sources. For each point source, the required input data include its identification, location coordinates, height above the ground level, directivity of noise, sound power level (SWL_o) in 1 octave or 1/3 octave in the units of dB(A), working hours and any user defined attenuation.

- Noise Receptors: The receiver points can be input as individual discrete points or grid points. For each point the required input data include its identification, location coordinates and height above the ground level.
- Barriers: Barriers are basically the screens and walls that exist between a source point and a receptor point. They are graphically entered into the model as a polyline. For each barrier, the required input data include its identification, end point location coordinates, height above the ground level, surface reflection factor (0 for no reflection to 1 for total reflection) and profile correction (ISO method recommends zero correction) .
- Buildings: Buildings are modelled as polygons with uniform height, and graphically entered into the model. They can be linked to one or more sources. For each building, the required input data include its identification, end point location coordinates, height above the ground level, surface reflection factor (0 for no reflection to 1 for total reflection) and profile correction (ISO method recommends zero correction) .
- Terrain Features: The terrain can be uniformly flat or undulating. For undulating terrain, the terrain height with reference to the mean sea level at each receptor point can be input numerically or using a digitised contour map.
- Topographical Features: The topography can be simple ground region (with specified ground absorption factor ranging from 0 for soft surface to 1 for hard surface), housing region (for heavily urbanised areas), industrial site (for industrial areas) or foliage region (for very dense plantations).
- Meteorological Parameters: Ambient air temperature, relative humidity and barometric pressure. These parameters are used for calculating noise attenuation by the air absorption. Wind speed, wind direction and atmospheric stability are not considered in the ISO method.
- Time Averaging: The hourly SPL values can be time averaged for up to four user specified periods (day, night, evening, other) and day-night (24 hour) average.

For each combination of a source point and a receptor point, the model calculates the SPL value at the receptor point using the following equation as per ISO method, as shown below.

$$SPL_r = SWL_o - C_t - C_m - D_c - A_{div} - A_{atm} - A_{gr} - A_{bar} - A_{bld}$$

SPL_r = Sound pressure level at a receptor	A_{div} = Attenuation due to geometric divergence
SWL_o = Sound power level at a point source	A_{atm} = Attenuation due to atmospheric absorption
C_t = Active time correction	A_{gr} = Attenuation due to ground absorption
C_m = Meteorological correction	A_{bar} = Attenuation due to barriers
D_c = Directivity correction	A_{str} = Attenuation due to buildings

The model uses subroutines to calculate the various attenuations and corrections. The attenuation levels for each source-receiver combination can be viewed to evaluate the quality of the calculations and as a help to determine how to reduce noise levels. The model calculates the overall SPL value for a given receptor point by logarithmically adding the individual SPL values for each contributing source.

7.1.3 Impact Assessment Criteria

K-EPA community noise standards are used for the purpose of community noise impact assessment. If the predicted noise levels are within the applicable limits, then it is assumed that there would be no adverse impact on the community. K-EPA community noise standards are summarised in the following table:

Table 7.1: K-EPA Community Noise Standards

Area Classification	Main Source/ Cause of Community Noise	Maximum Permissible Time Weighted Noise Level (L_{eq}) in		
		Day Time - dB(A) (7am-2pm)	Evening- dB(A) (2pm-10pm)	Night Time- dB(A) (10pm-4am)
Ideal Residential Area (Villa Areas and Suburbs)	Industrial activity	50	45	45
	Traffic movement	55	55	50
Urban Residential Areas	Industrial activity	55	50	45
	Traffic movement	62	60	55
Urban Residential Areas (with some commercial activities and workshops)	Industrial activity	60	55	50
	Traffic movement	65	65	60
Industrial Commercial Areas	Industrial activity	70	70	65
	Traffic movement	70	65	60

Notes: There are no specifications for the time period of 4am-7am. The community receptors near the CFP sites fall under the classification of 'Urban Residential Areas (with some commercial activities and workshops)'.

7.2 Site Description

7.2.1 MAA Refinery Site

As shown in the plot plan (Figure 2A) MAA Refinery Site is about 2750m by 3600m in area. However, most new plant facilities proposed to be installed as part of CFP will be located within a smaller area of around 750m by 1100m (referred to as the CFP Block) within the southwest quadrant of MAA Refinery Site.

As part of CFP, some existing plant equipment in MAA Refinery will be revamped. The revamp equipment are well scattered over the remaining MAA Refinery Site.

Adjacent to and toward east of the CFP Block, three new projects are being developed. These are the Fourth Gas Train Project (FGTP) and the Ethane Recovery Plant (ERP) and proposed area for the 5^{th} Train. These three projects are not included in the scope of this study, since there are being designed and engineered by third parties and detailed information on these projects is not available.

The environmental features of the MAA Refinery Site and the surrounding areas have been discussed in the Environmental Baseline Study. From community noise viewpoint, the significant receptors are the large urban settlements located in Fahaheel area, about 150m distance from the Tank Farm boundary and about a 1600m distance from the CFP Block toward the north. There are no other settlements in the vicinity toward east, south or west directions of MAA Refinery Site.

7.2.2 MAB Refinery Site

As shown in the plot plan (Figure 2C), MAB Refinery Site is about 3000m by 3500m in area. However, the new plant facilities proposed to be installed as part of CFP will be located within a smaller area of around 1250m by 1500m (referred to as the CFP Block within the south / southeast quadrant of MAB Refinery Site).

As part of CFP, some existing plant equipment in the MAB Refinery will be revamped. The revamp equipment are scattered over the northeast and northwest quadrants of the MAB Refinery Site.

The environmental features of MAB Refinery Site and surrounding areas have been discussed in the Environmental Baseline Study. From a community noise viewpoint, the significant receptors are a few villas located along the coastline about 500m distance from MAB Refinery New Plant Site toward the (south) east. There are no other settlements in the vicinity toward the north, west or south directions of the MAB Refinery Site.

7.2.3 Shuiaba Refinery Site

As shown in the plot plan (Figure 2E), Shuaiba Refinery Site is about 2900m by 850m in area. No new process plant facilities are proposed to be installed as part of CFP at Shuaiba Refinery Site. The existing process facilities will be decommissioned while some offsites facilities such as the tank farm will be integrated with operations at MAA and MAB.

The environmental features of Shuaiba Refinery Site and the surrounding areas have been discussed in the Environmental Baseline Study. From a community noise viewpoint, there are no human settlements located in the vicinity of Shuaiba Refinery

Site in any direction. The areas surrounding Shuaiba Refinery are designated as industrial areas.

7.2.4 Construction Footprint

The construction activities at the MAA CFP Block (about 750m by 1100m) and MAB CFP Block (about 1250m by 1500m) do not cover the entire site area at any given time due to the staggering of the construction activities. With regard to the early construction activities (Site Preparation and Earthworks), the maximum worked over area at any given time will be two adjacent sections each of about 200m by 250m area. Therefore all the early construction activities at any give time will be concentrated within approximately one quarter of the total area of each CFP Block. As discussed later in Section 7.4.1.2, the Site Preparation and Earthworks phase represents the worst case of the overall Construction Phase with regard to the environmental noise impact. No pile driving is envisaged for the foundation work needed for the CFP.

