TERMS OF REFERENCE FOR AN ENVIRONMENTAL IMPACT ASSESSMENT

Submitted by PETROJAM Ltd Refinery Upgrade Project.

Project Brief
The Petrojam Limited refinery is being upgraded from a simple hydroskimming plant to a conversion facility. The purpose of the upgrade is to expand the refinery capacity from 35,000 to 50,000 barrels per day and to convert Heavy Fuel Oil (HFO) into more valuable light products through the use of mature proven technology. The upgraded refinery will see the addition of the following main process units and key waste treatment facilities for both liquid and gaseous effluents.

Existing Units being Upgraded

- Crude Distillation Unit
- Gas Recovery Unit
- Kerosene Hydrotreater
- Asphalt Unit

Main New Process Units

- Distillate Hydrotreater
- Naphtha Hydrotreater
- Continuous Catalyst Regeneration Platformer Unit
- Vacuum Unit
- Delayed Coking Unit

New Effluent Treatment Units

- Sour Water Stripper
- Amine Absorber
- Sulphur Recovery Unit
- Tail Gas Treatment Unit
• Waste Water Treatment Plant
Crude from storage tanks will be passed through the existing Desalter for salt and solids removal, then pre-heated in a set of heat exchangers and then finally to the desired temperature in a fuel oil fired furnace (as is currently the case) before entering the upgraded Crude Distillation Unit (CDU). There will be five streams from the CDU: liquefied petroleum gas (LPG), naphtha, kerosene, distillate and fuel oil.

LPG
LPG and naphtha from the CDU will be fed to the Gas Recovery Unit (GRU). The GRU will consist of a series of heat exchangers and distillation towers where the naphtha is separated from the LPG and routed to the Naphtha Hydrotreater. Gases lighter than propane will subsequently be removed from the LPG and routed to the fuel gas system after H_2S is removed in the Amine Absorber. LPG (i.e., propane and butane) are separated from each other and sent to their respective storage facilities.

Naphtha (Gasolene Precursor)
Hydrogen-rich treat gas is added to the naphtha from the GRU and the combined stream heated in a pre-heat exchanger then in a fuel gas fired heater. The heated naphtha-hydrogen stream will then be fed to a new Naphtha Hydrotreater (NHT) for sulphur removal.

Hydrotreated naphtha will be fed to a Naphtha Splitter where light sour gases will be removed. Additionally, light virgin naphtha (LVN) will be separated from feed to the Continuous Catalyst Regeneration (CCR) Platformer and sent to tanks for blending.

In the CCR, naphtha will be upgraded to gasoline in a series of fuel gas fired heaters and catalytic reactors. Chlorides (in the form of perchloroethylene, PCE) will be added continuously to the reactor feed to ensure optimum catalyst activity. Hydrogen will be produced during the reforming reactions, some of which will be recycled to the CCR. The rest of the hydrogen will be compressed and sent to the Naphtha and Distillate Hydrotreaters. The gasoline product will be stripped of light gases in a distillation column then sent to tankage for blending. The stripped gases will combine with other gases to the Amine Absorber.

The key feature of the CCR is the continuous regeneration of the catalyst, whereby coke deposits
are burnt off. Chlorides are inevitably released from the catalyst during regeneration and are present in the vent gas as hydrochloric acid (HCl). There are two main options for HCl removal from vent gases: caustic scrubbing or use of an absorption system (Chlorsorb®). The Chlorsorb® method was chosen as it eliminates the use of caustic and hence the need to dispose of spent caustic. The Chlorsorb system is thus the environmentally friendly solution for reducing chloride emissions from a CCR Platforming unit. There is virtually no waste associated with the use of Chlorsorb®.

Note that there is also the option to add unhydrotreated naphtha from storage to the NHT, and also to add hydrotreated naphtha from storage to the CCR.

**Kerosene**

As with the existing refinery, kerosene from the CDU will be combined with hydrogen treat gas then fed directly to the Kerosene Hydrotreater (KHT) for sulphur removal. Hydrotreated kerosene will then enter a Kerosene Stripper where light gases (hydrocarbons, H₂S, H₂) will be removed and sent to the fuel gas system after sulphur recovery. The kerosene product will then be sent to tanks for blending. Note the light gases are burnt as fuel and are not released to the atmosphere.

