

**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY
REPORT FOR THE PROPOSED
INDUSTRIAL GASES PLANT ON PLOT L.R NO.
MACHAKOS/NGULUNI/4867, ALONG KANGUNDO ROAD,
NGULUNI AREA, MACHAKOS COUNTY.**

**Geographical Position: E037⁰14' 25.0" and S01⁰ 17' 04.9",
Elevation 1509 MASL**



Proponent

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December, 2019

DECLARATION

BY THE EIA LEAD EXPERT

I, the undersigned, do hereby declare that:

- I have conducted the study professionally using acceptable methodologies;
- The study findings are correct to the best of my knowledge, and have not been altered in any manner;
- The mitigating measures proposed (whenever relevant) to the best of my knowledge are reliable, practical and adequate to comply with the relevant legal requirements.

Lead Expert

Elijah Muigai

Lead Expert Reg No. 5086

BY THE PROJECT PROPONENT

I, the undersigned, representing Perfect Purity Gases Company Limited, do hereby declare that:

- I have provided correct and relevant information to the EIA Team;
- I have allowed the EIA Team to conduct the EIA professionally and independently;
- I agree to implement all mitigation measures proposed in this EIA report; and,
- I understand that additional mitigating measures may also be imposed by the government should the original mitigating measures proposed in this EIA report found not to be adequate
- I agree to comply with the relevant legal requirements.

Signature:

Name:

Date/Stamp:

ACKNOWLEDGEMENT

The undertaking of this Environmental Impact Assessment study and the successful compilation of its report was as a result of the direct or indirect contribution of several people whom I would wish to acknowledge.

First and foremost, I feel greatly indebted to Perfect Purity Gases Company Limited for giving us this assignment and providing all the necessary logistical support during the assessment. In particular, we wish to thank and appreciate Mr. Ahly Hussein and Stanley for the valuable support provided throughout the assessment. They were always available for consultation in conducting successful public participation.

I would like to acknowledge with gratitude the contribution the area chief who helped to coordinate the public participation Baraza within his are of jurisdiction. In addition we thank all stakeholder who attended the public participation Baraza and provided vital information related to the project, especially the prospective beneficiary community members during the various interviews. Your full participation in the assessment was highly appreciated, and your valuable contributions in terms of the perceived community benefits and negative impacts of the proposed project were very useful in the drafting of this report are acknowledged.

Lastly, I wish to express gratitude to the entire EIA Team which was comprised of myself as the Team Leader, Mr. Onana (occupational health and safety expert), Madam Esther (the sociologist), Mr. Muiruri (the analytical chemist), Mr. Masila (principle assistant and lead expert), Mr Ogoro Bonface (associate expert and public health specialist), Mr. Solomon Lupempe (associated expert), Dan Amollo (associate expert and specialist in hazardous waste management), Mary Njogu (office assistant), who all worked tirelessly during field data collection and in the compiling and editing of this report.

The findings and recommendations found herein are based on the team's understanding, observations, analyses and interpretation of data obtained based on the terms of reference.

ACRONYMS

°C	Degrees Celsius
AGST	Above Ground Storage Tank
ASP	Air Separator Plant
CBD	Central Business District
DMF	Dimethylformamide
EIA	Environmental Impact Assessment
EMCA	Environmental Management Coordination Act
ESMP	Environmental and Social Management Plan
ERP	Emergency Response Plan
HCFC	Hydro Chloro Floro Carbons
IEA	Initial Environmental Audit
KEB	Kenya Bureau of Standards
KM	Kilometers
LAN	Liquid Ammonium Nitrate
NEC	National Environment Council
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organizations
NPEP	National Poverty Eradication Plan
OHSO	Occupational Health and Safety Office
PCB	Polychlorinated Biphenyls
SWM	Solid Waste Management
TOR	Terms of Reference
UNEP	United Nations Environmental Programme
UST	Underground Storage Tank
VAT	Value Added Tax
VOC	Volatile Organic Compound
WRMA	Water Resources Management Authority

LIST OF TABLES

- Table 1: Summary of Impacts and Mitigation Measures
- Table 2: Machakos County Statistics
- Table 3: Crop Production in Machakos County
- Table 4: quantity and value of livestock and livestock products
- Table 5: Maximum Permissible Noise levels as per the First (1st) Schedule
- Table 6: Maximum Permissible Noise levels for Construction sites as per the 2nd Schedule
- Table 7: Best practices for water use in ASP processes
- Table 8: Construction Phase Environmental and Social Management/Monitoring Plan
- Table 9: Implementation Phase Environmental and Social Management/Monitoring Plan
- Table 10: Decommissioning Phase Environmental and Social Management/Monitoring Plan
- Table 11: Emergency Response Plan

LIST OF FIGURES

- Figure 1: Oxygen/Nitrogen Separation Process
- Figure 2: Acetylene Chemical Reaction Process
- Figure 3: Acetylene Chemical reaction process
- Figure 4: Map of Kenya Indicating the position of Machakos County

LIST OF PLATES

- Plate 1: The local Pastor open the public Baraza with a word of prayer
- Plate 2: Project affected person during public Baraza
- Plate 3: Introduction session during public Baraza
- Plate 4: Senior Chief Mr. J.B. Ndabuki welcomes community members to the public Baraza meeting
- Plate 5: The assistant Chief of Kwangi sub-location Madam Ruth Mwendu Mutua
- Plate 6: The proponent present the project to participants and neighbours to be.
- Plate 7: The lead expert presents the project impacts and answers questions from the participants
- Plate 8: The secretary of public participation meeting (Mary Njeri Njogu) takes minutes of the Baraza.
- Plate 9: More participants Keenly follow the proceedings of the public Baraza

TABLE OF CONTENTS

ACRONYMS	4
LIST OF TABLES.....	5
LIST OF MAPS	ERROR! BOOKMARK NOT DEFINED.
LIST OF FIGURES	5
LIST OF PLATES.....	5
TABLE OF CONTENTS.....	6
EXECUTIVE SUMMARY	11
1 INTRODUCTION.....	19
1.1 Scope objective and criteria of the Environmental Impact Assessment (EIA).....	19
1.1.1 Scope	19
1.1.2 Terms of Reference (TOR) for the EIA Process	19
1.1.3 Data collection procedures.....	21
1.1.4 EIA organization and structure.....	21
1.1.5 Reporting and documentation.....	21
1.1.6 Responsibilities and undertaking	21
1.1.7 Methodology outline.....	22
2 PROJECT DESCRIPTION	24
2.1 Project location and Size	24
2.2 Project Objectives	24
2.3 Project Implementation Programme	25
2.4 Project Design and Processes	25
2.4.1 Construction of the workshop, office block and Power House	26
2.4.2 Existing Perimeter fence and Security Gate and borehole.....	27
2.5 Project's Construction Activities	28
2.5.1 Sourcing and transportation of building materials.....	28
2.5.2 Storage of materials.....	28
2.5.3 Masonry, concrete work and related activities.....	28
2.5.4 Electrical work	28
2.5.5 Plumbing	28
2.5.6 Aesthetics.....	29
2.6 Project's Operational Activities.....	29
2.6.1 Oxygen/Nitrogen/Argon/Carbon Dioxide Air Separator Plant.....	29
2.6.1.1 Warm End Process	29
2.6.1.2 Coldbox Process	30
2.6.1.3 Storage and Vaporising Process.....	31
2.6.2 Acetylene Generator Plant	31
2.6.3 Solid waste and waste water management	33
2.6.4 Cleaning.....	33
2.6.5 General repairs and maintenance	34
2.7 Project's Decommissioning activities.....	34
2.7.1 Demolition works	34
2.7.2 Dismantling of Equipment and Fixtures.....	34
2.7.3 Site Restoration	34
2.8 Project Justification & Alternatives	34
2.9 Project Cost.....	35

3	BASELINE INFORMATION	36
3.1	Background Information	36
3.2	Project Area and Location	36
3.3	Administrative, Political Units, and Population.....	37
	TABLE 2: MACHAKOS COUNTY STATISTICS	38
3.4	Existing condition of the site.....	38
3.5	Neighbouring facilities	38
3.6	Infrastructural facilities.....	38
3.6.2	Power supply.....	38
3.6.3	Water Supply.....	39
3.7	Flora and Fauna	39
3.8	Natural (biophysical) Environment	39
3.8.1	Climate.....	39
3.10	Hydrological Systems	39
3.10.1	Surface water resources	39
3.11	Geology and soils	40
3.12	Economic Activity and land use	40
	Role of Agriculture in the county	40
4	RELEVANT LEGISLATIVE, POLICY AND REGULATORY FRAMEWORK	44
4.1	Introduction	44
4.2	Environmental Policy Framework	44
4.3	Institutional Framework	44
4.3.1	National Environmental Management Authority (NEMA).....	45
4.3.2	National Environmental Council (NEC)	46
4.4	Relevant Legislation	47
4.4.1	Environmental Management and Coordination Act (EMCA cap 387)	47
4.4.2	Environmental Management and Coordination (Waste Management) Regulations, 2006	47
4.4.3	Environmental Management and Coordination (Water Quality) Regulations, 2006	48
4.4.4	The Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009	49
4.4.5	The Environmental Management and Coordination (Controlled Substances) Regulations 2007.....	51
4.4.6	Public Health Act (Cap. 242)	52
4.4.7	County Government Act, 2012	53
4.4.8	Physical Planning Act, 1999	54
4.4.9	Land Planning Act (Cap. 303)	54
4.4.10	Land Control Act.....	54
	Land Title Deed.....	54
	Section 23 Certificate of Title Deed	55
4.4.11	Water Act, 2002.....	55
4.4.12	The Building & Construction Codes and Standards, Cap 123 and 496 Respectively	56
4.4.13	Building Code 2000.....	56
4.4.14	Penal Code Act (Cap.63)	56
4.4.15	Factories and Other Places of Work Act (Cap 514)	57
4.4.16	Fire Risk Reduction Rules, Legal Notice NO. 59 of 2007.	58
4.4.17	Occupier's Liability Act Cap. 34	59
4.4.18	Workmen's Compensation Act (Cap 236)	59
4.4.19	Standards Act, Cap 496, 1981	59

4.4.20	Machakos County Government (MCG) By-Laws,	60
4.4.21	The Petroleum Act, Cap 116	60
4.4.22	National Construction Authority Act, 2011	60
5	PUBLIC PARTICIPATION.....	61
5.1	Sources of Information.....	61
5.2	Public Baraza meeting	61
5.2	Photos of Public Participation Baraza.....	63
6	ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT	68
6.1	Introduction	68
6.2	Construction phase	68
6.2.1	Positive Impacts.....	68
6.2.2	Negative Impacts	69
6.3	Operation phase	71
6.3.1	Positive Impacts.....	71
6.3.2	Negative Impacts	72
7	MITIGATION MEASURES OF NEGATIVE ENVIRONMENTAL IMPACTS.....	74
7.1	Introduction	74
7.2	Construction related impacts	74
7.2.1	Air quality	74
7.2.2	Noise pollution	74
7.2.3	Hydrology and water quality degradation.....	75
7.2.4	Construction Waste	75
7.2.5	Generation of exhaust emission.....	76
7.2.6	Worker accidents and hazards when handling hazardous wastes.....	76
7.2.7	Populations of disease vectors	76
7.2.8	Possible exposure of workers to diseases	77
7.2.9	Worker accidents during construction	77
7.3	Operation Phase Impacts.....	77
7.3.1	OXYGEN/NITROGEN/ARGON/CARBON DIOXIDE FACILITY	77
7.3.1.1	Air Intake.....	77
7.3.1.1.1	Air Emissions	77
7.3.1.1.2	Air Filters	78
7.3.1.2	Compression	78
7.3.1.2.1	Energy.....	78
7.3.1.2.2	Noise-Vibrations	79
7.3.1.2.3	Oil.....	80
7.3.1.3	Cooling.....	80
7.3.1.3.1	Cooling Water	80
7.3.1.4	Refrigeration Unit.....	83
7.3.1.4.1	Volatile Organic Compounds	83
7.3.1.5	Maintenance	83
7.3.1.5.1	Regular Maintenance	83
7.3.1.5.2	Consumables	83
7.3.1.5.3	Catalysts	84
7.3.1.5.4	Battery and Electrical Cells.....	84
7.3.1.5.5	Metal Waste.....	84
7.3.1.5.6	Insulation Material	84
7.3.1.5.7	Silica Gel/Aluminium Gel/Molecular Sieve	84
7.3.1.6	Storage	85
7.3.1.6.1	Waste Storage	85
7.3.1.7	Visual	85

7.3.2	ACETYLENE FACILITY.....	85
7.3.3	Raw Material Storage.....	87
7.3.3.1	Calcium Carbide.....	87
7.3.3.1.1	Calcium Carbide Containers.....	87
7.3.3.1.2	Calcium Carbide Drums.....	88
7.3.3.1.3	Calcium Carbide Dust.....	88
7.3.3.2	Chemicals.....	88
7.3.3.2.1	Purifier Material.....	88
7.3.3.2.2	Solvents.....	88
7.3.3.2.3	Storage Tanks.....	89
7.3.3.2.4	Underground Storage Tanks.....	89
7.3.3.2.5	Above Ground Storage Tanks.....	89
7.3.4	Acetylene Generator.....	89
7.3.4.1	General.....	89
7.3.4.2	Calcium Carbide Residuals.....	90
7.3.4.3	Lime.....	90
7.3.4.4	Generator Water.....	91
7.3.4.5	Generator Cleaning Residuals.....	91
7.3.5	Gas Holder.....	92
7.3.5.1	Water.....	92
7.3.5.2	Oil.....	92
7.3.6	Purification.....	92
7.3.6.1	Sulphuric Acid.....	92
7.3.6.2	Sodium Hydroxide (NaOH) & Sodium Carbonate (Na ₂ CO ₃).....	93
7.3.6.3	Sodium Purification Media.....	93
7.3.7	Compression.....	93
7.3.7.1	Oil.....	93
7.3.7.2	Water-Oil Mixtures.....	94
7.3.8	Dryers.....	94
7.3.8.1	Silica Gel/Alumina Gel.....	94
7.3.8.2	Calcium Chloride.....	94
7.3.8.3	Sodium Hydroxide.....	94
7.3.8.4	Packaging Materials.....	94
7.3.9	Cylinder Filling.....	94
7.3.9.1	Cooling Water.....	94
7.3.9.2	Ethanol/Glycol.....	95
7.3.9.3	Acetylene Emissions.....	95
7.3.9.4	Acetone form Return Gas.....	95
7.3.10	Cylinder Maintenance.....	96
7.3.10.1	Scrap Metal.....	96
7.3.10.2	Scrap Cylinders.....	96
7.3.10.3	Paint.....	96
7.3.11	General.....	96
7.3.12	Noise.....	96
7.3.13	Air Emissions.....	96
7.3.14	Emergency Plan.....	96
7.4	Decommissioning Phase Impacts.....	97
7.4.1	Efficient solid waste management.....	97
7.4.2	Reduction of dust concentration.....	97
7.4.3	Minimization of noise and vibration.....	97
8	ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN.....	98
8.1	Significance of an ESMP.....	98
8.1.1	Construction Phase.....	98