7.3 Background Noise Levels

As part of Environmental Baseline Study for CFP noise monitoring was conducted in 2007 at twenty offsite locations around MAA and MAB sites. The noise monitoring was primarily intended to determine the background noise levels existing prior to the construction and operation of CFP facilities. The noise monitoring sites were located primarily around the perimeter of the planned MAA and MAB Refinery expansion sites, and some were located within 100m of residential areas in the vicinity. In addition, two noise monitoring sites were located outside the MAA and MAB Refinery sites. No noise monitoring sites were located around SHU Refinery Site because noise levels there will be reduced as a result of CFP operations due to the decommissioning of all existing process plant facilities. The locations where the noise was monitored are shown in Figure 7A (offsite), Figure 7B (MAA) and Figure 7C (for MAB).

The details of the background noise monitoring locations and the results are summarised in the following table. The noise measurements are presented as time weighted SPL (L_{eq}) for both day time and night time.

Table 7.2: Background Noise Levels[1]

Location ID	Location Description	UTM Coordinates		Area Classification	L_{eq} in dB(A)	
		Northing (m)	Easting (m)		Day	Night
N1 (MAA)	Near Busy Road	3,212,969	813,703	Residential (affected by traffic)	55	52
N2 (MAA)	Near Main-gate, Car Park & Flare	3,212,058	812,229	Industrial	62	61
N3 (MAA)	Near Flare/Road	3,212,334	812,152	Industrial	66	66

[1] Reference: EBS Report (2007)

Location ID	Location Description	UTM Coordinates		Area Classification	L_{eq} in dB(A)	
		Northing (m)	Easting (m)		Day	Night
N4 (MAA)	Near Busy Road / Flare Sound in Background	3,211,616	812,180	Industrial	52	55
N5 (MAA)	Near Flare (Continuous & Strong Flare Sound)	3,212,551	812,135	Industrial	69	68
N6 (Offsite)	Close to Major Highway & Mosque (Continuous Traffic Noise)	3,213,975	810,919	Residential (affected by traffic)	51	51
N7 (MAA)	Near Busy Road (Traffic Signal & Highway), Workshops & Working Machinery	3,213,126	812,204	Residential (affected by traffic)	60	57
N8 (MAA)	Lamp Post Opposite to Tank 758	3,213,102	814,437	Residential	53	50
N9 (MAA)	Near Road	3,211,040	812,369	Industrial	53	55
N10 (Offsite)	Near Busy Road (Working Machinery)	3,213,642	813,609	Residential (affected by traffic)	54	53
N11 (MAB)	Near KNPC Units (Background Noise from Birds)	3,206,897	818,294	Residential	50	50
N12 (MAB)	Near Road	3,206,588	816,142	Industrial	53	55
N13 (MAB)	Near KNPC Units (Construction Work)	3,207,235	818,120	Residential	55	55
N14 (MAB)	Near KNPC Units	3,206,510	818,504	Residential	45	45
N15 (MAB)	Near Busy Road and Working KNPC Units	3,206,234	816,499	Industrial	57	56
N16 (MAB)	Near Villas (Birds & Knocking Sounds in the Background)	3,206,010	818,763	Residential	46	49
N17 (MAB)	Near Busy Road (Garage and Working Crane)	3,207,385	815,234	Industrial	54	56
N18 (MAB)	Near Busy Road and Working KNPC Units (Aeroplane Flying in the Background)	3,207,872	814,821	Industrial	54	58
N19 (MAB)	Near Busy Road (Cranes Working Nearside)	3,208,726	814,067	Industrial	57	58
N20 (MAB)	Far from Working KNPC Units	3,206,043	817,190	Industrial	44	49

Of the above locations, the residential locations are N1, N6, N7, N8, N10, N11, N13, N14 and N16. All these locations fall under the category of "urban residential areas with some commercial activities and workshops". Out of these locations, N1, N6, N7 and N10 are also affected by noise from road traffic, and at these locations the maximum permissible limits for community noise are 65 dB(A) for the day time and 60 dB(A) for the night time. For the residential locations N8, N11, N13, N14 and N16, where road traffic is not significant, the maximum permissible limits for community noise are 60 dB(A) for the day time and 50 dB(A) for the night time. The remaining locations (N2, N3, N4, N5, N9, N12, N15, N17, N18, N19 and N20) are industrial locations, where the permissible limit for community noise is 70 dB(A) for the day time and 65 dB(A) for the night time.

As seen from the table above, while the day time noise levels at all locations are currently well within the relevant maximum permissible limits, the night time noise levels at two industrial locations (N3 & N5) – due to flare noise, and three residential locations (N8, N11 & N13) have either reached or exceeded the relevant maximum permissible limits. The locations where the baseline (current) noise levels exceed the permissible limits are highlighted in red in the table above and can be identified in Figures 7A, 7B and 7C below.