**Distillate**

Downstream processing of distillate is similar to that of kerosene. Distillate from the CDU and Delayed Coking Unit (DCU) will be combined with hydrogen-rich treat gas then heated in a new fuel fired furnace and fed to a new Distillate Hydrotreater (DHT). Hydrotreated distillate (diesel) will then be fed to a Diesel Stripper for removal of light gases (hydrocarbons, H₂S, H₂) and sent to the fuel gas system. The diesel product will then be sent to tanks for blending, while the naphtha removed will be routed to the NHT along with the naphtha from the GRU.

**Fuel Oil**

Fuel oil from the CDU will be split into two streams: one will be routed to the existing Asphalt Unit for asphalt production via the existing fuel fired heater; the other will be fed via a new fuel fired heater to a new Vacuum Unit and separated into atmospheric gas oil (AGO), vacuum gas oil (VGO) and vacuum tower bottoms. AGO will be combined with the diesel feed to the Diesel
Hydrotreater while VGO will be sent directly to storage tanks.

**Vacuum Tower Bottoms**

Vacuum tower bottoms (VTB) will be fed to a Delayed Coking Unit (DCU) via a fuel fired heater. In the DCU, the VTB is converted into lighter, more valuable products, namely LPG, naphtha, distillate and gas oil; products similar to those produced in the CDU. The residual petroleum coke (pet coke) will be sold as a by-product, which can be used to generate electricity in a similar fashion to coal.

- Gases lighter than LPG which are produced in the DCU will be routed to the refinery fuel gas system along with those from the main GRU.
- The LPG will be routed through a separate Gas Recovery Unit dedicated to DCU LPG, then to their respective storage vessels.
- The naphtha and distillate will be combined with the feed to the DHT.
- The coker gas oil (CGO) will be blended with the VGO and routed to storage.
- The pet coke will be stored in stockpiles.

**Sulphur Recovery**

All light hydrocarbon gases destined for the fuel gas system will first be passed through an Amine Absorber in which an aqueous solution of Methyl Diethanol Amine (MDEA) will be used to absorb H₂S, CO₂ and mercaptans from the gases. Consequently SO₂ emissions from fired heaters will be substantially reduced. The MDEA, rich in acid gas, will then be fed to an Amine Regenerator (distillation tower) where the acid gases will be removed from the MDEA stream. The resultant acid gas (rich with H₂S) will be routed to the Sulphur Recovery Unit (SRU), while the MDEA will be recycled to the Amine Absorber. In Phase I there will be only one Amine Absorber Unit, however, in Phase II a second unit will be installed when it is desirous to separate gases rich in hydrogen for reuse in the process.

Sour water streams (water with high H₂S and ammonia content) will be collected in a tank and fed to a Sour Water Stripping Unit which will use steam to remove the impurities. Stripped water
will then be recycled for process use, for example in the Desalter. The acid gas produced will be combined with the acid gases from the Amine Absorber and fed to the SRU.

The SRU will consist of two (2) Sulphur Recovery trains utilizing the Claus Process, whereby a catalytic converter will be used to recover elemental sulphur from the acid gases. The sulphur will be sold as a by-product, while the tail gas produced will be fed to a Tail Gas Treating Unit (TGTU). In the TGTU, the tail gas from the SRU will first be heated in a fired heater, then passed through a reactor then finally contacted with MDEA, thus removing most of the sulphur which remained in the tail gas from the SRU in the form of elemental sulphur. The treated gas will then be incinerated in a boiler and the MDEA regenerated.

**Waste Water Treatment**

Waste water will first enter an oil water separator then undergo additional treatment, possibly consisting of a dissolved air flotation system, as is used in many refineries worldwide. The exact configuration is unknown at this time; however, all waste water will undergo the requisite treatment to meet the national effluent standards prior to disposal.

**Utilities**

All primary utility systems as listed below will be upgraded to meet the demands of the upgraded refinery.

- Boiler facilities will be upgraded to produce the increased steam demand.
- Additional Cooling Towers will be installed.
- The fuel gas system will be upgraded to satisfy the increased demand arising from the installation of new fired heaters.
- The existing flare will be replaced with one of larger capacity. Flaring is an environmentally acceptable method for safe disposal of refinery waste gases.
  - An acid gas flare will also be installed to safely dispose of waste gases with high H₂S content.
- Additional Reverse Osmosis Plants for treatment of well water will be installed. The feed water will be extracted from new wells, the locations of which are being
determined through a comprehensive geological survey so as to minimize the potential environmental impact.