8.1.2	Operation Phase.....	102
8.1.3	Decommissioning Phase.....	111
9.0	ENVIRONMENT, HEALTH AND SAFETY (EHS).....	113
9.1	EHS Management and Administration	113
9.2	The Guiding Principles to Be Adopted By the Contractor	113
9.3	EHS Management Strategy to Be Adopted By the Contractor.....	113
9.4	Safety Requirement at the Project Site	114
9.5	Welding at the Construction Site.....	115
9.6	Emergency Procedures during Construction and Operation	115
10.0	CONCLUSION AND RECOMMENDATIONS.....	117
	REFERENCES.....	118
	APPENDICES	119

EXECUTIVE SUMMARY

Kenya, like many other developing countries in Africa, is experiencing rapid urbanization growth (UN Habitat, 2008, p.102). Many cities and towns have grown in population size and also expanded spatially to form huge metropolitan regions. Metropolitan regions do present huge development opportunities. Nairobi metropolitan region covers approximately 32,000 km². This covers 15 No. local authority areas - City Council of Nairobi (684 km²); County Councils of Kiambu, Olkejuado, Masaku and Thika; Municipal Councils of Ruiru, Thika, Kiambu, Limuru, Mavoko, and Machakos; and Town Councils of Karuri, Kikuyu, Kajiado, and Kangundo (Ministry of Nairobi Metropolitan Development, 2009). The metropolitan region population is projected to grow to 7.6 million people (2012), 10.8 million (2022), and 14.3 million (2030). Nairobi and its metropolitan region are both the largest and well established commercial and industrial regions in East and Central Africa. Huge commercial establishments are found in Nairobi. Nairobi is also the home of huge manufacturing industries in the region. The industrial growth of Nairobi has created high demand for various industrial gases used by both industrial producers and also in hospital. The proponent has identified this demand in this market and proposes to set up an industrial gases plant for; oxygen, nitrogen, acetylene food grade carbon dioxide and argon. The plant will be located along Kangundo road on Nguluni area within Machakos County on a plot L.R No. **MACHAKOS/NGULUNI/4867.**

Industrial gases are generally produced as close as technically and economically possible to the customer. This helps to minimise the impacts of transportation. Gas (in liquid or gaseous form) can be transported by pipeline, road, rail or sea. Pipeline transportation from on or off site gas generators avoid many of the environmental impacts, though the pipeline occupies land resources and there are compression losses.

The advent of small non-cryogenic gas generators has lead to an increase in the gas generated on nearer the customer. This avoids the environmental impacts of transporting the gas in liquid form and re-vaporizing it.

It is for these reasons that the proponent Perfect Purity Gases Company Limited proposes to set up an industrial gas manufacture and cylinder filling plant for the following industrial gases majorly for the industrial and medical sector market within Nguluni area, Machakos County and beyond;

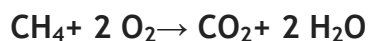
- **Oxygen-** Oxygen is a tasteless gas. It has no smell or color. It comprises 22% of the air. The gas is part of the air people use to breathe. This element is found in the human body, the Sun, oceans and the atmosphere. This gas is used in various industrial chemical applications. It is used to make acids, sulfuric acid, nitric acid and other compounds. It is applied in assorted chemical reactions. Hot oxygen air is required to make steel and iron in blast furnaces. Industries use the gas for cutting, welding and melting metals. The gas is capable of generating temperatures of 3000°C and 2800°C. This is required for oxy-hydrogen and oxy-acetylene blow torches. In healthcare institutions like hospitals, oxygen supplies are kept in stock. These are provided to patients who have difficulty breathing. The same oxygen gas is used to treat victims of carbon monoxide poisoning. Of all the uses of oxygen, sustaining life is the most important.
- **Nitrogen-** Nitrogen is a non-reactive gas. It has no color, odor or taste. Its atomic number is 7 and the symbol is N. it comprises around 78% of the Earth's atmosphere. This element is present in virtually all pharmacological drugs. In the form of nitrous oxide it is used as an anaesthesia. Cryopreservation also uses the gas to conserve egg, blood, sperm and other biological specimens. It is also used to take out actinic keratosis, warts and treat other skin disorders.
- **Argon Gas - Argon** is a chemical element with symbol **Ar** and atomic number 18. It is in group 18 of the periodic table and is a noble gas. Argon is the third-most abundant gas in the Earth's atmosphere, at 0.934% (9340 ppmv). It is more than twice as abundant as water vapor (which averages about 4000 ppmv, but varies greatly), 23 times as abundant as carbon dioxide (400 ppmv), and more than 500 times as abundant as neon (18 ppmv). Argon is the most abundant noble gas in Earth's crust, comprising 0.00015% of the crust.

Argon is produced industrially by the fractional distillation of liquid air. Argon is mostly used as an inert shielding gas in welding and other high-temperature industrial processes where ordinarily unreactive substances become reactive; for example, an argon atmosphere is used in graphite electric furnaces to prevent the graphite from burning. Argon is also used in incandescent, fluorescent lighting, and other gas-discharge tubes. Argon makes a distinctive blue-green gas laser. Argon is also used in fluorescent glow starters.

Argon has approximately the same solubility in water as oxygen and is 2.5 times more soluble in water than nitrogen. Argon is colorless, odorless, non-flammable and nontoxic as a solid, liquid or gas. Argon is chemically inert under most conditions and forms no confirmed stable compounds at room temperature.

- **Carbon Dioxide** - is a chemical compound composed of one carbon and two oxygen atoms. It is often referred to by its formula CO_2 . It is present in the Earth's atmosphere at a low concentration and acts as a greenhouse gas. In its solid state, it is called dry ice. It is a major component of the carbon cycle. It is a versatile industrial material, used, for example, as an inert gas in welding and fire extinguishers, as a pressurizing gas in air guns and oil recovery, as a chemical feedstock and as a supercritical fluid solvent in decaffeination of coffee and supercritical drying. It is added to drinking water and carbonated beverages including beer and sparkling wine to add effervescence. The frozen solid form of CO_2 , known as *dry ice* is used as a refrigerant and as an abrasive in dry-ice blasting. On the other hand, it is a promising feedstock for the synthesis of fuels and chemicals. Carbon dioxide can be obtained by distillation from air, but the method is inefficient. Industrially, carbon dioxide is predominantly an unrecovered waste product, produced by several methods which may be practiced at various scales.

The combustion of all carbon-based fuels, such as methane (natural gas), petroleum distillates (gasoline, diesel, kerosene, propane), coal, wood and generic organic matter produces carbon dioxide and, except in the case of pure carbon, water. As an example, the chemical reaction between methane and oxygen:



- **Acetylene** - It is the chemical compound with the formula C_2H_2 . It is a hydrocarbon and the simplest alkyne. This non-toxic, colourless and flammable gas is widely used as a fuel and a chemical building block. It is unstable in pure form and thus is usually handled as a solution. Pure acetylene is odourless, but commercial grades usually have a marked odor due to impurities. Approximately 20 percent of acetylene is supplied by the industrial gases industry for oxyacetylene gas welding and cutting due to the high temperature of the flame; combustion of acetylene with oxygen produces a flame of over 3600 K, releasing 11.8 kJ/g. Oxyacetylene is the hottest burning common fuel gas. Acetylene is a simple asphyxiant. Acetylene has no chronic harmful effects even in high concentrations. Acetylene has been used as an anaesthetic.

This will involve the installation of two separate plants for Oxygen/Nitrogen/argon/Carbon Dioxide, Acetylene and Carbon Dioxide since all these gases have different processes of manufacture. The proponent proposes to develop this gas plant by constructing two separate workshops; one for acetylene and the other for the other gases within a 2-acre piece of land adjacent to Kangundo road on Plot L.R. No. **MACHAKOS/NGULUNI/4867**.

The processes of the production of these gases will involve the following:

- **Oxygen/Nitrogen/Argon/Carbon Dioxide** -Will involve the installation of an air separator plant (ASP) capable of simultaneously producing oxygen, argon, carbon dioxide and nitrogen from free atmospheric air and filling in gas cylinders. The free atmospheric air is sucked in by a multi-stage compressor through a filter and compressed to the working pressure, cooled and taken through a separation process whereby the oxygen, argon, carbon dioxide and nitrogen are separated. Wastes from this process will be moisture. There are no chemical reactions involved in this process.
- **Acetylene**-Will involve the installation of a fully automatic Acetylene generator that generates the gas from reacting calcium carbide with water. This exothermic reaction between calcium carbide and water is as shown below :



Hydrated lime, Ca(OH)_2 , is also produced as a by-product. After separating from the carbide lime, excess water can be reused in the process and the lime can be recovered for use in various industrial or agricultural activities according to applicable local legislation.

Due to the fact that technical grade CaC_2 contains various impurities from the raw products used in its manufacture, coal and limestone, acetylene also contains impurities such as ammonia and phosphine.

The generated acetylene is purified, compressed, dried and filled into gas cylinders that are stored on site prior to distribution.

The project proponent **Perfect Purity Gases Company Limited** is a limited liability company incorporated in Kenya under the Companies Act, 2015. The proponent intends to set up the plant by constructing two separate workshops on a 2-acre piece of land referred to us L.R No. **MACHAKOS/NGULUNI/4867** along Kangundo road, Nguluni area, Matungulu sub-location of Machakos County. The plot belongs to the company. The neighborhood of the site includes light industries including an Agro Chemical and packaging industry, feed milling company, a ballast quarry, storage go-down, scattered residential premises, garages, timber yards, petrol stations among others. The proponent has also acquired a change of user from Machakos county Government and is attached to this report.

The Plant will be connected to the national power grid which is already adjacent to the property along Kangundo road. The proponent will apply for 3-phase industrial connection with own electricity transformer to cater for the high electrical power required, while water will be obtained from a borehole already drilled on site. The site is not served with the sewer system and therefore the proponent will develop a septic tank for waste water management. The storm water from the facility will be connected to existing storm water drainage channels along Kangundo road. The proponent also proposes to engage a NEMA approved solid waste collector for solid waste management.

The proposed project is in line with the Government's Economic Recovery Strategy, 2003 which focuses on Wealth and Employment creation, and also the Kenya Vision 2030 with objectives to create a globally competitive and prosperous country, with a high quality of life for all citizens by the year 2030. The project is envisaged to create employment opportunities both directly and indirectly to 20 and 25 citizens of Kenya respectively.

Leynisha Services Limited, a Firm of Experts, **NEMA Reg. No. 9467** led by lead expert **Elijah Muigai Reg No. 5086** has been appointed by the proponent to carry out an Environmental Project Study and prepare a project report in pursuant to the Environmental Management and Coordination Act (EMCA) cap 387 and the Environmental (Impact Assessment and Audit) regulations, 2003 contained in the Kenya gazette supplement No 56, legislative supplement No.31 Legal notice No.101 of 13th June 2003.

In pursuant to the EMCA, cap 387 section 58(1) and the Environmental (Impact assessment and audit) regulations, 2003 part II, an environmental project study was carried out for the proposed Industrial Gas Plant, in order to submit a project report to NEMA.

The proposed project falls under category 1 of projects to undergo an EIA as specified in the second schedule of the Environmental Management and Coordination Act (EMCA), cap 387. The study was carried out in order to determine the anticipated environmental impacts of the proposed project and to identify the necessary mitigation measures with a view of obtaining the necessary approvals and licenses from National Environmental Management Authority (NEMA).

The environmental project study was carried out using a combination of methods including public consultation, site inspections, questionnaires and interviews with

stakeholders. Existing literature on statutory legislation and other requirements was also reviewed. Environmental aspects were reviewed, analysed and categorized into the following categories

- Physical aspects
- Biological and Ecological aspects
- Socio-Economic aspects

Mitigation measures have been developed in respect of the significant negative environmental impacts which if adapted will make the proposed project viable. An Environmental and Social Management Plan (ESMP) has been developed which should be adopted to ensure the mitigation process is successful.

The following table shows a summary of potential significant environmental impacts and mitigation measures:

Potential Impacts	Mitigation Measures
Construction Phase	
Dust	<ul style="list-style-type: none"> • Sprinkling floor surface with water
Health and Safety hazards	<ul style="list-style-type: none"> • Emergency response signs • Use of personal protective equipment, PPE
Physical environment	<ul style="list-style-type: none"> • Minimum soil excavation on areas outside construction site
Solid and Liquid wastes	<ul style="list-style-type: none"> • Engage NEMA approved refuse and solid waste collector and use of sewer system already in use at site
Operation Phase	
Dust and particulates	<ul style="list-style-type: none"> • Use of personal protective equipment, PPE
Noise	<ul style="list-style-type: none"> • Use of personal protective equipment -ear plugs where applicable • Install a sound proof plant
Health and safety Hazards	<ul style="list-style-type: none"> • Use of personal protective equipment - heat resistant gloves,

Potential Impacts	Mitigation Measures
	<p>goggles, safety boots, industrial gloves and clothing for employees</p> <ul style="list-style-type: none"> • First aid and basic fire fighting training of employees • Provide emergency assembly point • Provide appropriate warning signage • Provide used drums storage area • Provide filled cylinder storage area • Provide dedicated containers on an impervious surface with secondary containment for chemical storage • Construct the two separate processing plant i.e. acetylene and the others (oxygen, carbon dioxide, nitrogen and argon)
Solid waste management	<ul style="list-style-type: none"> • Provision of adequate number of solid waste containers • Contract NEMA licensed solid waste and spent chemicals transporter and disposer or Provide a suitable industrial incinerator
Liquid waste	<ul style="list-style-type: none"> • Construct adequate septic tank and soak pit to manage liquid waste
Fire Explosion and burns risk associated with industrial gases production	<ul style="list-style-type: none"> • Provision of adequate fire extinguishers and sand buckets • Proper emergency response, first aid and medical treatment measures, planned before hand and implemented • Store the gas in authorised safe containers • Storage tanks to be fitted with proper safety valves

Potential Impacts	Mitigation Measures
	<ul style="list-style-type: none"> Always separate production, packaging, storage and staffing of acetylene to that of oxygen
Road Safety	<ul style="list-style-type: none"> Install appropriate cautionary signage for motorists entering the proposed plant
Excessive usage and contamination of water resources	<ul style="list-style-type: none"> Recycling of water is recommended Provide a rain water harvesting system Ensure all waste water is tested and appropriately treated before disposing to natural environment Contract NEMA approved used chemical disposer

Table 1: SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

Conclusions

In relation to the proposed mitigation and environmental management measures that will be incorporated during construction and operational activities, the proposed Industrial Gas Plant project is considered beneficial and important. Major concerns should nevertheless be focused towards minimizing the occurrence of impacts that would degrade the general environment. This can be overcome through close follow-up and implementation of the recommended Environmental Management and Monitoring Plans.