Figure 7A: Soil, Noise & Air sampling sites Offsite

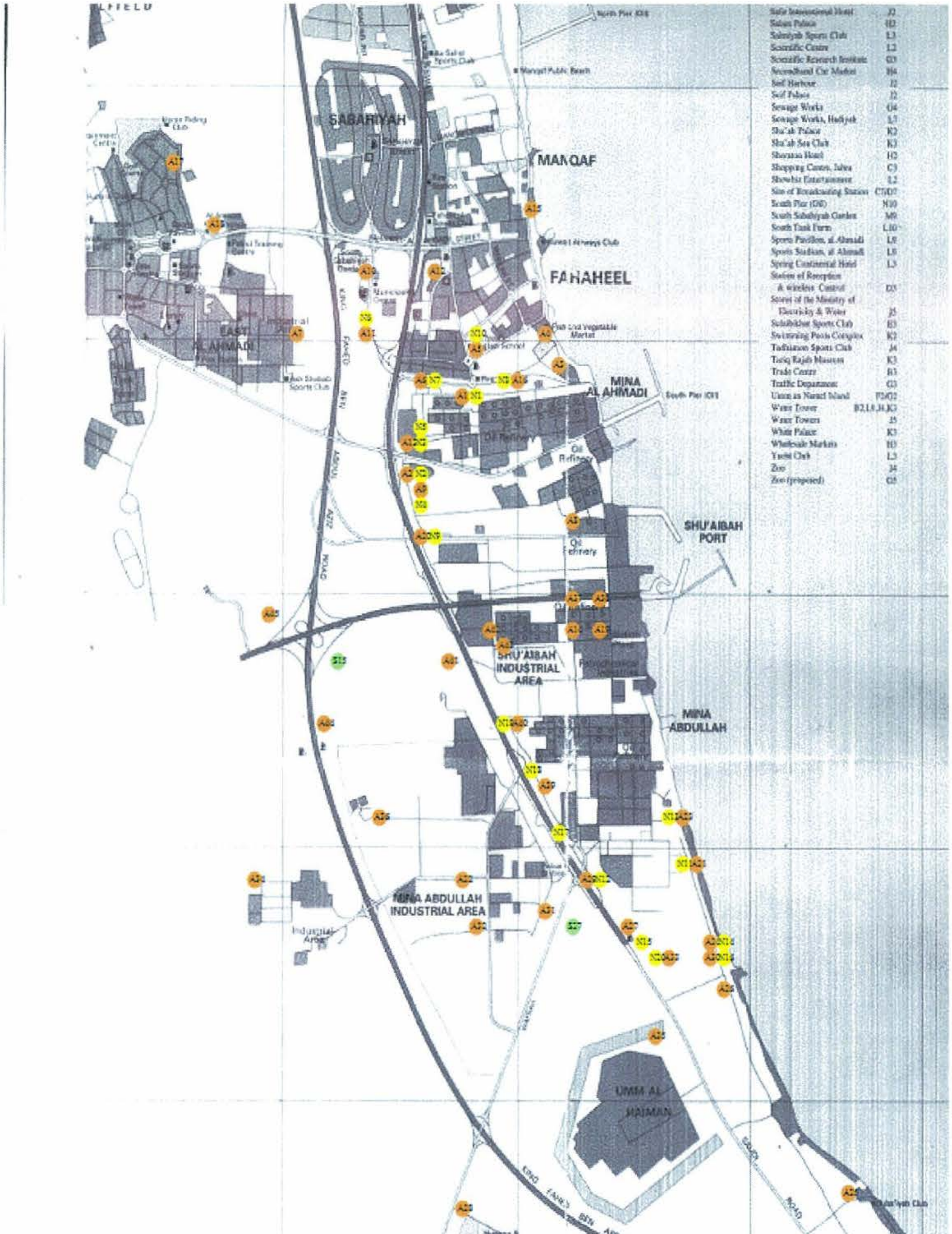


Figure 7B: Soil, Noise & Air sampling sites at MAA

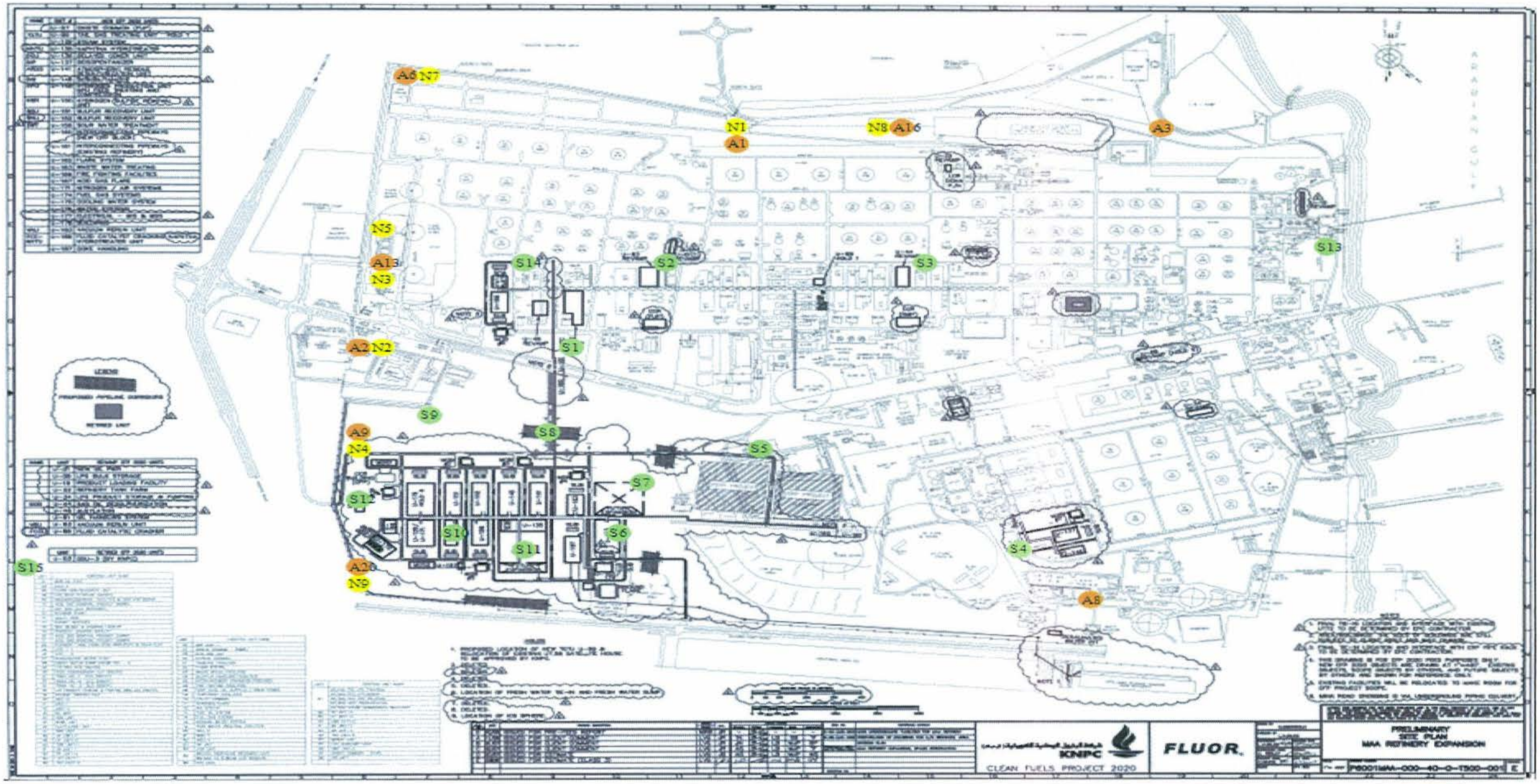
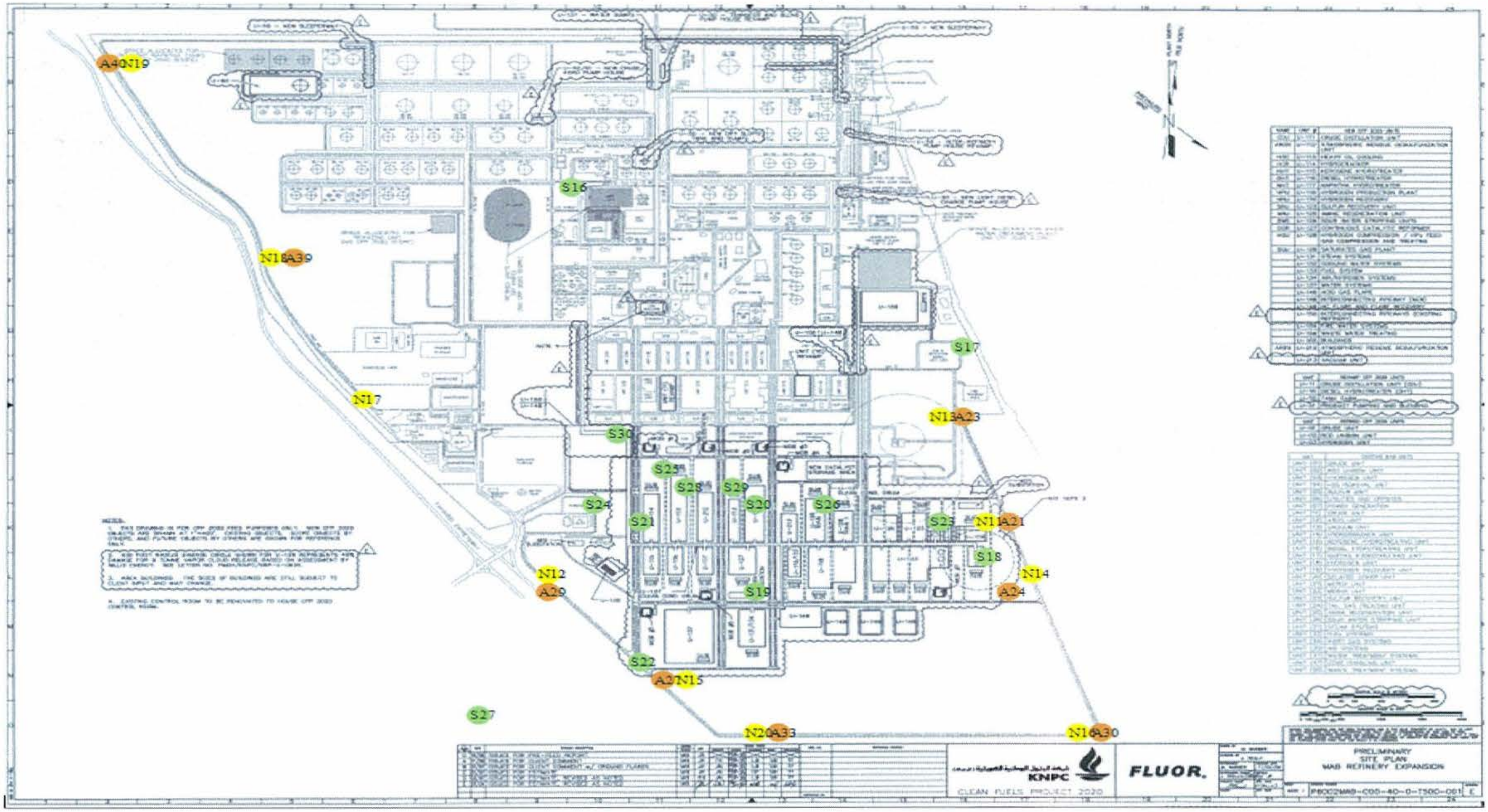