- Additional compressors will be installed to supply the required instrument and utility air.

The upgraded refinery will also see the installation of hydrogen and nitrogen production plants using steam methane reforming (SMR) and pressure swing absorption (PSA) technology, respectively.

Electricity and steam will be purchased from the neighboring JPS plant from a newly installed Cogeneration unit. The arrangement will be one of synergy, as Petrojam will supply JPS with the petcoke which will be used for the generation of electricity and steam. Petrojam will in turn return the condensate to JPS.

Gases lighter than propane will be routed to the fuel gas system after H₂S is removed in the Amine Absorber. Propane and butane will be

Naphtha that may have been carried over in the LPG will also be separated and combined with the naphtha stream from the CDU.

In Phase II however, the LVN will be fed to an Isomerization Unit, consisting of a catalytic reactor which in addition to increasing the octane of the LVN also removes benzene.

The main products of the DCU are similar to that of the will be heavy fuel oil (HFO) to which cutterstock (light hydrocarbon material) will be added before being sent to storage. Visbroken naphtha and distillate will also be produced; these will be combined with the feed to the DHT. Gases from the Visbreaker are compressed and combined with the feed to the GRU. In Phase II, the Visbreaker will be replaced with a Delayed Coker Unit which will produce gas, coker naphtha, coker distillate and petroleum coke. The petroleum coke will be sold as a by-product whilst the light hydrocarbons (gas, naphtha and distillate) will be routed in a similar manner to the products from the Visbreaker.
Map of Kingston, Jamaica showing the Petrojam site location.
Terms of Reference

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

1) Objectives
2) Complete description of the existing site proposed for development.
3) Significant environmental issues of concern through the presentation of baseline data which should include social, cultural and heritage considerations. Assess public perception of the proposed development.
4) Policies, Legislation and Regulations relevant to the project.
5) Likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and their relative importance to the design of the development’s facilities.
6) Mitigation action to be taken to minimise predicted adverse impacts and quantify associated costs.
7) Monitoring Plan which should ensure that the mitigation plan is adhered to.
8) Alternatives to the project that could be considered at that site or at any other location.
9) Conclusions

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The following tasks will be undertaken:

Task #1. Description of the Project

Provide a comprehensive description of the project and its the surrounding environment specifying any information necessary to identify and assess the environmental effects of the project. This should include project objectives and information on the nature, location/ existing setting, timing, duration, frequency, general layout and size of facility including ancillary buildings, pre-construction activities, construction methods, works and duration, and post construction plans. A description of raw material inputs, technology and processes to be used as well as products and by-products generated, should be provided. Note areas to be reserved for construction and areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment.
Wastewater and sewage treatment systems including treated effluent disposal will be clearly outlined as well as solid waste disposal methods. In addition, plans for storm water collection and disposal as well as plans for providing utilities and other services will be clearly stated. This will involve the use of maps at appropriate scales, site plans, aerial photographs and other graphic aids and images, as appropriate.

In terms of beach modification, any proposed works on the foreshore and the floor of the sea will be clearly described including but not limited to any seagrass or coral removal and replanting. A storm surge analysis must be conducted to inform coastal setbacks of buildings and impact mitigation structures/measures.

All phases for the project will be clearly defined the relevant time schedules, phased maps, diagrams and appropriate visual aids will be included.

**Task #2. Description of the Environment.** Baseline Studies Data Collection and Interpretation

The study area/geographical boundaries, and methodology to be utilized for baseline and other data and the length of the study will be described. This task involves the generation of baseline data which is used to describe the study area as follows:

i) Physical environment

ii) Biological environment

iii) Socio-economic and cultural constraints.

**(A) Physical**

i) A detailed description of the existing soil and geology and geomorphology, landscape, aesthetic values and hydrology. Special emphasis will be placed on storm water run-off, drainage patterns, aquifer characteristics, effect on groundwater and availability of potable water. Any slope stability issues that could arise should be thoroughly explored.
ii) **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the development. Quality Indicators should include but not necessarily be limited to nitrates, phosphates, faecal coliform, and suspended solids.

iii) **Coastal and Marine** ecosystems, including but not limited to any wetlands including mangroves, seagrass and coral community with indication of its function and value in the project area.

iv) **Climatic conditions and air quality** in the area of influence including particulate emissions from stationary or mobile sources, NO\textsubscript{x}, SO\textsubscript{x}, wind speed and direction, precipitation, relative humidity and ambient temperatures,

v) **Noise levels** of undeveloped site and the ambient noise in the area of influence.

vi) Obvious sources of existing pollution and extent of contamination.

viii) Availability of solid waste management facilities.