It is thus hereby recommended that the project be granted the required approval and an EIA license be issued as appropriate.

1 INTRODUCTION

1.1 Scope objective and criteria of the Environmental Impact Assessment (EIA)

1.1.1 Scope

The Kenya Government policy on all new project, programmes or activities requires that an environmental impact assessment be carried out at the planning stages of the proposed undertaking to ensure that significant impacts on the environment are taken into consideration during the design, construction, operation and decommissioning of the facility. The scope of this Environmental Impact Assessment, therefore, covered:

- The baseline environmental conditions of the area,
- Description of the proposed project,
- Provisions of the relevant environmental laws,
- Identification and discuss of any adverse impacts to the environment anticipated from the proposed project,
- Appropriate mitigation measures,
- Provision of an environmental management plan outline.

1.1.2 Terms of Reference (TOR) for the EIA Process

Leynisha Services Limited, a Firm of Experts, NEMA Reg. No. **9467** led by lead expert **Elijah Muigai Reg No. 5086**, was appointed as a Consultant to conduct the Environmental Impact Assessment of the proposed Industrial Gas Plant development Project in Nguluni area, Machakos County. The scope of the assessment covered the construction and operations of an Industrial Gas Plant for Oxygen, Nitrogen, argon, carbon dioxide and Acetylene gases. Activities will include construction of two separate workshops, power house and an office block installation of equipment and machinery, installation of service lines as well as the utilities required by the project and production and cylinder filling for the above gases. The output of this work was a comprehensive Environmental Impact Assessment project report for the purposes of applying for an EIA licence.

Any form of development such as the proposed gas plant project is likely to impact the site and the surrounding environment hence, before any commencement of any work, there was an urgent need to carry out an Environmental Impact Assessment in compliance with the Environmental Management and Coordination Act (EMCA) cap 387 and Environmental (Impact Assessment and Audit) Regulations 2003.

The Environmental Impact Assessment included the necessary specialist studies to determine the environmental impacts relating to the biophysical, health and safety and socio-economic aspects and to determine the issues or concerns from the relevant authorities and interested and/or affected parties. The appropriate measures to ensure co-existence of the proposed development with other social and economic activities in the area are provided as part of Environmental Management Action Plan.

The main objective of the assignment was to assist the proponent to prepare a project report after carrying out an Environmental Impact Assessment (EIA) of the Proposed Industrial Gas Plant development in Nguluni area, Machakos County, to ensure the proposed development takes into consideration appropriate measures to mitigate any adverse impacts to the environment. The study identified existing and potential environmental impacts and possible concerns that interested and/or affected parties have with the development, as well as the associated prevention and mitigation measures for the negative impacts as stipulated in the Environmental and Social Management Plan (ESMP) proposed.

The consultant on behalf of the proponent conducted the study by incorporating but not limited to the following terms of reference:-

- The proposed location of the Industrial Gas Plant
- A concise description of the national environmental legislative and regulatory framework, baseline information, and any other relevant information related to the project.
- Construction of two workshops, power house, office block and other support facilities
- The objectives of the project.
- The technology, procedures and processes to be used, in the implementation of the project.
- The materials to be used in the construction and implementation of the project.
- The products, by-products and waste to be generated by the project.
- A description of the potentially affected environment.
- The environmental effects of the project including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated.
- To recommend a specific environmentally sound and affordable wastewater management system.

- Provide alternative technologies and processes available and reasons for preferring the chosen technology and processes.
- Analysis of alternatives including project site, design and technologies.
- An environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, timeframe and responsibility to implement the measures.
- Provide an action plan for the prevention and management of the foreseeable accidents and hazardous activities in the cause of carrying out development activities.
 - Propose measures to prevent health hazards and to ensure security in the working environment for the employees, residents and for the management in case of emergencies.
 - An identification of gaps in knowledge and uncertainties which were encountered in compiling the information.
 - Such other matters as the Authority may require.

1.1.3 Data collection procedures

First, the Consultant undertook environmental screening and scoping to avoid unnecessary data. The data collection was carried out through questionnaires/standard interview schedules, use of checklists, observations and photography, site visits, public participation Baraza, desktop environmental studies, where necessary in the manner specified in Part V (section 31-41) of the Environmental (Impact Assessment and Audit) Regulations, 2003.

1.1.4 EIA organization and structure

The EIA was carried out to full completion from the date of undertaking and the Lead Expert coordinated the day-to-day functions and any related institutional support matters.

1.1.5 Reporting and documentation

The Environmental Impacts Assessment Project Report from the findings was compiled in accordance with the guidelines issued by NEMA for such works and was prepared and submitted by the proponent for consideration and approval. The Consultant ensured constant briefing of the client during the exercise. Plant layout plans, certificates, list of attendant of public participation, minutes of the public participation, photographs of the public participation meeting and questionnaires are part of the Appendices.

1.1.6 Responsibilities and undertaking

The Consultant undertook to meet all logistical costs relating to the assignment, including those of production of the report, site visitations, public Baraza consultations and any other

relevant material. The consultant arranged for own transport and travels during the exercise. The proponent provided and coordinated the site visitation, Chief public participation and provided information and documents required to the consultant. The proponent also provided site plan(s) showing roads, service lines, buildings layout and the actual sizes of the sites, details of raw materials, proposed process outline and anticipated by-products, future development plans, registration certificates, land-ownership documents and site history.

The output from the consultants includes the following:-

- An Environmental Impact Assessment Project Report comprising of an executive summary, study approach, baseline conditions, anticipated impacts and proposed mitigation measures,
- An Environmental Management Plan outline which also forms part of the report recommendations.

1.1.7 Methodology outline

Since the proposed site is located within an area with no rich natural resources whose total effect to the surroundings could not be adverse and noting that the intended development and use of the facility will be in line with what exists in the surrounding areas, an environmental project report is seen to be adequate. The general steps followed during the assessment were as follows:

- Environment screening, in which the project was identified as among those requiring environmental impact assessment under schedule 2 of EMCA, cap 387
- Environmental scoping that provided the key environmental issues
- Desktop studies and interviews
- Physical inspection of the site and surrounding areas
- EIA Public participation Baraza meeting, minutes of the meeting, list of attendants and questionnaires all stamped and verified by the senior chief of Nguluni location.
- Reporting.

1.1.7.1 Environmental screening

This step was applied to determine whether an environmental impact assessment was required and what level of assessment was necessary. This was done in reference to requirements of the EMCA, cap 387, and specifically the second schedule. Issues considered included the physical location, sensitive issues and nature of anticipated impacts.

1.1.7.2 Environmental scoping

The Scoping process helped narrow down onto the most critical issues requiring attention during the assessment. Environmental issues were categorized into physical, natural/ecological and social, economic and cultural aspects.

1.1.7.3 Desktop study

This included documentary review on the nature of the proposed activities, project documents, designs policy and legislative framework as well as the environmental setting of the area among others. It also included discussions with the proponent contact person and design engineers as well as interviews with neighbours and stakeholders.

1.1.7.4 Site assessment and public participation

Field visits were meant for physical inspections of the site characteristics and the environmental status of the surrounding areas to determine the anticipated impacts. To ensure adequate public participation a public Baraza was called through the office of senior chief of Nguluni location **Mr. J.B Ndabuki**. The Baraza took place on Wednesday 17th April 2019 from 10:30A.M. The Baraza was attended by neighbours, local leaders and all other stakeholders. The total attendees were 49 and they all captured their Names, I.D. Numbers, mobile numbers, their individual signatures and those with specific leadership position within Nguluni community captured their designation or role they place within the community. The participants also filled in 40No. Questionnaires to capture their opinion regarding the proposed project in their neighbourhood. In addition minutes of the meeting were captures. All this document were verified by the area chief.

1.1.7.5 Reporting

In addition to constant briefing of the Proponent, through the contact person, this environmental impact assessment project report was prepared. The contents were presented for submission to NEMA as required by law.

2 PROJECT DESCRIPTION

2.1 Project location and Size

The proposed project will be situated within Nguluni area, adjacent to Kangundo road. The proposed project will seat on a 2- acres piece of land belonging to the company. The land measures 158m by 56m. The Land is referred to us L.R. No. **MACHAKOS/NGULUNI/4867**. The parcel is free hold land tenure and has absolute right to the owner. The property has been granted approval to change the land use from agricultural to industrial by Machakos county government on 11th December 2018. The is located on longitude; **E037o 14' 25.0"** and latitude; **S01o 17' 04.9"**. The site also lies **1509Metres** above sea level. The proposed development will entail construction of 2-workshops for industrial gas production and other support facilities in for of; an office block, a power house, perimeter wall and access roads. The project are is occupied by, a feed mill, a storage go-down, a floor milling plant, ballast quarry, filling station, timber yards, commercial shops and some residential premises.

2.2 Project Objectives

Nguluni area falls under Nairobi Metropolis which is the key market target for the industrial gas market by the proponent. Nairobi metropolitan region covers approximately 32,000 km². This covers 15 No. local authority areas - City Council of Nairobi (684 km²); County Councils of Kiambu, Olkejuado, Masaku and Thika; Municipal Councils of Ruiru, Thika, Kiambu, Limuru, Mavoko, and Machakos; and Town Councils of Karuri, Kikuyu, Kajiado, and Kangundo (Ministry of Nairobi Metropolitan Development, 2009). The metropolitan region population is projected to grow to 7.6 million people (2012), 10.8 million (2022), and 14.3 million (2030). Nairobi and its metropolitan region are both the largest and well established commercial and industrial regions in East and Central Africa. Huge commercial establishments are found in Nairobi. Nairobi is also the home of huge manufacturing industries in the region. The industrial growth of Nairobi has created high demand for various industrial gases used by both industrial producers and also in hospitals. The proponent has identified this demand in this market and proposes to set up an industrial gases plant for; oxygen, nitrogen, acetylene food grade carbon dioxide and argon. The plant will be located along Kangundo road on Nguluni area within Machakos County on a plot **L.R No. MACHAKOS/NGULUNI/4867**.

Industrial gases are generally produced as close as technically and economically possible to the customer. This helps to minimise the impacts of transportation. Gas (in liquid or gaseous form) can be transported by pipeline, road, rail or sea. Pipeline transportation from on or off site gas generators avoid many of the environmental impacts, though the pipeline

occupies land resources and there are compression losses.

The advent of small non-cryogenic gas generators has led to an increase in the gas generated on nearer the customer. This avoids the environmental impacts of transporting the gas in liquid form and re-vaporizing it.

It is for these reasons that the proponent Perfect Purity Gases Company Limited proposes to set up an industrial gas manufacture and cylinder filling plant for Oxygen, Nitrogen, Acetylene, argon and carbon dioxide gases majorly for industrial and medical sector market within Nairobi Metropolis and beyond. The plant is envisaged to produce 240 bottles per day of Oxygen/Nitrogen/argon/carbon dioxide, and 400bottles of acetylene per day.

The project will also create several employment and business opportunities in addition to the several positive impacts discussed in Chapter 6.

2.3 Project Implementation Programme

The design of the proposed industrial gas plant will be construct and operate within the set standards to produce acceptable quality industrial gas authorized by KEBs. The proponent is currently engaged in the process of purchasing two suitable plants from overseas namely an Air Separator Plant for Oxygen, nitrogen, argon and carbon dioxide and an Acetylene generator plant all from **Handan Dyon Air separation Co. Limited**, a world leading industrial plants manufacturer and supplier. It is expected that the construction phase of the project will take about 6 months including the shipping period .The proponent envisages to start development once they have acquired an EIA License from NEMA.

2.4 Project Design and Processes

In general, the design of the project will tend to essentially optimise the use of best available technology to prevent or minimize potentially significant environmental impacts associated with the project and to incorporate efficient operational controls together with trained staff, to ensure high level business and environmental performances. The development has also been designed in such a way as to optimize on the plot size, create enough light within the building, safe and energy saving. A fire fighting system is also included in the design consisting of roof top water storage tanks, water pump, automatic fire alarm and fire extinguishers in appropriate locations.

The project will involve the installation of two separate plants for

Oxygen/Nitrogen/argon/carbon dioxide and Acetylene since all these gasses have different processes of manufacture.

The processes of the production of these gases will involve the following:

- **Oxygen/Nitrogen/argon/carbon dioxide** -Will involve the installation of an air separator plant (ASP) capable of simultaneously producing oxygen and nitrogen from free atmospheric air and filling in gas cylinders. The free atmospheric air is sucked in by a multi-stage compressor through a filter and compressed to the working pressure, cooled and taken through a separation process whereby the oxygen, nitrogen, carbon dioxide and argon are separated. Wastes from this process will be moisture. There are no chemical reactions involved in this process.
- **Acetylene**-Will involve the installation of a fully automatic Acetylene generator that generates the gas from reacting calcium carbide with water. This exothermic reaction between calcium carbide and water is as shown below :



Hydrated lime, Ca(OH)_2 , is also produced as a by-product. After separating from the carbide lime, excess water can be reused in the process and the lime can be recovered for use in various industrial or agricultural activities according to applicable local legislation.

Due to the fact that technical grade CaC_2 contains various impurities from the raw products used in its manufacture, coal and limestone, acetylene also contains impurities such as ammonia and phosphine.