Figure 7C: Soil, Noise & Air sampling sites at MAB



7.4 Significant Noise Sources & Source Noise Levels

7.4.1 General

7.4.1.1 Construction Activities

The Construction Phase of CFP uses fewer noise generation sources (construction machinery and equipment) compared to the Operations Phase. The nature and the type of construction will be similar at both the MAA and MAB Refinery Sites. The Construction Phase consists of three distinct sub-phases: Site Preparation and Earthworks; Erection of Plant Equipment and Buildings; and Commissioning and Testing of Equipment.

From a noise impact viewpoint, the early Construction Phase, viz., Site Preparation and Earthworks Phase is the most significant due to the use of relatively high noise generating construction machinery and equipment. Therefore, the Site Preparation and Earthworks Phase represents the worst case of environmental noise impact of the construction use phase at both the MAA and MAB Refinery Sites.

The significant noise generating sources present during the Site Preparation and Earthworks Phase include bull dozers, dump trucks, wheel loaders, excavators, graders, roller compactors, asphalt machines and rollers. Intermittent and transient noise sources are not considered as significant sources of community noise, since their contribution to L_{eq} values (time weighted average) will be negligible.

7.4.1.2 Operations Activities

Almost all plant equipment generate noise of varying degrees, with SWL ranging from as low as 40 dB(A) to as high as 130 dB(A). At both MAA and MAB sites, there are several hundred such sources of noise generation. For the purpose of noise impact prediction, it is necessary to identify those sources that are significant. Since SWL is represented on a logarithmic scale[2], when there are sources with high SWL, the sources with low SWL can be disregarded without causing any noticeable error in the overall impact prediction. In this study, only those sources with 60 dB(A) or higher SWL are considered in noise impact modelling.

The significant noise sources include turbines, compressors, pumps, motors, fans, blowers, coolers, heaters, furnaces, boilers, heat exchangers, ejectors, crushers, collectors, separators, conveyors, flares and high flow pipelines.

Intermittent and transient noise sources like pressure safety valves and emergency diesel generators are not included.

There are currently numerous noise sources (i.e. existing plant equipment items) located at the MAA, MAB and SHU Refinery Sites. The net noise impact from these sources (as well as any existing external sources) is reflected in the current baseline noise levels (also known as the background noise levels). Therefore, it is not necessary to include the existing noise sources in any of these sites (MAA, MAB and SHU) in the current noise impact prediction modelling study.

[2] Sound power level, SWL is proportional to log [sound power]

Only the new sources (i.e. the new CFP plant equipment items) that will be installed at these sites are considered in this study. As noted in Sections 7.2.1 and 7.2.2, the new sources are mostly located within the CFP Blocks at MAA and MAB refineries.

It is also noted in Sections 7.2.1 and 7.2.2 that the CFP scope also involves the replacement or revamping some existing plant equipment in both the MAA and MAB refineries. Such equipment is well dispersed within MAA and MAB sites. In all likelihood, the source noise level of equipment being revamped or replaced will be either lower or similar to that of the existing equipment. Therefore it is expected that the net impact on environmental noise from replacement or revamping of existing equipment at MAA and MAB sites will be more or less neutral. As a result, the noise sources from replacement/revamping activity are not included in this modelling study.

With reference to the SHU Refinery Site, as noted in Section 7.2.3, KNPC plans to decommission all of the existing processing facilities. Therefore, many major sources of noise generation will be removed, resulting in a significant reduction in the environmental noise in the vicinity of Shuaiba site. As a result, SHU is excluded from the scope of work in this modelling study.

7.4.1.3 Decommissioning Activities

It is recognised that the decommissioning of the existing facilities in the SHU Refinery can generate some noise due to the associated civil and mechanical work. However, decommissioning of facilities at SHU is not part of the CFP scope and will need to be addressed in a separate EIA study for KNPC.

7.4.2 Source Noise Levels at MAA Refinery Site

7.4.2.1 Construction Phase

As discussed earlier in Section 7.4.1.1, the early Construction Phase activities (i.e. Site Preparation and Earthworks) are considered for the worst case noise impact during the Construction Phase. The significant noise generating sources present during the early Construction Phase have also been identified in Section 7.4.1.1. The estimated SWL value for each of these sources is shown in the following table, along with other details.

Table 7.3: Characterisation of Significant Noise Sources in CFP Block at MAA Refinery Site: Construction Phase

Name of Construction Equipment	Number of Units (Individual Noise Sources)	Spacing between Individual Units (m)	Height[a] of Noise Emission Source (m)	SWL_{total} [dB(A)] – Each Source
Bulldozer	5	75	1	109
Dumper Truck	25 (as clusters of 5)	100 (for clusters)	1	103
Wheel Loader	4	75	1	104
Excavator	5	75	1	109
Grader	3	75	1	109
Roller Compactor	5	75	1	104

Name of Construction Equipment	Number of Units (Individual Noise Sources)	Spacing between Individual Units (m)	Height[a] of Noise Emission Source (m)	SWL_{total} [dB(A)] – Each Source
Asphalt Machine & Roller	1	None	1	104

Note: [a]. Emission height with reference to the site ground level at the lowest elevation.

All the sources are assumed to be continuous noise emission sources with 360° directivity. It is also assumed that SWL of any source does not show any variance with time, either diurnal or seasonal.

7.4.2.2 Operations Phase

Based on the discussion presented in Section 7.4.1, only those equipment items located within the CFP Block with SWL above 60 dB(A) are considered as significant noise sources in the model input. Each new unit within the MAA CFP Block consists of a number of equipment items with varying SWL values. Using the preliminary technical information (provided by Fluor, the FEED contractor) for each major individual equipment item, the SWL value is estimated based on the equipment type and its electrical power rating, as well as using DNV's noise data bank. DNV's internal noise data bank for typical plant equipment is based on DNV's experience from real onsite monitoring at various industrial locations combined with empirical correlations.

After estimating the SWL values for each piece of major equipment within each unit, the total SWL value (SWL_{total}) for the unit is calculated by logarithmic addition of the individual SWL values. Thus, each unit is modelled as a single virtual point source with its SWL value equal to the logarithmic total. The location coordinates of this virtual point source correspond to the actual location coordinates of the real point source with the highest individual SWL value in that unit.

This simplification is made in order to conserve the runstream time (due to the presence of several hundred individual point sources in each site) and due to dynamic memory limitations of the model. Trial runs showed that this simplification does not lead to any noticeable error with regard to the SPL values at receptors outside the fence line.

Pipelines with high fluid velocity (>3m/s) are considered as significant noise sources and hence included in the model. These are modelled as line sources. The calculated SWL_{total} value for each unit in the MAA CFP Block is shown in the following table.