**(B) Biological**

Present a detailed description of the flora and fauna (terrestrial and aquatic) of the area, with special emphasis on rare, threatened, endemic, protected, endangered species. Migratory species wild food crop plants and presence of invasive alien species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Generally, species dependence, habitats/niche specificity, community structure and diversity ought to be considered.

**(C) Socio-economic & cultural**

Present and projected population; present and proposed land use; planned development activities; issues relating to squatting and relocation; (housing demand and supply) community structure; economic base /employment; distribution of income; goods and services; utilities; recreation; public health and safety; cultural peculiarities, aspirations and attitudes should be explored. The historical importance (heritage, archaeological sites and feature) and other material assets of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment
may vary with community structure and may take multiple forms such as public meetings or questionnaires/surveys.

**Task #3 – Policy, Legislative and Regulatory Considerations**

Outline the pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the NRCA Act, the Housing Act, the Town and Country Planning Act, The Petroleum Act, Building Codes and Standards, Development Orders and Plans and the appropriate international convention/protocol/treaty where applicable.

**Task #4 – Identification and Assessment/Analysis of Potential Impacts**

Identify the significant environmental and public health/safety issues of concern and indicate their relative importance.

Identify the nature, severity, size and extent of potential direct, indirect and cumulative impacts (for terrestrial and aquatic environments) during the pre-construction, construction and operational phases of the development as they relate to, (but are not restricted by) the following:

- change in drainage patterns
- flooding potential
- landscape impacts of excavation and construction
- loss of and damage to geological and palaeontological features
- loss of species and natural features
- habitat loss and fragmentation species
- biodiversity/ecosystem functions
- pollution of potable, coastal, marine, surface and ground water
- air pollution
- capacity and design parameters of proposed sewage treatment facility
- Socio-economic and cultural impacts.
- Impact of flooding, loss of natural features, excavation and construction on the historic landscape, architecture and archaeology of the site.
Identify the interaction between different impacts and impacts of other projects should also be considered. In addition, the impacts that have occurred and those impacts which could still occur as a consequence of the clearing works that were conducted on the site prior to the preparation of the TORs should also be identified and analysed.

Distinguish between significant positive and negative impacts, reversible or irreversible direct and indirect, long term and immediate impacts as well as avoidable and irreversible impacts.

Characterize the extent and quality of the available data, explaining significant information deficiencies, assumptions and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should be represented in matrix form with separate matrices for pre and post mitigation scenarios.

Task #5 – Drainage Assessment

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

i. Drainage for the site during construction, to include mitigation for sedimentation to the aquatic environment

ii. Drainage for the site during operation, to include mitigation for sedimentation to the aquatic environment
iii. Drainage control for the gully traversing the property, to include impacts that this drain will have on the aesthetics, water quality and sedimentation of the beach area, etc.

**Task #6 Mitigation**

Prepare guidelines for avoiding or reducing (e.g. restoration and rehabilitation), as far as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development. Quantify and assign financial and economic values to mitigating methods.

**Task #7 - Environmental Management and Monitoring Plan**

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

An outline monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit and/or licence(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

The Monitoring report should also include, at minimum:
• Raw data collected. Tables and graphs are to be used where appropriate
• Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
• Recommendations
• Appendices of data and photographs if necessary.

**Task #8 - Project Alternatives**
Examine alternatives to the project including the no-action alternative. This examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself. Refer to NEPA guidelines for EIA preparation.

**Task #9 Public Participation/Consultation Programme**
Conduct a public presentation on the findings of the EIA to inform, solicit and discuss comments from the public on the proposed development.

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

All Findings must be presented in the EIA report and must reflect the headings in the body of the ToRs, as well as references. Ten hard copies and an electronic copy of the report should be submitted to the National Environment and Planning Agency..
The report should include an appendix with items such as maps, site plans, the study team, photographs, ToR and other relevant information.