The generated acetylene is purified, compressed, dried and filled into gas cylinders that are stored on site prior to distribution.

The technology used in the design of these three plants will be based on company standards and will incorporate company best practices. All the plants will be purchased from **Handan Dyon Air Separation Plant Co. Limited** and imported to Kenya while the installation and commissioning will be done by experts from the supplier and certified by KEBS.

2.4.1 Construction of the workshop, office block and Power House

The construction of the two workshops, office block and power house will involve erection of masonry walls, concrete floors and beam and structurally steel reinforced building each with the following features:

a) Oxygen workshop

Although referred to as oxygen workshop, it will also produce nitrogen, argon and carbon dioxide through fractional distillation of air. The workshops will have:

- Workshop/production area measuring 6.8m by 19.3m
- A bottle room
- A platform

b) Acetylene Workshop

Its component will be:

- Acetylene production room
- Acetylene compressor room
- Acetylene filling room
- Filling acetone room
- Filled bottles room
- A control room

c) Power room

Its component will be:

- Generator room
- Distribution room
- Transformer room

d) Office Block

- Ground floor with reception, accounts office, staff office, manager office, dining/meeting room and a kitchen
- Upper floor with accommodation

2.4.2 Existing Perimeter fence and Security Gate and borehole

The compound has a perimeter wall erected. The construction of the perimeter wall and the borehole were both licensed by NEMA at the county level and the license are attached with this report. The borehole is already drilled and the perimeter wall is already constructed.

2.5 Project's Construction Activities

2.5.1 Sourcing and transportation of building materials

Small quantities of Building materials will be transported to the project site from their extraction, manufacture, or storage sites using Lorries or pickups. The building materials to be used in construction of the project will be sourced from Machakos and neighbouring areas. Greater emphasis will be laid on procurement of building materials from within the local area, which will make both economic and environmental sense as it will reduce negative impacts of transportation of the materials to the project site through reduced distance of travel by the materials transport vehicles.

2.5.2 Storage of materials

Building materials will be stored on site in quarters since majority of these materials are bulky in nature. These will include; sand, ballast, iron bars, backfilling stones and marram, cement, paints and glasses etc.

2.5.3 Masonry, concrete work and related activities

The construction of the building will involve: civil excavation works, backfilling the foundation base, setting PVC polythene sheet, casting of the floor, slabs, beams, column, Masonry walls erection using machine cut stones and mortar, storm water drainage channels construction, septic tank construction, manholes and manhole covers construction, welding of metallic doors making, erection of roof trace, purlins, runners and iron roof fixing and other components of the project. This will involve masons, carpenters and metal works expert.

2.5.4 Electrical work

Electrical work during construction phase will include installation of electrical gadgets and appliances including electrical cables, lighting apparatus, sockets, fire alarm system, etc. In addition, there will be other activities involving the use of electricity such as welding and metal cutting. All Electrical work to be carried out by a licensed electrician to the satisfaction of Kenya Power Company regulations including application for additional power load.

2.5.5 Plumbing

Installation of pipe-work for water supply and distribution will be carried out within the building. In addition, pipe-work will be done to connect the building with the septic tank and soak pit to be constructed on site. Storm water from the rooftop will be drained into a

storm water harvesting system and to storm water drainage channel adjacent to Kangundo road. Plumbing activities will include metal and plastic cutting, the use of adhesives, metal grinding and wall drilling among others. All plumbing and drainage will comply with Machakos County government Specifications. All service ducts will be accessible from all floors while drains passing beneath buildings and driveways to be encased in 150mm concrete surround. All testing of pipes must be completed before plastering.

2.5.6 Aesthetics

To improve the aesthetic value or visual quality of the building, the proponent will paint the building with a visual appetizing colour scheme.

2.6 Project's Operational Activities

The plant will have two separate gas plants producing Oxygen/Nitrogen/carbon dioxide/argon, and Acetylene. Each plant will operate independently as follows;

2.6.1 Oxygen/Nitrogen/Argon/Carbon Dioxide Air Separator Plant

The machine referred to as KZON -50/50 once installed will have the following components: an air compressor, a pre-cooler, a rectification column, a liquid pump, an air compressor, a purifier, a purifier control box, a low voltage power box stainless steel pipes and perlite. The plant will have a capability of simultaneously producing Oxygen/Nitrogen/argon and carbon dioxide of high purity and filling the gas to cylinders. The plant is envisaged to produce 240 bottles per day of Oxygen/Nitrogen/argon/carbon dioxide, and 400 bottles of acetylene per day.

The process of the Air Separator Plant is as follows;

2.6.1.1 Warm End Process

Atmospheric air is roughly filtered and pressurised by a compressor, which provides the product pressure to deliver to the customer. The amount of air sucked in depends on the customer's oxygen demand.

The air receiver collects condensate and minimises pressure drop. The dry and compressed air leaves the air to refrigerant heat exchanger with about 10°C.

To clean the process air further, there are different stages of filtration. First of all, more condensate is removed, then a Coalescing filter acts as a gravity filter and finally an adsorber filled with activated carbon removes some hydrocarbons.

The last unit process in the warm end container is the thermal swing adsorber (TSA). The Air purification unit cleans the compressed process air by removing any residual water vapour. It comprises two vessels, valves and exhaust to allow the changeover of vessels. While one of the TSA beds is on stream the second one is regenerated by the waste gas flow, which is vented through a silencer into the ambient environment.

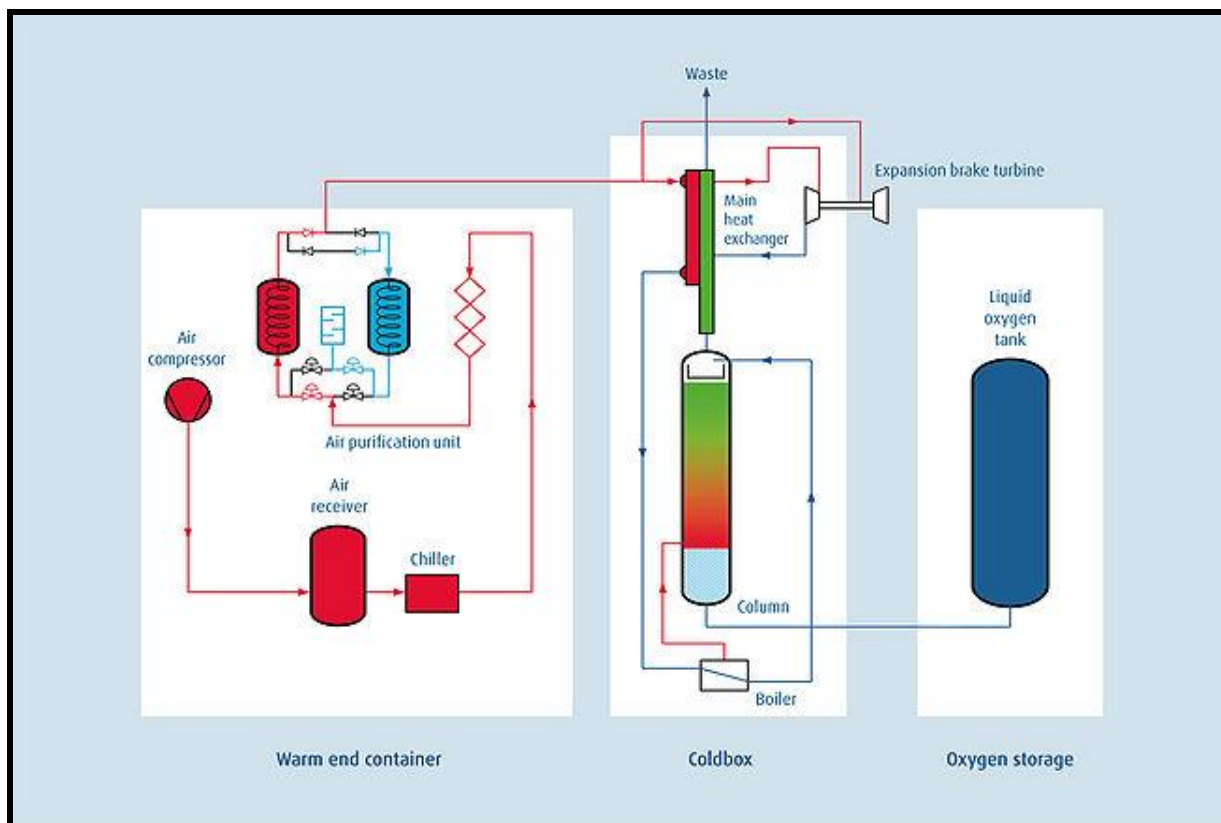


Figure 1: Oxygen/Nitrogen/argon/carbon dioxide separation process

2.6.1.2 Coldbox Process

The process air enters the main heat exchanger in the cold box where it is cooled in counter flow with the waste gas stream. After leaving the main heat exchanger the process air has a temperature of about -112°C and is partly liquefied. The complete liquefaction is achieved through evaporation of cooled liquid oxygen in the boiler. After passing a purity control valve process air enters on tip of the distillation column and flows down through the packing material.

The steam of evaporated oxygen vapour in the shell of the boiler vents back into the distillation column. It rises through the column packing material and encounters the descending stream of liquid process air.

The liquid air descending down the column loses nitrogen. It becomes richer in oxygen and collects at the base of the column as pure liquid oxygen. It flows out into the boiler to the cold box liquid product valve. An on-line oxygen analyser controls the opening of the liquid product valve to transfer pure low-pressure liquid oxygen into the storage tank.

The rising oxygen vapour becomes rich in nitrogen and argon. It leaves the column and exits the cold box at ambient temperature through the main heat exchanger as a waste gas. This waste gas provides purge gas to regenerate the TSA unit and to cool the refrigeration turbine.

Turbines located at the base of the cold box provide refrigeration for the process. A stream of high-pressure gas from the main heat exchangers is cooled and expanded to low pressure in the turbine. This cold air returns to the waste stream of the heat exchanger to inject refrigeration. Energy removed by the turbine re-appears as heat in the turbine's closed-cycle air-brake circuit. This heat is removed in an air-to-air cooler by waste gas from the cold box.

The production of argon involves connecting a "side arm" column, which receives a feed vapor from the low pressure column at a point near the maximum argon concentration, but also at a point where nitrogen concentration is still low. The typical argon "side arm" column connected to a double tower system.

The remaining air will have high concentration of Carbon Dioxide that will undergo purification to remove moisture.

2.6.1.3 Storage and Vaporising Process

Liquid from the tank is compressed to high pressure in a cryogenic liquid pump. It is then vaporised in an ambient air vaporiser to produce gaseous oxygen. The high-pressure gas then can pass into cylinders via the gas manifold .

2.6.2 Acetylene Generator Plant

There are two basic conversion processes used to make acetylene. One is a chemical reaction process, which occurs at normal temperatures. The other is a thermal cracking process, which occurs at extremely high temperatures. The proponent proposes to install an

Acetylene plant that uses the chemical reaction process between calcium carbide and water.

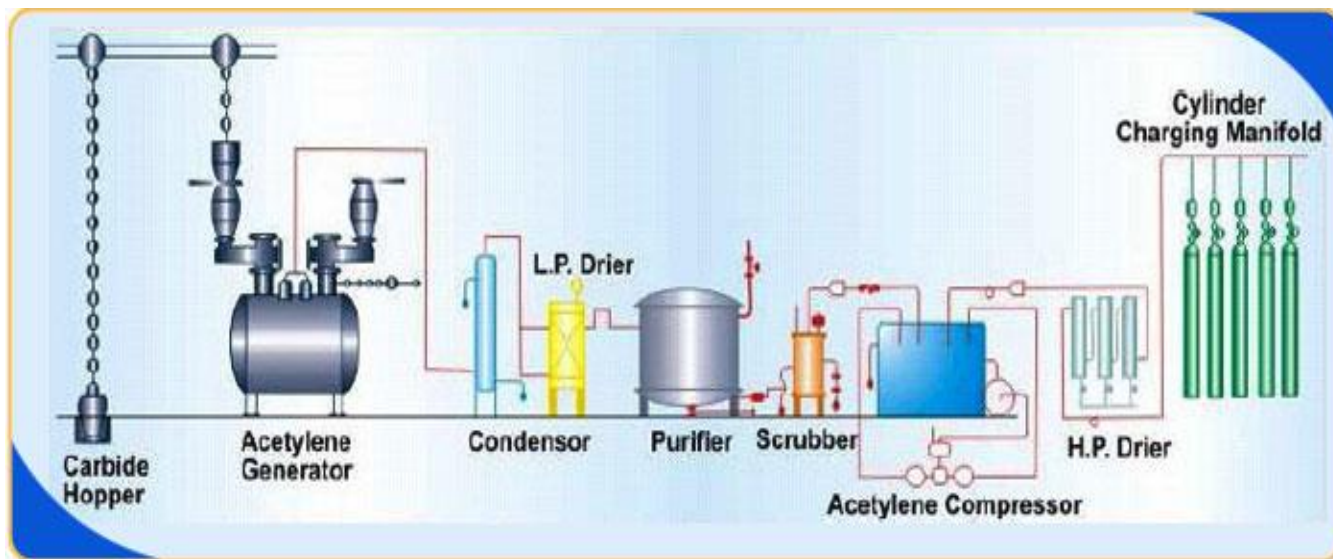


Figure 2: Acetylene Generation Process

This reaction produces a considerable amount of heat, which must be removed to prevent the acetylene gas from exploding. There are several variations of this process in which either calcium carbide is added to water or water is added to calcium carbide. Both of these variations are called wet processes because an excess amount of water is used to absorb the heat of the reaction. A third variation, called a dry process, uses only a limited amount of water, which then evaporates as it absorbs the heat. The first variation is most commonly used worldwide and is described below.

1. Most high-capacity acetylene generators use a rotating screw conveyor to feed calcium carbide granules into the reaction chamber, which has been filled to a certain level with water. The granules measure about 0.08 in x 0.25 in (2 mm x 6 mm), which provides the right amount of exposed surfaces to allow a complete reaction. The feed rate is determined by the desired rate of gas flow and is controlled by a pressure switch in the chamber. If too much gas is being produced at one time, the pressure switch opens and cuts back the feed rate.
2. To ensure a complete reaction, the solution of calcium carbide granules and water is constantly agitated by a set of rotating paddles inside the reaction chamber. This also prevents any granules from floating on the surface where they could over-heat and ignite the acetylene
3. The acetylene gas bubbles to the surface and is drawn off under low pressure. As it leaves the reaction chamber, the gas is cooled by a spray of water. This water spray

also adds water to the reaction chamber to keep the reaction going as new calcium carbide is added. After the gas is cooled, it passes through a flash arrester, which prevents any accidental ignition from equipment downstream of the chamber.