Table 7.4: Characterisation of Significant Noise Sources in CFP Block in MAA Refinery Site: Operations Phase[a]

Name of Unit	Source ID	Number of Significant Sources in Process Unit	Height[b] of Noise Emission (m)	SWL_{total}[dB (A)]
Isomerisation Unit	U-107	12	13.5	111.6
LPG Treatment Unit	U-125	9	13.5	114.1
Steam System	U-129	7	33.1	108.6
Naphtha Hydrotreater	U-135	6	30.2	103.3
Delayed Coker Unit	U-136	19	30.2	113.7
Deisopentanizer	U-137	18	13.5	108.4
ICS Merox Unit	U-138	8	12.5	104.2
Atmospheric Residue Desulfurization Unit	U-141	25	30.2	112.7
Gas Oil Desulphurisation Unit	U-144	24	13.5	114.8
Deisobutanizer	U-146	19	13.5	109.8
Hydrogen Production Unit	U-148	13	30.2	112.4
Hydrogen Sulphide Removal Unit	U-150	4	33.1	104.6
Sulphur Recovery Unit	U-151	10	33.1	110.1
Sulphur Recovery Unit	U-152	10	33,1	110.1
Hydrogen Sulphide Removal Unit	U-153	6	17.8	105.8
Sour Water Treatment	U-156	3	33.1	94.5
Interconnecting Pipeways	U-160	Line source	variable	78.0
Interconnecting Pipeways	U-161	Line source	variable	78.0
Hydrocarbon Flare	U-162	4	27.6 134.1	88.5[c] 145.0[d]
Waste Water Treating	U-163	17	27.6	112.6
Fire Fighting Facilities	U-166	-	34.8	110.0
Acid Gas Flare	U-167	3	33.1 132.6	82.8[c] 135.0[d]
Nitrogen / Air Systems	U-171	3	33.1	103.0
Fuel Gas Systems	U-174	2	33.1	90.5
Cooling Water System	U-175	4	34.8	107.7
Water Systems (1st partition)	U-176	13	32.1	97.7
Water Systems (2nd partition)	U-176	1	34.8	77.0
Vacuum Rerun Unit	U-183	13	27.6	108.5
Fluid Catalyst Cracking Naphtha Hydrotreater Unit	U-186	4	33.1	107.6
Coke Handling	U-187	7	28.6	114.1

FCC Sour Water Treating	U-195	9	33.1	97.5
Cooling Water System	U-275	2	32.1	103.1
Heavy Oil Cooling	U-283	3	26.6	103.3

Notes:

[a] Some existing units will be retired; the subsequent benefit via a reduction of noise has not been considered in this assessment..

[b]. Noise emission height with reference to the site ground level at the lowest elevation.

[c]. At normal plant operation with minimal continuous flaring.

[d]. At plant upset condition with maximum flaring at the design rating.

All the sources are continuous noise emission sources with 360° directivity. It is assumed that SWL of any source does not show any variance with time, either diurnal or seasonal. For flares, under normal plant operation, there will be minimal flaring and the SWL will be relatively low.

7.4.3 Source Noise Levels at MAB Refinery Site

7.4.3.1 Construction Phase

The significant noise sources for the MAB construction activities, their relative locations, and their SWL values are identical to those presented in Section 7.4.2.1 for the CFP Block in MAA site. However, since the scope of work at the MAB site is much larger than that at MAA site, it is conservatively assumed that the number of equipment items present at MAB site is double that at the MAA site.

The estimated SWL value for each of these sources is shown in the following table, along with other details.

Table 7.5: Characterisation of Significant Noise Sources in CFP Block in MAB Refinery Site: Construction Phase

Name of Construction Equipment	Number of Units (Individual Noise Sources)	Spacing between Individual Units (m)	Height[a] of Noise Emission Source (m)	SWL_{total} [dB(A)] – Each Source
Bulldozer	10	75	1	109
Dumper Truck	50 (as clusters of 5)	100 (for clusters)	1	103
Wheel Loader	8	75	1	104
Excavator	10	75	1	109
Grader	6	75	1	109
Roller Compactor	10	75	1	104
Asphalt Machines & Roller	2	100	1	104

Note: [a]. Emission height with reference to the site ground level at the lowest elevation.

7.4.3.2 Operations Phase

Each new unit within the CFP Block in MAB consists of a number of equipment items with varying SWL values. As discussed in Section 7.4.2.2, each unit is modelled as a single virtual point source. The calculated SWL_{total} value for each unit in the MAB CFP Block is shown in the following table.

Table 7.6: Characterisation of Significant Noise Sources in CFP Block in MAB Refinery Site: Operations Phase

Name of Process Unit	Source ID	Number Significant Sources in Process Unit	Height[a] of Noise Emission (m)	SWL_{total} [dB(A)]
Crude Distillation Unit	U-111	19	22.2	114.3
Atmospheric Residue Desulfurization Unit	U-112	22	22.2	118.3
Heavy Oil Cooling	U-113	3	22.2	106.6
Hydrocracker	U-114	16	22.2	115.2
Kerosene Hydrotreater	U-115	7	22.2	112.3
Diesel Hydrotreater	U-116	9	22.2	115.1
Naphtha Hydrotreater	U-117	5	19.0	106.9
Hydrogen Production Plant	U-118	12	17.0	114.3
Hydrogen Recovery Unit	U-119	4	16.0	103.4
Sulfur Recovery Unit	U-123	9	13.9	112.0
Amine Regeneration Unit	U-125	4	13.9	109.9
Sour Water Stripping Units	U-126	4	12.4	108.1
Continuous Catalytic Reformer	U-127	13	20.0	112.7
Train 1 - HPU Feed Treatment & Compression	U-128/1	3	17.0	107.3
Train 2 - Hydrogen Compression	U-128/2	6	17.0	115.9
Saturated Gas Plant	U-129	3	10.9	106.8
Steam Systems	U-131	11	20.0	112.0
Cooling Water Systems	U-132	7	27.8	109.1
Fuel System	U-133	1	16.0	77.0
Air / Nitrogen Systems	U-134	1	19.5	108.0
Water Systems	U-137	18	16.0	103.3
Acid Gas Flare	U-146	2	13.4 132.4	85[b] 138.0[c]
Interconnecting Pipeway	U-148	Line source	Variable	78.0
HC Flare and Flare Recovery System[b]	U-149	3	17.3 77.3 / 80.3	90[c] 143.0[d]
Interconnecting Pipeway	U-150	Line Source	Variable	78.0

Name of Process Unit	Source ID	Number Significant Sources in Process Unit	Height[a] of Noise Emission (m)	SWL_{total} [dB(A)]
Fire Water System	U-154	1	16.0	110.0
Waste Water Treating	U-156	17	9.9	114.1
Atmospheric Residue Desulfurization Unit	U-212	15	23.2	116.3
Vacuum Unit	U-213	1	19.0	108.5
Hydrocracker Unit	U-214	21	23.2	116.1
Diesel Hydrotreater	U-216	24	24.3	116.5
Diesel Hydrotreater Flare	U-249	2	13.9 89.4	101.0[c] 140.0[d]
Hydrocracker Flare	U-314	2	107.7 123.7	140.0[c] 140.0[d]

Notes: [a] Noise emission height with reference to the site ground level. [b] The HC Flare and Flare Recovery System consists of a flare recovery unit (U-149/a) and two HC flares (U-149/b/c) with each HC flare consisting of two stacks of same height. [c] At normal plant operation with minimal continuous flaring. [d] At plant upset condition with maximum flaring at the design rating.

All the sources are continuous noise emission sources with 360° directivity. It is assumed that the SWL of any source does not show any variance with time, either diurnal or seasonal. For flares, under normal plant operation, there will be minimal flaring and the SWL will be relatively low.

7.4.4 Source Noise Levels at SHU Refinery Site

As discussed in Section 7.4.1, noise impact modelling is not considered necessary at the SHU Refinery site. Noise levels at SHU will decrease because the process units (and some utility units) within that refinery will be decommissioned. This is regarded as a positive impact for CFP.

7.5 Model Set Up

7.5.1 Model Options and Assumptions

The description of the noise model used in this study and the input requirements are presented in Section 7.1.2. The model options used and the assumption made in this study are described in the following table.

Table 7.7: Model Options and Assumptions

Parameter	Option Used
Noise Sources	• All sources, except pipelines are considered as point sources. Pipelines with high fluid velocity are considered to be high noise generating sources and, therefore, included in the model. These are modelled as line sources. • The source location coordinates are determined from

Parameter	Option Used
	the plot plans and the source heights are determined from the equipment specification datasheets. • SWL values are entered using 1 octave option for the frequency bands 62.5, 125, 250, 500, 1000, 2000, 4000 and 8000Hz[3]. In the absence of any vendor information, the SWL values are estimated based on the equipment specifications (equipment type and electrical power rating) and using DNV's noise data bank. • Considering that there are several hundred pieces of equipment with some noise generation, only the equipment with SWL above 60 dB(A) are considered as significant noise source. This assumption does not lead to any noticeable error, since SPL is added on a logarithmic scale. For instance, the net SPL from a 60 dB source and an 80 dB source is 80.04 dB. • Each Process Unit is modelled as a single virtual point source. The total SWL of the virtual source is calculated by logarithmic addition of the various individual point sources (up to over 20 for each Unit). This simplification is made to conserve the runstream time and due to dynamic memory limitations. • For each source, the directivity is assumed to be 360°. Similarly, the working (operating) period is assumed to be 24 hours. Both are conservative assumptions, representing the worst case.
User Defined Attenuation	• User defined attenuation takes into consideration the reduction in source noise level achieved by providing acoustic enclosures and barriers around high noise generating sources. • In this modelling study, the user defined attenuation is taken as zero (worst case) for all sources except for the following sources as detailed below. • For flares at both MAA and MAB sites, 15 dB(A) attenuation is assumed. In compliance with the KNPC noise specifications, the flares are designed in such a way that SPL outside the enclosure will not exceed 115 dB(A).
Noise Receptors	• Uniform rectangular grid of 50m spacing is used for the receptor points. • Additional discrete receptors at locations, where background noise levels are available from the Environmental Baseline Study, are also used. • All receptors are placed at 1.8m above the local ground level, representing the average hearing height of human receptor.
Barriers	• No barriers are used, since none are present at the project sites. This in any case is a conservative assumption.
Buildings	• Buildings details are input into the model based on the plot plans. • All buildings are assumed to have totally reflective

[3] As per ISO 9613 method, the frequency band 31Hz is not entered.

Parameter	Option Used
	surfaces (no absorption) as well as vertical surfaces (no profile correction). This is a conservative assumption.
Terrain	• Terrain is assumed to be flat, as recommended in the ISO method. • It is recognised that there is about 10-20m drop in the elevation across the plant site for each refinery. However there are no valleys and peaks that act as sound barriers.
Topography	• The topography is assumed to be a simple ground region with hard surface (zero ground absorption). This is a reasonable assumption as well as being conservative
Meteorological Conditions	• Based on two years of meteorological data recorded at the project site, the worst case meteorological parameters are used for calculating noise attenuation by the air absorption. • As noted earlier, wind speed, wind direction and atmospheric stability are not considered in ISO method.
Time Averaging	• Since none of the input parameters has any time dependence, there is no need for selecting different time averaging periods.
Time-of-the-day Compensation	• As a standard default, the model output returns L_{den} value, which is a time weighted average value of SPL in which a penalty of +5 dB and +10 dB is applied for the evening and night hours respectively. • This option is not used in this study because such penalties are already applied in the K-EPA's ambient noise standards (refer Table 7.1). Consequently, the model output returns the 'uncompensated' SPL values.

7.5.2 Modelling Scenarios

Considering that the noise sources are different for the Construction Phase and the Operations Phase, for each site (MAA and MAB), separate model runs were performed. Within the Operations Phase, two different scenarios were considered – normal operation and plant upset condition. The difference is that the flaring will be at the design rating under plant upset condition, while flaring will be minimal under normal plant operation.

The following scenarios were considered for noise modelling:

Scenario MAA 1: Operations Phase (Normal Plant Operation) – MAA Site

Scenario MAA 2: Operations Phase (Plant Upset Condition) – MAA Site

Scenario MAA 3: Construction Phase – MAA Site

Scenario MAB 4: Operations Phase (Normal Plant Operation) – MAB Site

Scenario MAB 5: Operations Phase (Plant Upset Condition) – MAB Site

Scenario MAB 6: Construction Phase – MAB Site

7.5.3 Layout of Noise Sources and Buildings

Using the plot plans for the MAA and MAB sites, the virtual point noise sources and the buildings between the sources and the receptors were entered into the Predictor model. The screen shots taken from the model software after entering the above input data for both the sites for the Operations and Construction Phases are shown in Figures 7D through 7G. It should be noted that the sources and buildings, and their locations for the Operations Phase remain the same under normal operation and upset condition.

Figure 7D: Screen Shot Showing Layout of Noise Sources in MAA CFP Block – Construction Phase
(Note: The construction footprint progresses from one end to the other within the CFP)