4. As the calcium carbide reacts with the water, it forms a slurry of calcium carbonate, which sinks to the bottom of the chamber. Periodically the reaction must be stopped to remove the built-up slurry. The slurry is drained from the chamber and pumped into a holding pond, where the calcium carbonate settles out and the water is drawn off. The thickened calcium carbonate is then dried and sold for use as an industrial waste water treatment agent, acid neutralizer, or soil conditioner for road construction

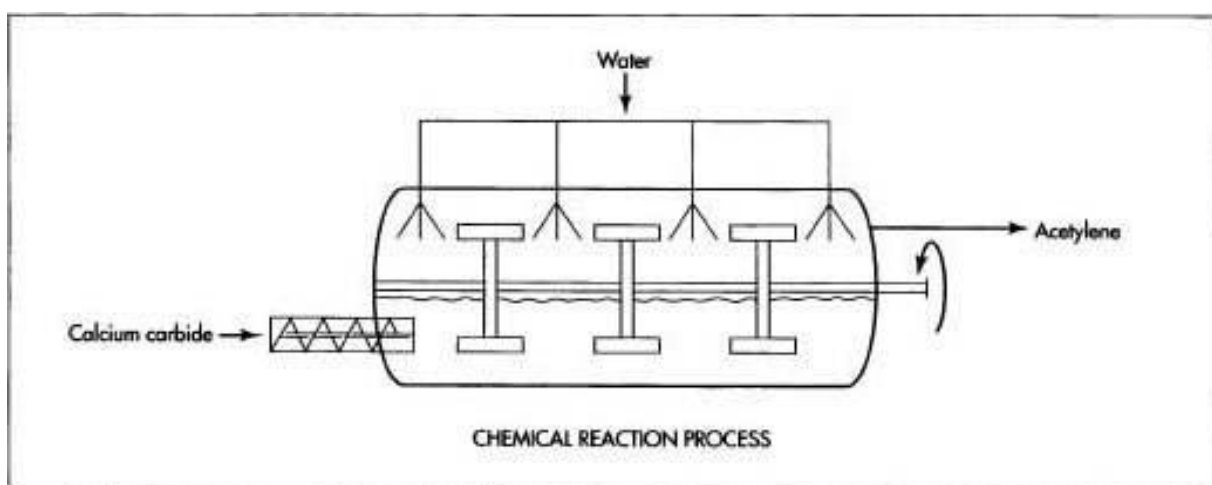


Figure 3: Acetylene Chemical Reaction Process.

2.6.3 Solid waste and waste water management

The proponent will provide facilities for handling solid waste generated within the facility. These will include dust bins/skips for temporarily holding waste within the premises before final disposal at the town's designated dumping site by a NEMA approved waste disposer.

Sewage generated from the building will be discharged a septic tank and soak pit, while storm water from the project area will be channelled into the council's storm water drainage system adjacent to the proposed site.

2.6.4 Cleaning

The proponent will be responsible for ensuring regular washing and cleaning of the entire site area. Cleaning operations will involve the use of substantial amounts of water, disinfectants and detergents.

The proponent plans to set up a rainwater harvesting system to utilize the water for cleaning purposes.

2.6.5 General repairs and maintenance

The go down and associated facilities will be repaired and maintained regularly during the operational phase of the project. Such activities will include repair of building walls and floors, repair and maintenance of the gas producing plants, firefighting system, electrical gadgets and equipment, generator, leaking water pipes, painting, and replacement of worn out materials among others.

2.7 Project's Decommissioning activities

2.7.1 Demolition works

Upon decommissioning, the project components including the gas producing equipment and machinery, buildings, pavements, drainage systems and the entire buildings will be uninstalled and demolished. This will produce a lot of solid waste, which will be reused for other construction works or if not reusable, disposed of appropriately by a licensed waste disposal company. A Decommissioning Plan should be developed three months before decommissioning and presented to NEMA for approval.

2.7.2 Dismantling of Equipment and Fixtures

All equipment including electrical installations, equipment, machinery, furniture, finishing fixtures partitions, pipe-work and sinks among others will be dismantled and removed from the site on decommissioning of the project. Priority will be given to reuse of these equipment in other projects. This will be achieved through resale of the equipment to other building owners or contractors or donation of these equipment to schools, churches and charitable institutions.

2.7.3 Site Restoration

Once all the waste resulting from demolition and dismantling works is removed from the site, the site will be restored through replenishment of the top soil and re-vegetation using indigenous plant species.

2.8 Project Justification & Alternatives

In order to harness the potential of technological advancements, Perfect Purity Gases Company Limited will be in a position to boost the availability of industrial gases for medical and industrial applications.

Since there is a large number of hospitals and industries in Nairobi Metropolis area, there has been increased demand for medical gases such as Oxygen, Nitrogen, argon, carbon dioxide and Acetylene. This proposed plant will thus provide these much needed gases at cheaper cost.

The location of the project is a semi-urban set-up where unemployment is high. The proponent is committed to creating a sustainable project that guarantees accommodation to the ever increasing Kenyan population. The proposed project will create job opportunities both directly and indirectly. During the operation phase, it will be dealing with many industries and hospitals. In addition, the growth potential of the investment could see a dramatic rise in the number of employees hired at the establishment.

The site chosen being a designated Industrial area is ideal for the project given the availability of necessary utilities. The area is serviced by a good infrastructure; which include a tarmac road, a rear access road, electricity and telecommunication service; adequate water supply, Fire brigade services, several hospitals and sufficient security.

2.9 Project Cost

The entire project will cost **Kshs. 28,000,000.00** (Twenty Eight Million Shillings Only). NEMA license fee was waived and therefore non applicable

3 BASELINE INFORMATION

3.1 Background Information

Introduction

This section is a presentation of the general background information of Machakos County and its environment. Machakos County is one of the new devolved counties of Kenya. Its borders follow those of the original Machakos District, one of the former administrative districts of the former Eastern Province in Kenya. Its headquarters is Machakos Town. The county has area of 6208.2 Km² most of which is semi-arid. The county is divided into eight sub counties/constituencies namely; Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko, Machakos Town and Mwala. The County has a total of 40 wards and 75 Locations. It lies between latitudes 0°45' South and 1°31' South and longitudes 36°45' East and 37°45' East. To the North the county borders Embu, Murang'a and Kiambu counties, to the west Nairobi and Kajiado counties; to the south Makueni County; and to the East Kitui County. According to the to the 2009 Kenya Population and Housing census, the county has a population of 1,098,584. The Kenya National Bureau of Statistics has projected a total population growth of 1,238,650 in 2015 and 1,289,200 in 2017. The projected population growth is at approximately 1% over the years while the projected population growth of men is 1% more than women. The county has an average population of 188 per square kilometre. The average household size is 4 with a life expectancy of 65.5%. Absolute poverty is at a rate of 60.7% with a contribution of 4.7% to national poverty. The poverty line is a threshold below which people are deemed poor. The last official statistics summarizing the bottom of the consumption distribution (i.e. those that fall below the poverty line) were provided in 2005/06. The poverty line was estimated at KES 1,562 and KES 2,913 per adult equivalent per month for rural and urban households respectively. Nationally, 45.2 percent of the population lives below the poverty line (2009 estimates) down from 46 percent in 2005/06. (KNBS, 2009) Masinga Sub County had the highest rate of individuals below the poverty line at 61.3%, which was 15.3% above the national average. Mavoko had the lowest rate at 22.8%, 23.2% below the national average.

3.2 Project Area and Location

The project is located on **L.R. No. MACHAKOS/NGULUNI/4867**, measuring approximately a **2-acres**. The site is situated within Machakos County, along Kangundo road and within Nguluni area. The defining GPS Co-ordinates are **S01° 17' 04.9" & E037° 14' 25.0"**. The site lies at an altitude of **1508MASL**.



Source: Kenya National Bureau of Statistics, 2013

Figure4: Map of Kenya indicating position of Machakos County

3.3 Administrative, Political Units, and Population

Sub-counties in Machakos

Administratively, Machakos County is divided into eight sub-counties, namely Machakos, Masinga, Yatta, Kangundo, Matungulu, Kathiani, Athi River and Mwala as shown in Table 1.1. The sub-counties are further subdivided into twenty two divisions, seventy one locations and two hundred and thirty three sub-locations. The county has eight constituencies which include; Machakos Town, Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko and Mwala. The county has 39 electoral wards. Machakos Town constituency has the highest

number of county assembly wards with seven; Mwala with six; Yatta, Masinga and Matungulu with five each; and Kangundo, Kathiani and Mavoko with four each.

Table 1: Machakos County Statistics

Sub-county	Area (km ²)	Divisions	No. of Locations	No. Of Sub- Locations
Machakos	925.2	2	13	39
Kangundo	177.2	3	9	25
Kathiani	207.1	1	4	21
Athi River	843.2	4	3	8
Yatta	1,057.3	3	8	23
Masinga	1,402.8	2	9	29
Matungulu	577.5	3	10	30
Mwala	1,017.9	4	15	58
TOTAL	6,208.2	22	71	233

Source: County Commissioner's Office, Machakos, 2013

3.4 Existing condition of the site

The site is currently open field with vegetation and not developed. The only development is that there is a borehole and a perimeter wall erected the EIA license for the borehole drilling and perimeter wall construction are attached in this report.

3.5 Neighbouring facilities

The site is located within Nguluni area animal feeds plant. The site is also adjacent to Kangundo road. There are other commercial and industrial premises such as service stations, timber yard, floor milling plant, a ballast quarry, commercial shops and hardware.

3.6 Infrastructural facilities.

The area is well served with communication and transport network.

3.6.2 Power supply

The area is well served with electricity with a Kenya Power sub-station situated in the area. Service lines with stepped down power exists and most businesses in the area have electricity installed and in use.

3.6.3 Water Supply

The area doesn't have piped water and will use own borehole as a source of water supply to the project.

3.7 Flora and Fauna

Natural vegetation within the county includes trees, grass and shrubs. The notable trees in the site and its neighborhood include *Syzygium cuminii*, *Markhamia lutea*, *Acacia*, *Wucalyptus*, *euphorbia*, *Cassia simea*, *Psidium guajava*, *Mangifera indica* and *Albizia coriaria*. The planted crops include: bananas, cassava, maize, vegetables, and tomatoes. The vegetation is not so much compromised since the area is not much populated and the vegetation. No wild animals were observed within the project area. Bird species including sparrows, were however, and observed in the surrounding.

3.8 Natural (biophysical) Environment

3.8.1 Climate

Generally the annual rainfall of the County is unevenly distributed and unreliable. The average rainfall is between 500 mm and 1300 mm. The short rains are expected in October and December while the long rains are expected in March to May. The highland areas within the County such as Mua, Iveti and Kangundo receive an average of 1000mm while the lowland areas receive about 500mm;

Ideally the rainfall within the County is influenced by the latitude. In terms of temperature, July is the coldest month while October and March are the warmest. Temperature varies between 18°C and 29 °C throughout the year. Since the County does not experience rain throughout the year it then means that there are months that

Experience dry spells. These months are mainly February to March and August to September.

3.10 Hydrological Systems

3.10.1 Surface water resources

Machakos area is drained by two seasonal rivers: Twake and Kaiti. Kaiti River is located in the Northern part. Twake River is 10km west of the study area, just outside both rivers drain into the Athi River, 2km east of the study area. There are several watersheds in the area that determine whether water flows to Twake River in the west or Kaiti River in the North.

3.11 Geology and soils

Soils of Machakos are naturally deficient in phosphorus. Repeated cultivation without fertilization reduces nitrogen, carbon and exchangeable cations to low levels. Even long fallowing under grazing fails to restore soil nutrients to the levels found on uncultivated land. Fertility management is therefore critically important for the sustainability of arable farming.

3.12 Economic Activity and land use

Land has generally been under-exploited for agricultural production. Only 31 percent of land in the high and medium potential area is under production which represents only 5 percent of the land in the county. Arid and semi-arid lands (ASALs) represent 84 percent of the land and also remains largely underutilized.

Optimal utilization of the land both for livestock and crop production can be achieved through expansion of existing and introduction of new irrigation schemes. Absence of the national land use policy has led to the proliferation of informal settlement, inadequate infrastructure services, environmental degradation, unplanned urban centres, pressure on agricultural land and conflicts. The high population growth rate has led to a continuous decrease in average farm sizes. The average farm size under small-scale farming is 0.756 hectares while that under large-scale farm is 10 hectares.

Role of Agriculture in the county

Agriculture is the predominant economic activity in the county. It is leading in terms of employment, food security and income earnings. Therefore, growth in the agricultural sector contributes proportionally more to poverty reduction than growth in any other economic sector. The sector is made up of four major sub-sectors namely; industrial crops; food crops; horticulture; and livestock & fisheries. Agricultural productivity is generally constrained by a number of factors; including high cost of inputs especially price of fertilizer and seeds, poor livestock husbandry, limited extension services, over dependence on rain fed agriculture, lack of markets, and limited application of agricultural technology and innovation.

The county agricultural production is dominated by cereals, grain legumes, root crops and several industrial crops like cotton and coffee. Many of the horticultural crops have a dual; subsistence as well as cash functions. The county has the potential to become a major player in horticulture production for the export as well as the domestic consumers. Although

impressive gains in number of farmers, hectarage, tonnage and value have been achieved, many factors still constrain exploitation of the development potential offered by the sub-sector. The table below shows crop production in Machakos County.

Table 3: Crop Production in Machakos County

Crop	Area (hectares)	Production (90 kg bags)
Dry maize	149,338	1,092,210
Sorghum	11,539	54,758
Beans	75,025	397,572
Millet	20,191	149,010
Cow peas	34,710	168,812
Green grams	13,873	62,895
Pigeon peas	50,302	274,874

Source: Machakos County Development Profile (2012)

According to the 2009 Kenya Population and Housing Census, the number of animals species in the county were; 230,891 cattle, 126,608 sheep, and 629,974 goats. In addition, there were 862,592 indigenous poultry, 4,026 pigs, 21,336 donkeys, 46,370 beehives and 20 camels. There is growth in this sub-sector because of various government programmes to develop this sector and the ready market by the Kenya Meat Commission (KMC) in Athi River. In addition there are two livestock markets found in Masii and Masinga where farmers can sell their livestock.

The fishing industry is not well established in the county due to unavailability of large water bodies. The main fishing activities are done in Masinga dam and on a small-scale along major rivers such as Athi River which traverses the county. Fishing in the rivers is mostly done by use of hooks for purposes of domestic consumption. Through the economic stimulus program, each constituency constructed 200 fish ponds. Table 1.3 shows the quantity and value of livestock and livestock products in Machakos County.

Table 4: Quantity and value of livestock and livestock products

Information Category	Statistics
Ranches	
Company ranches	2

Institution ranches	2
Group ranches	3
Individual	23
Total	30
Average size of ranches(Ha)	50
Main livestock breed	beef cattle, dairy cattle, goats, sheep
Land carrying capacity	10
Total number of ranches	30
Bee keeping apiaries	1,120
Bee hives	19,161
Milk production	
Quantity (litres)	19,395,036
Value (KES)	564,768,900
Beef production	
Quantity	3,505,900
Value (KES)	701,164,800
Mutton production	
Quantity(Kg)	687,036
Value (KES)	140,478,480
Fisheries production	
Fishermen number	314
Fish farm families (no.)	1303
Fish ponds	1200

Area of fish ponds (m ²)	21,357
Main species of fish catch	2
Fish catch types	Tilapia, mudfish

Source: Machakos County Development Profile (2013)

Some of the major challenges to agricultural production in the county are:

- The over-reliance on rainfall which exposes producers to impacts of climate change, the effects of which are manifested in the form of unreliable and erratic rainfall patterns.
- Rainfall and temperature fluctuations lead to both increased incidences and emergence of new pests and diseases which in turn lead to low crop yields and post-harvest losses
- Limited access to farm inputs such as certified seeds and fertilizer resulting from high costs attributed to poor infrastructure and distribution network
- Inadequate extension services due to a high farmer to staff ratio. In addition, the extension personnel lack access to emerging knowledge on modern farming practices
- Poor market access, partly due to poor infrastructure, low productivity and poor access to accurate and timely market information

4 RELEVANT LEGISLATIVE, POLICY AND REGULATORY FRAMEWORK

4.1 Introduction

There is a growing concern in Kenya and at global level that many forms of development activities cause damage to the environment. Development activities have the potential to damage the natural resources upon which the economies are based. A major national challenge today is how to maintain sustainable development without damaging the environment. The Environmental Impact Assessment is a useful tool for protection of the environment from the negative effects of developmental activities. It is now accepted that development projects must be economically viable, socially acceptable and environmentally sound. It is a condition of the Kenya Government to conduct Environmental Impact Assessment on the development Projects.

According to Sections 58 and 138 of the Environmental Management and Coordination Act (EMCA) cap 387 and Section 3 of the Environmental (Impact Assessment and Audit) Regulations 2003 (Legal No. 101), residential complexes require an Environmental Impact Assessment project report prepared and submitted to the National Environment Management Authority (NEMA) for review and eventual Licensing before the development commences. This was necessary as many forms of developmental activities cause damage to the environment and hence the greatest challenge today is to maintain sustainable development without interfering with the environment.

4.2 Environmental Policy Framework

Environmental Impact Assessment (EIA) is a methodology used to identify the actual and probable impacts of the projects and programmes on the environment and to recommend alternatives and mitigating measures. The assessment is required at all stages of project development with a view to ensuring environmentally sustainable development for both existing and proposed public and private sector development ventures. The National EIA regulations were issued in accordance with the provisions of Environmental Management and Coordination Act (EMCA) cap 387. The EIA Regulations must be administered, taking into cognizance provisions of EMCA cap 387 and other relevant national laws. The intention is to approve and license only those projects that take into consideration all aspects of concern to the public as they impact on health and the quality of the environment.

4.3 Institutional Framework

At present there are over twenty (20) institutions and departments which deal with environmental issues in Kenya. Some of the key institutions include the National

Environmental Council (NEC), National Environmental Management Authority (NEMA), the Forestry Department, Kenya Wildlife Services (KWS) and others. There are also local and company NGOs involved in environmental issues in the country.

4.3.1 National Environmental Management Authority (NEMA)

The object and purpose for which NEMA is established is to exercise general supervision and co-ordinate over all matters relating to the environment and to be the principal instrument of the government in the implementation of all policies relating to the environment. A Director General appointed by the president heads NEMA

However, NEMA mandate is designated to the following committees:

4.3.1.1 County and Sub-county Environment Committees

According to EMCA, cap 387, the Minister by notice in the gazette appoints County and sub-county Environment Committees of the Authority in respect of every County and sub-county respectively.

Sub-County Environment Committees are responsible for the proper management of the environment within the County in respect of which they are appointed. They are also to perform such additional functions as are prescribed by the Act or as may, from time to time be assigned by the Minister by notice in the gazette. The decisions of these committees are legal and it is an offence not to implement them.

Like in the case of sub-county Environment Committees, the County Environment Committee is responsible for the proper management of the environment within the county, which they are appointed. They are also to perform such additional functions as are prescribed by this Act or as may from time to time be assigned by the Minister by notice in the gazette.

4.3.1.2 Public Complaints Committee

The Committee performs the following functions:

- Investigate any allegations or complaints against any person or against the authority in relation to the condition of the environment in Kenya and on its own motion, any suspected case of environmental degradation and to make a report of its findings together with its recommendations thereon to the Council.
- Prepare and submit to the Council periodic reports of its activities which shall form part of the annual report on the state of the environment under section 9 (3) and
- To perform such other functions and exercise such powers as may be assigned to it by the council.

4.3.1.3 National Environment Action Plan Committee

This Committee is responsible for the development of a 5-year Environment Action plan among other things.

4.3.1.4 Standards and Enforcement Review Committee

This is a technical Committee responsible for environmental standards formulation methods of analysis, inspection, monitoring and technical advice on necessary mitigation measures

Standards and Enforcement Review Committee consists of the members set out in the third schedule to the Environmental Management and Co-ordination Act. The Permanent Secretary under the Minister is the Chairman of the Standard and Enforcement Review Committee. The Director General appoints a Director of the Authority to be a member of the Standards and Enforcement Review Committee who is the Secretary to the committee and who provides secretarial services to the Committee. The Committee also regulates its own procedure. The Standard and Enforcement Review Committee may co-opt any person to attend its meetings and a person so co-opted shall participate at the deliberations of the committee but shall have no vote. Finally, the Committee shall meet at least once every three months for the transactions of its business.

4.3.1.5 National Environmental Tribunal

This tribunal guides the handling of cases related to environmental offences in the Republic of Kenya. National Environmental Tribunal consists of the following members:

4.3.2 National Environmental Council (NEC)

EMCA cap 387 part iii section 4 outlines the establishment of the National Environment Council (NEC). NEC is chaired by the Minister for Environment and Natural Resources.

NEC is responsible for policy formulation and directions for purposes of EMCA; set national goals and objectives and determines policies and priorities for the protection of the environment and promote co-operation among public departments, local authorities, private sector, non-governmental organisations and such other organisations engaged in environmental protection programmes. It also performs such other functions as are assigned under EMCA.

4.4 Relevant Legislation

4.4.1 Environmental Management and Coordination Act (EMCA cap 387)

This Act came into force on 14th January 2000. It aims at coordinating environmental protection activities in the country. On its preamble, the Act states that every person in Kenya has a right to a clean and healthy environment.

Section 68 of this Act requires all on-going projects to be subjected to an Environmental Audit (EA). The purpose is to establish the extent to which the operations of a project comply with the legislative requirements and to enhance establishment of a framework for continuous performance geared towards promoting sustainable environmental management. It also aims at assessing if the processes and activities have any negative impacts on the environment and to propose mitigation measures to counter such impacts.

In addition, the operators must give account of their operations and the precautions they intend to take on the basis of investigations carried out in connection with permit applications and records of self-checks in the course of operations. The idea behind carrying out of environmental audit is to equip the operator/ proponent with means through which he/she can monitor effects of the operations on the environment in order to take measures on his/ her own initiative that are necessary for compliance with the provisions of the Act.

Apart from the environmental audit and monitoring requirements, EMCA cap 387 has provisions for environmental quality standards that include air and water quality standards, waste and effluents management, excessive noise and vibrations, among others.

Compliance

The proponent is advised to carry out an environmental audit annually for the entire perfect Purity Gases Company Limited Plant facility.

4.4.2 Environmental Management and Coordination (Waste Management) Regulations, 2006

Part II (1) States that no person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle. The regulations require that a permit be obtained for transportation of wastes, operation of a waste disposal site/plants and plants or sites established for re-use and recycling of wastes valid for a period of one year from the date of issue.

Part VI states that waste considered as hazardous, shall be any waste specified in the Fourth Schedule or any waste having the characteristics defined in the Fifth Schedule, such

as Fourth Schedule Y18- Residues arising from industrial waste disposal operations and Fourth Schedule Y34-Acidic solutions or acid in solid form with pH value of 2.0 or less, or basic solutions or bases in solid form with pH value of 11.5 or more by weight (in case of substances in solid form, pH value of the solution of water-substance has a ratio 1:3 in weight).

Part V (25) states that no person shall dispose of any pesticide or toxic substance other than at a designated site/plant approved by the Authority.

Treatment of hazardous wastes

Part IV 26. (1) States that every person who generates toxic or hazardous waste shall treat or cause to be treated such hazardous waste using the classes of incinerators prescribed in the Third Schedule to these Regulations or any other appropriate technology approved by the Authority.

Compliance

The solid wastes generated from the gas plant shall be disposed off appropriately through a NEMA approved waste handler. Wastes shall hydrated lime form the Acetylene generation plant.

4.4.3 Environmental Management and Coordination (Water Quality) Regulations, 2006

Part II section 2 states that no person shall throw/ cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution.

Section 6 states that no person shall discharge any effluent from sewage treatment works, industry or other point sources without a valid effluent discharge license issued in accordance with the provisions of the Act.

Every person who generates and discharges effluent into the environment under a license issued under the Act shall carry out daily effluent discharge quality and quantity monitoring and shall submit quarterly records of such monitoring to the Authority or its designated representative.

Part III section 11 states that no person shall discharge or apply any poison, toxic, noxious or obstructing matter, radioactive wastes or other pollutants or permit any person to dump

or discharge such matter into the aquatic environment unless such discharge, poison, toxic, noxious or obstructing matter, radioactive wastes or pollutants complies with the standards set out in the third schedule of these regulations.

4.4.4 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009

These regulations were published as legal Notice No. 61 being a subsidiary legislation to the EMCA, cap 387. The regulations provides as follows:

- i. Prohibition of excessive noise and vibration
- ii. Provisions relating to noise from certain sources
- iii. Provisions relating to licensing procedures for certain activities with a potential of emitting excessive noise and/or vibrations and
- iv. Noise and excessive vibrations mapping.

According to regulation 3 (1), no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Regulation 4 prohibits any person to (a) make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or (b) cause to be made excessive vibrations which exceed 0.5 centimeters per second beyond any source property boundary or 30 metres from any moving source.

Regulation 5 further makes it an offence for any person to make, continue or cause to be made or continued any noise in excess of the noise levels set in the First Schedule to these Regulations, unless such noise is reasonably necessary to the preservation of life, health, safety or property.

Zone		Sound Level Limits dB(A)		Noise Rating Level (NR)	
		Day	Night	Day	Night
A	Silent Zone	40	35	30	25
B.	Places of worship	40	35	30	25

Zone		Sound Level Limits dB(A)		Noise Rating Level (NR)	
		<i>(Leq, 14h)</i>		Day	Night
		Day	Night		
C.	Residential: Indoor				
	Outdoor	50	35	40	25
D.	Mixed residential (with some commercial and				
E.	Commercial	60	35	55	25

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Table 5: Maximum Permissible Noise Levels as per the First (1st) Schedule

Time Frame:

Day: 6.00 a.m - 8.00 p.m (Leq, 14 h)

Night: 8.00 p.m - 6.00 a.m (Leq, 14 h)

Regulation 12 (1) makes it an offence for any person to operate a motor vehicle which- (a) produces any loud and unusual sound; and (b) exceeds 84 dB(A) when accelerating. According to sub regulation 2 of this regulation, No person shall at any time sound the horn or other warning device of a vehicle except when necessary to prevent an accident or an incident.

Regulation 13 (1) provides that except for the purposes specified in sub-Regulation (2) there under, no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the Second Schedule to these Regulations.

(Measurement taken within the facility)

Facility		Maximum Noise Level Permitted (Leq) in dB(A)	
		Day	Night
i.	Health facilities, educational institutions, homes for disabled		

Facility		Maximum Noise Level Permitted (Leq) in dB(A)	
ii.	Residential	60	35
iii.	Areas other than those prescribed in	75	65

Table 6: Maximum Permissible Noise Levels for Construction Sites as per the Second (2nd) Schedule

Time Frame:

Day: 6.00 a.m. - 6.00 p.m. (Leq, 12 h)

Night: 6.00 p.m. - 6.00 a.m. (Leq, 12 h)

Regulation 16 (1) stipulates that where a sound source is planned, installed or intended to be installed or modified by any person in such a manner that such source shall create or is likely to emit noise or excessive vibrations, or otherwise fail to comply with the provisions of these Regulations, such person shall apply for a license to the Authority. According to regulation 18 (6) the license shall be valid for a period not exceeding seven (7) days

Regulation 19 (1) prohibits any person to carry out activities relating to fireworks, demolitions, firing ranges or specific heavy industry without a valid permit issued by the Authority. According to sub regulation 4, such permit shall be valid for a period not exceeding three months.

Compliance

The project proponent is advised to comply with the above mentioned regulations in order to promote a healthy and safe working environment.

4.4.5 The Environmental Management and Coordination (Controlled Substances) Regulations 2007

Part 6. (1) States that No person shall store, distribute, transport or otherwise handle a controlled substance unless the controlled substance is accompanied by the material safety data sheet

(2) Any person producing or importing a controlled substance shall at the time of production, packaging or importation ensure that the material safety data sheet accompanies the produced, packaged or imported controlled substance.

Part 7(1) Any person wishing to dispose of a controlled substance shall inform the Authority(NEMA) which shall ensure that the controlled substance is disposed of in an environmentally sound manner.