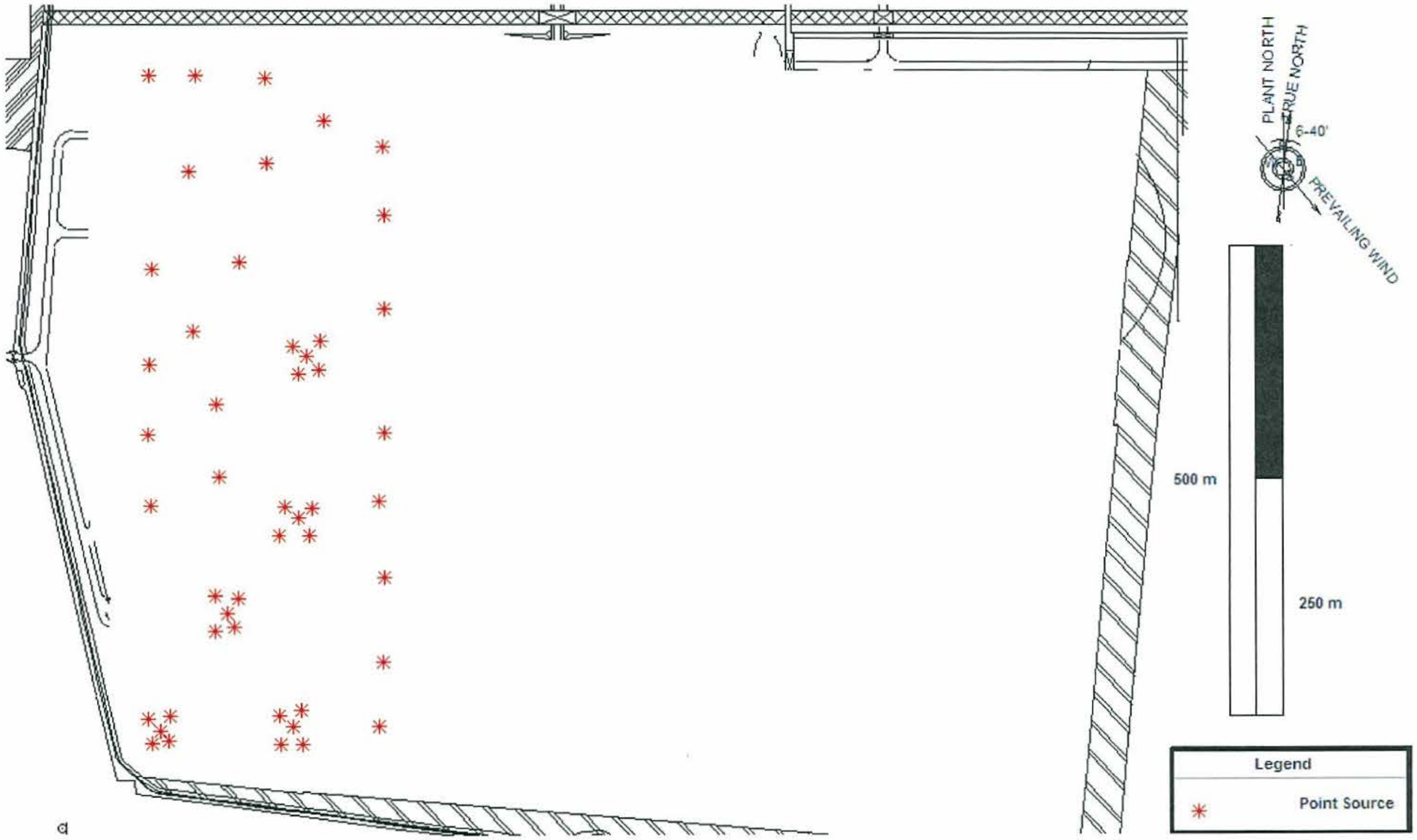


Figure 7E: Screen Shot Showing Layout of Noise Sources and Buildings in MAA CFP Block – Operations Phase

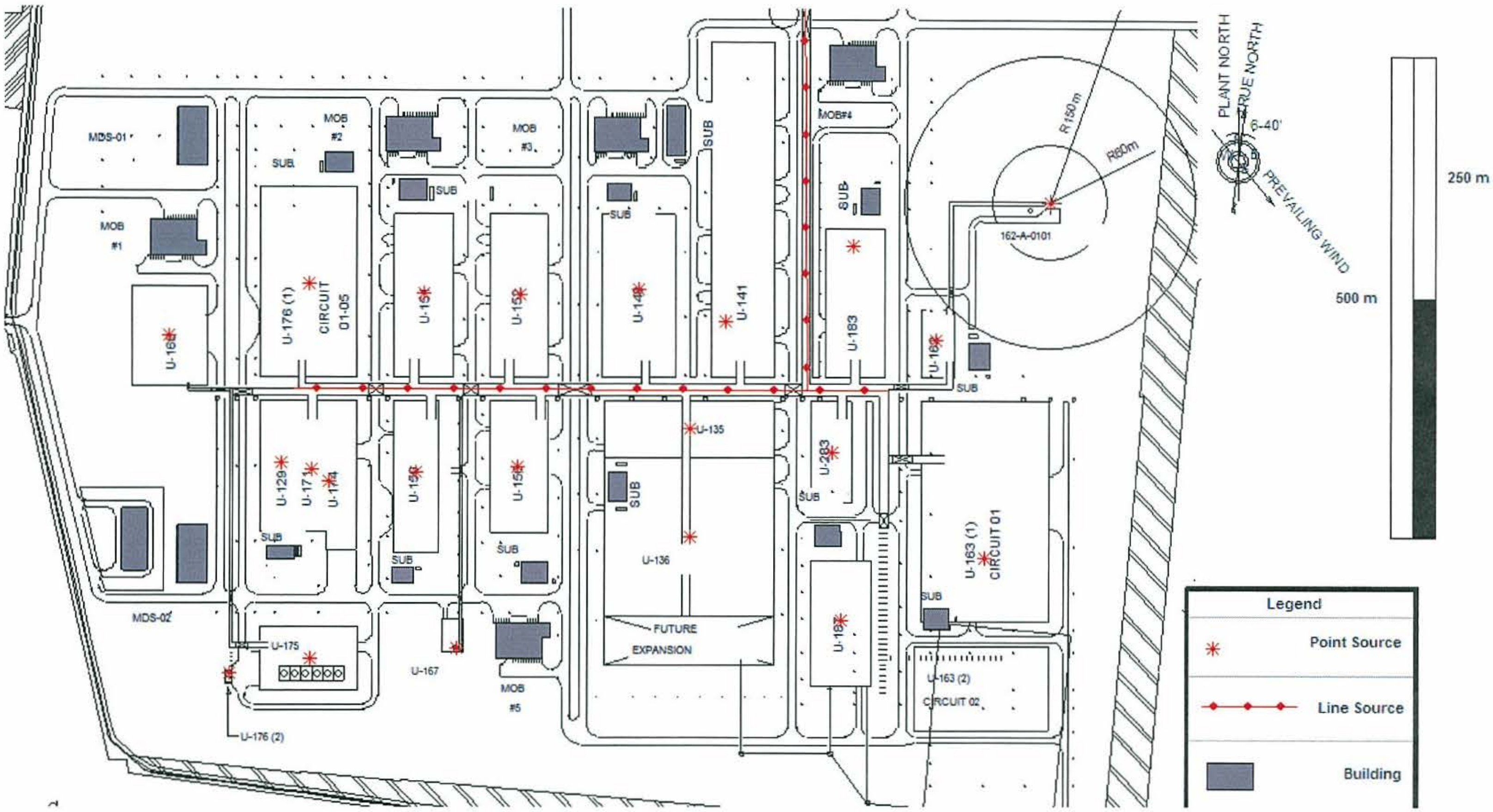


Figure 7F: Screen Shot Showing Layout of Noise Sources in MAB CFP Block – Construction Phase
(Note: The construction footprint progresses from one end to the other within the CFP Block.)