Compliance

There is possibility of emissions of Volatile Organic Compounds (VOC): hydrochlorofluorocarbons (HCFC), chlorofluorocarbons (CFC), chlorinated solvents during maintenance or accidentally from the chillers, and discharges of contaminated water.

4.4.6 Public Health Act (Cap. 242)

Part IX, section 115, of the Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires that Local Authorities take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable to be injurious or dangerous to human health.

Such nuisance or conditions are defined under section 118 as waste pipes, sewers, drainers or refuse pits in such state, situated or constructed as in the opinion of the medical officer of health to be offensive or injurious to health. Any noxious matter or waste water flowing or discharged from any premises into the public street or into the gutter or side channel or watercourse, irrigation channel, or bed not approved for discharge is also deemed as nuisance. Other nuisances are accumulation of materials or refuse which in the opinion of the medical officer of health is likely to harbour rats or other vermin.

On responsibility of the Local Authorities Part XI, section 129, of the Act states in part “It shall be the duty of every Local Authority to take all lawful, necessary and reasonably practicable measures for preventing any pollution dangerous to health of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes

Section 130 provides for making and imposing regulations by the Local Authorities and others the duty of enforcing rules in respect of prohibiting use of water supply or erection of structures draining filth or noxious matter into water supply as mentioned in section 129. This provision is supplemented by section 126A that requires Local Authorities to develop by laws for controlling and regulating among others private sewers, communication between

drains and sewers and between sewers as well as regulating sanitary conveniences in connection to buildings, drainage, cesspools, etc. for reception or disposal of foul matter.

Part XII, Section 136, states that all collections of water, sewage, rubbish, refuse and other fluids which permits or facilitates the breeding or multiplication of pests shall be deemed nuisances and are liable to be dealt with in the matter provided by this Act.

Compliance

The Proponent is advised to obtain all relevant health certification from the Machakos County Government and the Ministry of Health.

4.4.7 County Government Act, 2012

Section 160 helps county governments ensure effective utilization of the sewages systems. It states in part that county governments have powers to establish and maintain sanitary services for the removal and destruction of, or otherwise deal with kinds of refuse and effluent and where such service is established, compel its use by persons to whom the services is available. However, to protect against illegal connections, section 173 states that any person who, without prior consent in writing from the county, erects a building on; excavate or opens-up; or injures or destroys a sewers, drains or pipes shall be guilty of an offence. Any demolitions and repairs thereof shall be carried out at the expense of the offender.

Section 170, allows the right to access to private property at all times by County Government its officers and servants for purposes of inspection, maintenance and alteration or repairs of sewers. To ensure sustainability in this regard, the county government is empowered to make by laws in respect of all such matters as are necessary or desirable for maintenance of health, safety, and wellbeing of the inhabitants of its area as provided for under Section 201 of the Act.

The Act under section 176 gives powers to county government to regulate sewage and drainage, fix charges for use of sewers and drains and require connecting premises to meet the related costs. According to section 174, any charges so collected shall be deemed to be charges for sanitary services and will be recoverable from the premise owner connected to the facility. Section 264 also requires that all charges due for sewage sanitary and refuse removal shall be recovered jointly and severally from the owner and occupier of the premises in respect of which the services were rendered. This in part allows for application of the “polluter-pays-principle”.

4.4.8 Physical Planning Act, 1999

The County Government are empowered under section 29 of the Act to reserve and maintain all land planned for open spaces, parks, urban forests and green belts. The same section, therefore allows for the prohibition or control of the use and development of land and buildings in the interest of proper and orderly development of an area.

Section 30 states that any person who carries out development without development permission will be required to restore the land to its original condition. It also states that no other licensing authority shall grant license for commercial or industrial use or occupation of any building without a development permission granted by the respective Local Authority.

Finally, section 36 states that if connection with a development application, County Governments is of the opinion that the proposed development activity will have injurious impact on the environment, the application shall be required to submit together with the application an environment impact assessment EIA report. EMCA, cap 387 echoes the same by requiring that such an EIA is approved by the NEMA and should be followed by annual environmental audits.

Compliance

The proponent has gotten change of user of the land and his proposed designs for the project are approved by county government of Machakos.

4.4.9 Land Planning Act (Cap. 303)

Section 9 of the subsidiary legislation (The Development and Use of Land Regulations, 1961) under this Act requires that before the Local authorities submit any plans to then Minister for approval, steps should be taken as may be necessary to acquire the owners of any land affected by such plans. Particulars of comments and objections made by the landowners should be submitted. This is intended to reduce conflict with the interest such as settlement and other social and economic activities.

4.4.10 Land Control Act

Land Title Deed

A land title deed shall be applied for where land is to be disposed of by way of sale, transfer, lease, exchange or position to a person who is; -

- (i) A citizen of Kenya; or

- (ii) A private company or co-operative society all of whose members are citizens of Kenya; or
- (iii) Group representatives incorporated under the land (Group Representatives) Act; or
- (iv) A state corporation within the meaning of State Corporation Act:

Section 23 Certificate of Title Deed

The certificate of title issued by the registrar to a purchase of land upon a transfer or transmission by the proprietor therefore shall be taken by all courts as conclusive evidence that the person named therein as proprietor of the land is the absolute and indefeasible owner thereof, subject to the inconveniences, easements, refractions and the title of that proprietor shall not be subject to challenge, except on the ground of fraud or misrepresentation to which he is proved to be a party.

has been done and identified that the project design has incorporated systems to manage wastewater.

4.4.11 Water Act, 2002

Part II, section 18, of the Water Act 2002 provides for national monitoring and information system on water resources. Following on this, sub-section 3 allows the Water Resources Management Authority (WRMA) to demand from any person or institution, specified information, documents, samples or materials on water resources. Under these rules, specific records may require to be kept by a facility operator and the information thereof furnished to the authority.

The Water Act Cap 372 vests the rights of all water to the state, and the power for the control of all body of water with the Minister, the powers is exercised through the Minister and the Director of water resources in consultation with the water catchments boards, it aims at among others:

1. Provision of conservation of water and
2. Appointment and use of water resources.

Water apportionment board is a National Authority whose duty is to advise the Minister on issues with respect to water use. Permission to extract underground water for large-scale use lies with the board and the pollution of such water source is an offence. Failure to comply with such directives is an offence. The Minister is given the power to appoint undertakers of water supply and in most cases are Town, Municipal and Town Councils.

Further in order to provide security and supply of water the Minister can declare a catchment's area of particular source of water as protected area and restrict activities in those areas. Such orders must be publicized in Kenya gazette.

Pollution of any water course is an offence and the Act also prohibits whoever throws, conveys, cause or permits throwing of rubbish, dirt, refuse, effluent, trade waste to anybody of water. It enhances the Ministry's to enforce the Act by reviewing the water user fees.

Section 76 states that no person shall discharge any trade effluent from trade premises into sewers of a licensee without the consent of the licensee upon application indicating the nature and composition of effluent, maximum quality anticipated, flow rate of the effluent and any other information deemed necessary. The consent shall be issued on conditions including payment of rates for discharge as may be provided under section 77 of the same Act.

Compliance

The proposed site has a borehole drilled on site and the proponent was given permit by Water resources management Authority (WRMA) to drill the borehole.

4.4.12 The Building & Construction Codes and Standards, Cap 123 and 496 Respectively

These laws are set to cater for safety in residential, commercial building and other places of work. The law stipulates standards which must be met during building and construction of large scale developments such as storey buildings with imposed loads. The building code and standards are also reinforced by the industrial and commercial building fire safety Act, number 4 of 1973, in order to cater for disaster management.

4.4.13 Building Code 2000

Section 194 requires that where sewer exists, the occupants of the nearby premises shall apply to the Local authority for a permit to connect to the sewer line and all the wastewater must be discharged into sewers. The code also prohibits construction of structures or buildings on sewer lines.

The proponent proposes to connect all liquid sanitary wastes to a septic tank and soak pit.

4.4.14 Penal Code Act (Cap.63)

Section 191 of the penal code states that if any person or institution that voluntarily corrupts or foils water for public springs or reservoirs, rendering it less fit for its ordinary use is guilty of an offence. Section 192 of the same Act says a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons /institution is dwelling or business premises in the neighbourhood or those passing along public way, commit an offence.

4.4.15 Factories and Other Places of Work Act (Cap 514)

Before any premises are occupied, or used a certificate of registration must be obtained from the chief inspector. The occupier must keep a general register. The Act covers provisions for health, safety and welfare.

4.4.15.1 Health

The premise must be kept clean, daily removal of accumulated dust from floors, free from effluvia arising from any drain, sanitary convenience or nuisance and without prejudice to the generality of foregoing provision. A premise must not be overcrowded, there must be in each room 350 cubic feet of space for each employee, not counting space 14 feet from the floor and a 9 feet floor-roof height.

The circulation of fresh air must secure adequate ventilation of workrooms. There must be sufficient and suitable lighting in every part of the premise in which persons are working or passing. There should also be sufficient and suitable sanitary conveniences separate for each sex, must be provided subject to conformity with any standards prescribed by rules. Food and drinks should not be partaken in dangerous places or workrooms.

Provision of suitable protective clothing and appliances including where necessary, suitable gloves, footwear, goggles, gas masks, and head covering, and maintained for the use of workers in any process involving expose to wet or to any injurious or offensive substances.

4.4.15.2 Safety

Fencing of premises during construction and dangerous parts of other machinery is mandatory. Training and supervision of inexperienced workers, protection of eyes with goggles or effective screens must be provided in certain specified processes. Floors, passages, gangways, stairs, and ladders must be soundly constructed and properly maintained and handrails must be provided for stairs.

Special precaution against gassing is laid down for work in confined spaces where persons are liable to overcome by dangerous fumes. Air receivers and fittings must be of sound construction and properly maintained. Adequate and suitable means for extinguishing fire must be provided in addition to adequate means of escape in case of fire must be provided.

4.4.15.3 Welfare

An adequate supply of both quantity and quality of wholesome drinking water must be provided. Maintenance of suitable washing facilities, accommodation for clothing not worn during working hours must be provided. Sitting facilities for all female workers whose work is done while standing should be provided to enable them take advantage of any opportunity for resting.

Section 42 stipulates that every premise shall be provided with maintenance, readily accessible means for extinguishing fire and person trained in the correct use of such means shall be present during all working periods.

Section 45 states that regular individual examination or surveys of health conditions of industrial medicine and hygiene must be performed and the cost will be met by the employer. This will ensure that the examination can take place without any loss of earning for the employees and if possible within normal working hours.

Section 55B provides for development and maintenance of an effective programme of collection, compilation and analysis of occupational safety. This will ensure that health statistics, which shall cover injuries and illness including disabling during working hours, are adhered.

4.4.16 Fire Risk Reduction Rules, Legal Notice NO. 59 of 2007.

The fire risk reduction rules require that every owner or occupier of a workplace shall undertake the following:

- i. Cause a fire safety audit at the workplace to be carried out once in every period of 12 Months by an approved fire safety auditor.
- ii. Establish a fire fighting team at the work place.
- iii. Ensure that every member of the firefighting team undertakes basic fire safety training.
- iv. Ensure that a fire drill is conducted at least once every period of twelve months and a Record of such drill kept available for inspection by the Directorate of occupational health and Safety services.
- v. Establish and implement a written fire safety policy outlining the organization and arrangements for carrying out the policy.
- vi. Identify a location in the workplace where every worker shall assemble in the event of a fire.

- vii. Provide suitable means of alerting persons in the work place, in the event of a fire and that such means shall be made known to all workers.
- viii. Ensure that any door of any store where flammable substances are stored is constructed in a manner that the door shall be self-closing, opening outwards or sliding and capable of containing smoke from within the workroom in the event of a fire.

4.4.17 Occupier's Liability Act Cap. 34

The act regulates the duty that an occupier of premises owes to his visitors in respect to the dangers due to the state of the premises or to things done or omitted to be done on them. It requires that the occupier warns the visitors of the likelihood of dangers within his premises to enable the visitors take reasonable care of themselves.

The proponent is advised to acquire a Public Liability Insurance cover during construction and operation phases.

4.4.18 Workmen's Compensation Act (Cap 236)

The Act provides for compensation in case of death or incapacity resulting from accidents in the place of work or while officially on duty wherever you may be.

The proponent is advised to acquire a Workmen's Compensation Insurance cover during construction and operation phases.

4.4.19 Standards Act, Cap 496, 1981

The Kenya Bureau of Standards has been established under this Act to promote standardization in industry and commerce amongst other functions.

It partly states on Part III, 9 (2) Where a Kenya Standard has been declared under subsection (1), the Minister, on the advice of the Council, shall, by order in the *Gazette*, prescribe a date after which no person shall manufacture or sell any commodity, method or procedure to which the relevant specification or code of practice relates unless it complies with that specification or code of practice.

Part III ,10(4) Where any person manufactures, or intends to manufacture, any commodity in respect of which a standardization mark has been specified under paragraph (b) of subsection (1) he may notify the Bureau of his intention to comply with the approved specification and his wish to apply the relevant standardization mark, and the Bureau, if it is satisfied that he is capable of manufacturing the commodity in accordance with the relevant specification, shall issue him with a permit to use that standardization mark.

Compliance

The proponent is advised to acquire all necessary certification from KEBS of procedure of production and quality of products of the gas plant.

4.4.20 Machakos County Government (MCG) By-Laws,

Under the County Government Act, 2012, the MCG has several bye laws .The following will be relevant with the proposed development

- Fire brigade
- Public roads and streets
- Conservancy/Environmental
- Solid Waste Management
- General Nuisance

4.4.21 The Petroleum Act, Cap 116

The Petroleum Act, Cap 116 is the primary legislation in Kenya that regulates petroleum operations including handling of petroleum products. This Act whose commencement date is August 31st, 1948 is fairly old and was last revised in 1972. The subsidiary legislation appended to the main body of the Act is known as the Petroleum installations.

Compliance

The proposed facility will have a standby generator that will consume petroleum products.

4.4.22 National Construction Authority Act, 2011

This Act establishes the National Construction Authority with the objective of overseeing the construction industry and coordinates its development in the country.

Compliance

The proponent is advised to engage an NCA registered contractor, for the construction of production workshops and support facilities. The project should also be registered with NCA specifying the Architect in charge, Engineer in Charge, quantity surveyor in charge and the main contractor of the project. All the professionals must also be properly registered with their respective registration boards.