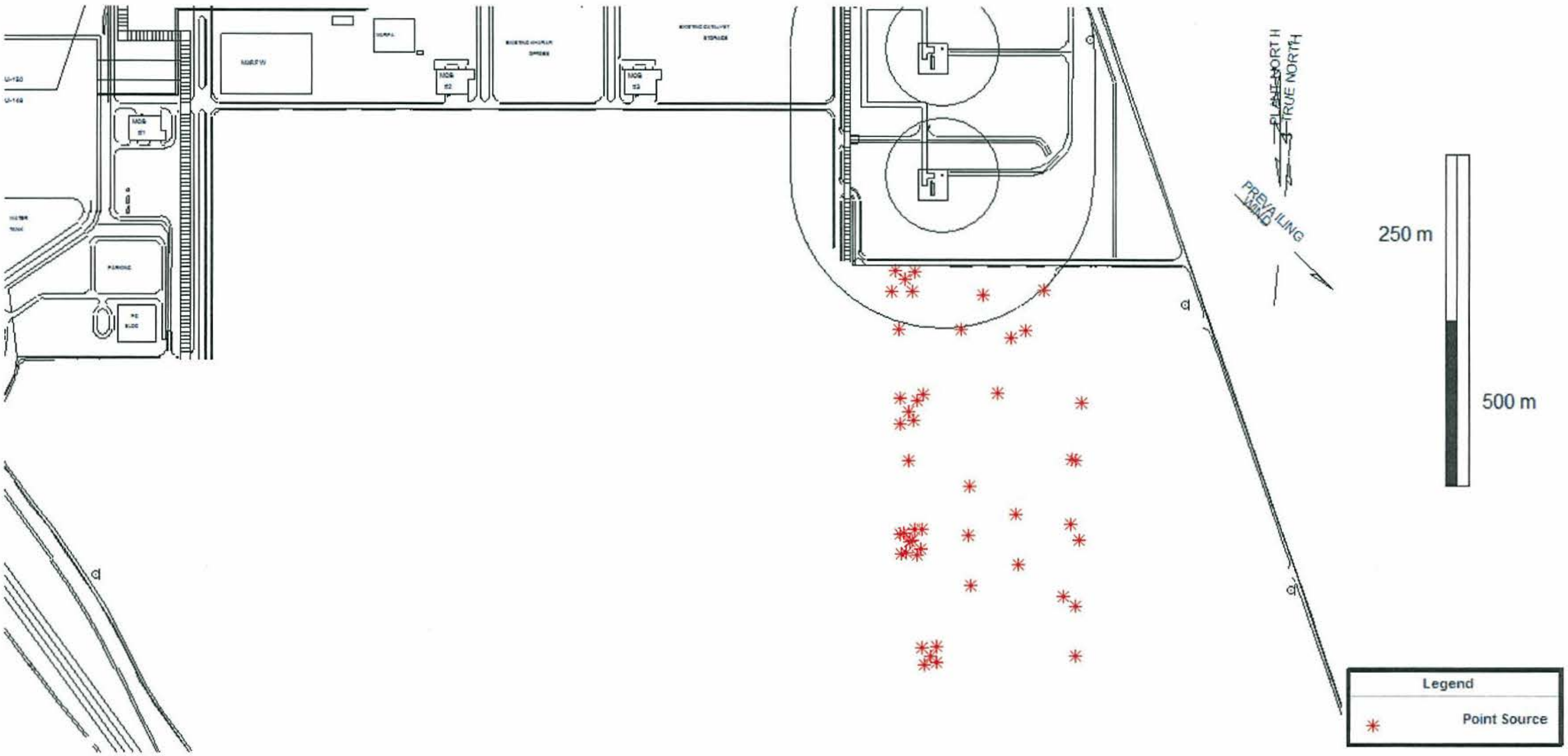
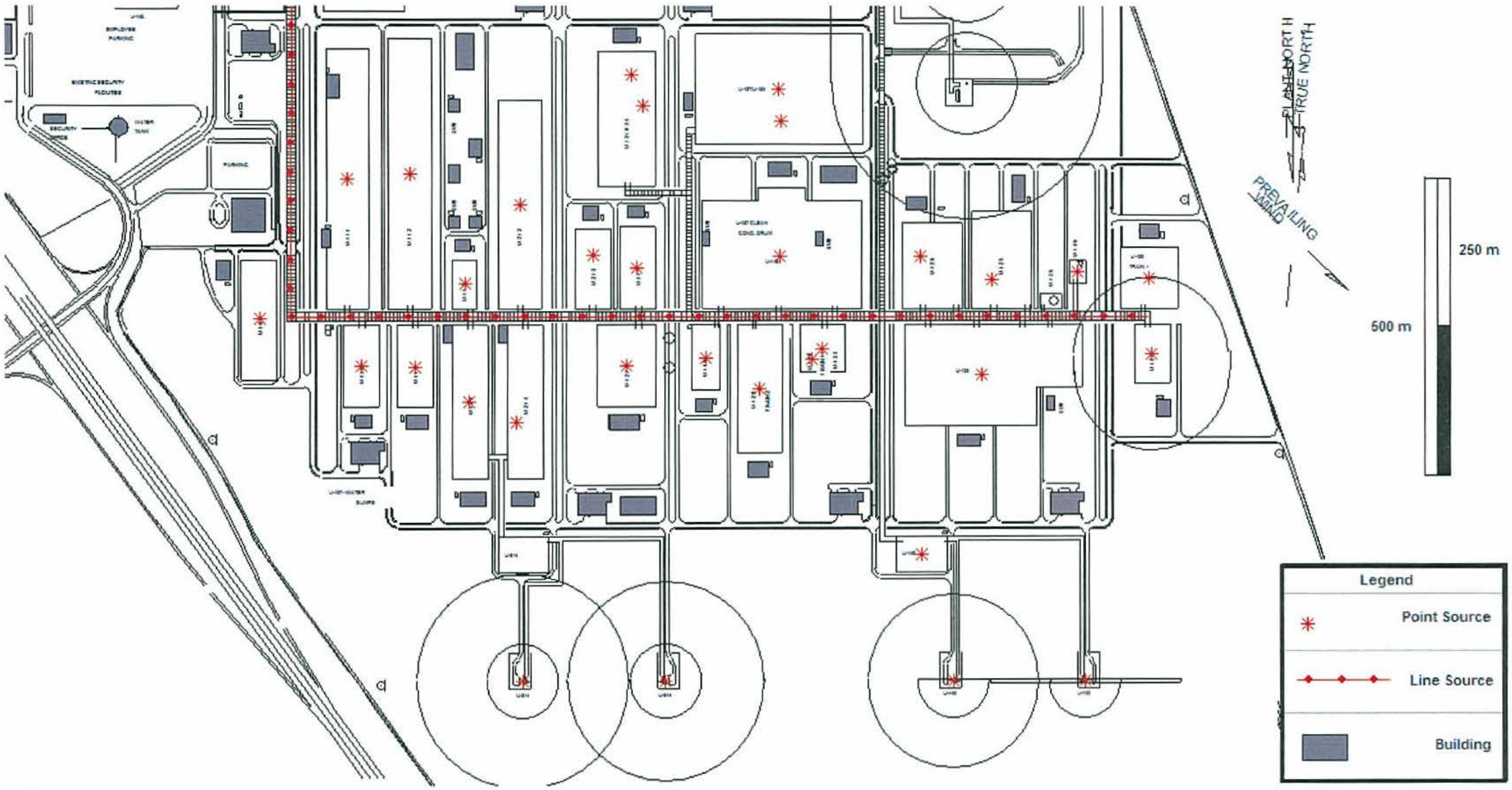


Figure 7G: Screen Shot Showing Layout of Noise Sources and Buildings for MAB CFP Block – Operations Phase



7.6 Model Set Up

7.6.1 General

For each of the scenarios listed in Section 7.5.2, noise modelling was performed as discussed in Section 7.5.1. The results are presented graphically as noise contours, which are overlain on the plot plans. Additionally, the results are also shown in tables, including a few selected receptors. The selected receptors include the fence line points and residential sites (where background noise levels were monitored as part of environmental baseline monitoring).

Also as discussed in Table 7.7, L_{den} values are not used; hence no penalties are applied for the evening and night hours.

7.6.2 MAA Refinery Site

The predicted noise contours for Scenarios MAA 1 (Operations Phase - Normal Plant Operation), MAA 2 (Operations Phase - Plant Upset Condition) and MAA 3 (Construction Phase) are shown in the following figures. It shall be noted that the noise values shown are for any time of the day, expressed as SPL in dB(A) and do not include the background noise levels. The effect of the background noise levels on the predicted values is discussed later in Section 7.7.1.

Figure 7H: Predicted Noise Levels for Construction Phase (Site Preparation & Earthworks) - within MAA CFP Block

(Note: Background noise levels are not included. Site Preparation & Earthworks stage represents the worst case with respect to noise generation during the Construction Phase)