5 PUBLIC PARTICIPATION

5.1 Sources of Information

One of the key information sources used during the Environmental Impact Assessment exercise was public participation exercise. Positive and negative views of the project site neighbours were sought. The exercise was conducted by a team of experienced registered environmental experts via a public Baraza.

5.2 Public Baraza meeting

The area chief was briefed of the proposed development in his locality by the proponent together with the lead expert with the purpose of conducting public participation. The air of the baraza was to inform the neighbour and all other relevant stakeholders of the intended construction and operation of industrial gases facility in their locality. The Baraza was also called with the purpose to identify the positive and negative impacts that will come with the project. It also helped in identifying any other miscellaneous issues which may bring conflicts in case project implementation proceeds as planned. The Baraza was called by the Senor Chief of Nguluni location **Mr. J.B. Ndabuki** and all neighbours, local leaders and all interested parties were informed and welcome. The Baraza was held on Wednesday 17th April 2019 in uncompleted go-down adjacent to the site from 10:30AM and was chaired by the chief. The project owner was present and was given an opportunity to introduce himself to the community and gave a brief description of the proposed project. The lead expert together with his team explain the technical, environmental, bio-physical and social implication of the project to the attendees. The community was interrogate the project by way of asking question and initiating meaningful discussion on the project. The community was generally pleased by the proposed project and praised it to be a source of employment to the many youths who are unemployed. They also praised it as development that would make their area grow and attract many other companies. Some praised the project because it will help the value of land to accelerate. They also praised he project that it will produce gas to be used by other industries and hospital and pay tax to government. However, they had concerns on the following specific issues:

- excessive usage of electrical power
- possibility of fire if not properly managed
- Influx of people with bad characters like thieves

All the respondents were informed on all mitigation measures put in place to reduce or avoid any of the above concerns. These included;

- Upgrading of electricity transformer serving project area
- To install and operate the acetylene facility at most care following the laid down procedure and processes
- The company to work with the local chief, Nyumba kumi committee and the village elder to register and monitor new people who will be introduced by the company due to its operation.

NOTE

- I. That the a list of attendants capturing the Name, the I.D number, the mobile number, the signature and designation of the attendee was filled by all people in attendance. The attendance list was verified, signed and stamped by the chief of Nguluni sub-location
- II. That the Baraza was attended by 49 participants of different position or with deferent roles in Nguluni location. They included; the chief. The assistant chief, senior assistant chief, retired chief, an army captain from Nguluni, a pastor from local church, a Khadhi from Nguluni Mosque, village elders, a civil servant, a church elder, Nyumba kumi coordinators, a local activities, a representative of masons, a representative of Nguluni market and general immediate neighbors with no portfolio in Nguluni community.
- III. That minutes of the public participation meeting were taken/compile or written by Mary Njeri Njogu (secretary/office assistant - Leynisha services limited), confirmed by Elijah Muigai (the lead expert) and verified by **Mr. J.B Ndambuki** - the senior chief Nguluni location
- IV. That 40-questionnaires were filled in by the participants to capture their written opinion concerning the project. All the questionnaires were verified by the chief to be those of the project affected persons and duelers of Nguluni location.
- V. That all the above three documents are annexed in this report for confirmation and verification
- VI. That photos of public participation are herein attached in this report.

5.2 Photos of Public Participation Baraza



Plate 1: The local Pastor open the public Baraza with a word of prayer



Plate 2: Project affected persons during public Baraza



Plate 3: Introduction session during public Baraza



Plate 4: Senior Chief Mr. J.B Ndambuki welcomes community members to the public Baraza meeting



Plate 5: The assistant Chief of the Kwangi Sub-location Madam Ruth Mwende Mutua welcome participant to the Baraza



Plate 6: The proponent present the project to participants and his neighbours to be



Plate 7: The lead expert presents the project, project impact and answers questions from participants



Plate 8: The secretary of the public participation meeting (Mary Njogu) takes minutes of the Baraza



Plate 9: More participants keenly follow the proceedings of the public Baraza

6 ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT

6.1 Introduction

This Section identifies both positive and negative impacts associated with the proposed Perfect Purity Gases Company Limited facility. These impacts are hereby identified at two distinct phases of the project i.e. -Construction Phase and Operational Phase. Another study will be carried out during the projects decommissioning phase.

6.2 Construction phase

6.2.1 Positive Impacts

6.2.1.1 Job opportunities

One of the main positive impacts during projects construction phase will be the availability of employment opportunities especially to casual workers and several other specialised workers. Employment opportunities are of benefit both economically and in a social sense. In the economic sense it means abundant unskilled labour will be used in construction hence economic production.

In the social sense these young and energetic labour force will be engaged in productive employment other than remaining idle which may lead them into social ills such as drug abuse and other unproductive activities like criminology. Several workers including casual labourers, masons, carpenters, joiners, electricians and plumbers are expected to work on the site for a period that the project will start to the end. Apart from casual labour, semi-skilled and unskilled labour and formal employees are also expected to obtain gainful employment during the period of construction.

6.2.1.2 Improving growth of the economy

Through the use of locally available materials during the construction phase of the project including cement, concrete and ceramic tiles, timber, sand, ballast , pipes, electrical cables etc, the project will contribute towards growth of the economy by contributing to the gross domestic product. The consumption of these materials, fuel oil and others will attract taxes including VAT which will be payable to the government hence increasing government revenue while the cost of these raw materials will be payable directly to the producers.

6.2.1.3 Boosting of the informal sector

There are usually several informal businesses which come up during the construction periods of such projects. These include activities such as food vending who benefit directly from the construction staff members who buy food and other commodities from them. This will promote the informal sector in securing some temporary revenue and hence livelihood.

6.2.2 Negative Impacts

6.2.2.1 Disposal of unused materials

All unused materials needs to be collected, transported and disposed off appropriately in approved designated areas. It is encouraged that other alternative uses of these materials should be found

6.2.2.2 Oil Spills

The machines and equipment on site contain moving parts which require continuous oiling to minimise the usual corrosion or wear and tear. Likewise, moving vehicles on site may also require oil change. Such oils spills due to accidental occurrences, leakages or negligence have a high potential of causing soil and water contamination and hence having detrimental effects on the surrounding environment.

6.2.2.3 Noise pollution

The construction works on site will most likely have noise operation due to the moving machines including cranes, communicating workers, incoming vehicles to deliver construction materials, workers to site and other normal construction activities. This may prove to be a potential source of disturbance to the surrounding neighbours and a health hazard to the workers themselves. Such noise emissions should be minimised as much as possible from the source point while workers should be provided with appropriate personal protective wear.

6.2.2.4 Increased water demand

Both the workers and the construction works will create an increased demand for water in addition to the existing demand. Water will be mostly used in the testing of the plants.

6.2.2.5 Dust emissions

Particulate matter pollution is likely to occur during the site clearance, and transportation of the construction waste. There is a possibility of PM₁₀ suspended and settle-able particles affecting the site workers and even neighbours health.

6.2.2.6 Generation of exhaust emissions

Exhaust emissions are likely to be generated during the construction period by the various construction machinery and equipment. Motor vehicles used to mobilise the work force and materials for construction would cause a potentially significant air quality impact by emitting pollutants through gaseous exhaust emissions.

6.2.2.7 Energy used

The main sources of energy that will be required for construction of the project will include mains electricity and fossil fuels (especially diesel). Electricity will be used for welding, metal cutting/grinding, provision of light and testing of plant. Diesel will run material transport vehicles and building equipment/machinery such as generators. The proponent should promote efficient use of building materials and energy through proper planning to reduce economic and environmental costs of construction activities.

6.2.2.8 Waste management

Moderate amounts of solid waste will be generated during construction of the project. These will include metal cuttings, rejected materials, surplus materials, surplus spoil, paper bags, empty cartons, empty paint and solvent containers, broken glass among others.

Solid wastes if not well managed have a potential of causing disease outbreaks due to suitable breeding conditions for vectors of cholera and typhoid. Malaria outbreak could also be exacerbated by the presence of open water ditches for breeding of anopheles mosquitoes. The major vulnerable groups are children who could be exposed to these conditions.

The construction workers will also generate faecal waste during their day-to-day operations. The generated waste needs proper handling to prevent disease, for example cholera, typhoid and diarrhoea outbreak on the site. Unless this is addressed, it can prove to be an environmental/health disaster.

6.2.2.9 Workers accidents and hazards during construction

During construction of the proposed gas plant project, it is expected that construction workers are likely to have accidental injuries and hazards as a result of accidental occurrences, handling hazardous waste, lack or neglect of the use of protective wear etc. All necessary health and safety guidelines should be adhered to so as to avoid such circumstances.

Workers are also likely to be exposed to diseases from contact with potentially harmful building materials. It is therefore recommended that before the construction commences, there is need for the materials to be well inspected and harmonised to the occupational health and safety standards.

6.2.2.10 Solid waste opportunities

During construction solid waste will be generated. These include papers used for packing cement, Plastics and timber remains among others. Dumping of such materials around the site will interfere with the aesthetic status of the area. Disposal of the same solid wastes off-site could also be a social inconvenience if done in the wrong places. The off-site effects could be aesthetic, pest breeding, pollution of physical environment, invasion of scavengers and informal recycling communities.

6.3 Operation phase

6.3.1 Positive Impacts

6.3.1.1 Provision of Industrial Gases

Currently the Nairobi Metropolis demand for industrial gases is enormous considering the large number of industries and hospitals that require these gases. The plant will thus ease the shortages of the gases locally.

6.3.1.2 Employment generation

Employment opportunities are one of the long term impacts of the proposed development that will be realised after construction and during the operation and maintenance of the gas plant. These will involve other sources of employment such as direct service provision to the domestic sector e.g. house helps, security personnel, gardeners, suppliers etc.

6.3.1.3 Optimal use of land

By creating the gas plant the design has incorporated an optimal use of the available land by utilising the entire land and thus optimising the usage of land locally.

6.3.1.4 Incorporation of collective waste management

The project is designed such that there will be provision of a designated spot for the dumping of garbage which is well protected from rain and animals. This wastes will thus be collected from the site in bulk and as one unit such that the careless disposal and hence proliferation of wastes within the surrounding areas will be curbed.

6.3.1.5 Increase in revenue

There will be positive gain for the revenue of the proponent from the proceeds of charging for the industrial gases.

6.3.2 Negative Impacts

6.3.2.1 Increased pressure on infrastructure

The proposed gas plant will lead to increased pressure on existing infrastructure such as the parking area, roads, sewer lines, water usage, electricity usage etc.

6.3.2.2 Water pollution

Poor solid waste management could lead to the washing down of these wastes into public drains during rainy seasons. Poor waste management may also lead to the blocking of drains which in turn can lead to flooding and unsanitary conditions within the housing estate. Blocked drains produce bad odour hence are environmentally unfriendly. The project management proposes to have controlled solid management to avoid this from occurring.

6.3.2.3 Vector breeding grounds

If the project does not have well designed storm water drains, the rain water may end up stagnating and hence creating conducive breeding areas for mosquitoes and other water based vectors which may lead to human diseases like malaria. Poor solid waste management practices may also lead to breeding grounds for pests such as rats and other scavenging animals. The proponent will put in place efficient storm water and waste management systems that will prevent the accumulation of rain water and uncontrolled waste, as well as an efficient collection system and off-site disposal.

6.3.2.4 Electricity consumption

In completion of the proposed project, it shall consume large amounts of electricity, due to the activities that will take place once the project is complete including running and operating the three gas producing plants. Since electric energy in Kenya is generated mainly through natural resources, namely water and geothermal resources, increased use of electricity have adverse impacts on these natural resources base and their sustainability.

6.3.2.5 Occupational Hazards

Chemical reactions and heat produced during the production of the proposed gases will cause potential hazards to workers and neighbours.

6.3.2.6 Solid and Chemical wastes

More solid waste will be produced including waste from empty plastic containers, cartons, etc will be generated during the operational phase of the project. Chemical wastes including hydrated lime and solutions with acid will also be produced.

7 MITIGATION MEASURES OF NEGATIVE ENVIRONMENTAL IMPACTS

7.1 Introduction

This section highlights the necessary mitigation measures for the expected negative impacts of the proposed project. The potential impacts and the possible mitigation measures have herein been analysed under two categories as done in chapter six. These are Construction phase, Operational phase and Decommissioning phase.

7.2 Construction related impacts

7.2.1 Air quality

Controlling dust during construction is useful in minimizing nuisance conditions and consequently health (respiratory and eye) complications. It is recommended that a standard set of feasible dust control measures be implemented for all construction activities.

7.2.2 Noise pollution

Significance of noise impacts depends on whether the project would increase noise levels above the existing ambient levels by introducing new sources of noise. Noise impacts would be considered significant if the project would result in the following:

- Exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Exposure of persons to, or generation of, excessive ground-borne vibration or ground-borne noise levels.
- A substantial permanent increase in ambient noise levels (more than five dBA) in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

The proponents shall put in place several measures that will mitigate noise pollution arising during the construction phase. The following noise-suppression techniques will be employed to minimise the impact of temporary construction noise at the project site.

- Use quiet equipment (i.e. equipment designed with noise control elements).
- Co-ordinate with relevant agencies regarding all construction activities

- Limit pick-up trucks and other small equipment to an idling time of five minutes, observe a common-sense approach to vehicle use, and encourage workers to shut off vehicle engines whenever possible.

7.2.3 Hydrology and water quality degradation

Several measures shall be put in place to mitigate the impacts that are likely to lead to surface and groundwater quality degradation. The proponent will prepare a hazardous substance control systems and emergency response plans that will include preparations for quick and safe clean-up of accidental spills. It will prescribe hazardous-materials handling procedures to reduce the potential for a spill during construction, and will include an emergency response programme to ensure quick and safe clean-up of accidental spills.

If suspected contaminated groundwater is encountered in the depths of the proposed construction areas, samples will be collected and submitted for laboratory analysis of petroleum hydrocarbons, metals, volatile organic compounds and semi-volatile organic compounds. If necessary, ground water will be collected during construction contained and disposed of in accordance with all applicable regulations. Appropriate personal protective equipment will be used and waste management will be performed in accordance with applicable regulations. Oil absorbent material, taps and storage drums will be used to contain and control any minor releases of engine and other equipment oil.

7.2.4 Construction Waste

It is recommended that demolition and construction waste be recycled or reused to ensure that materials that would otherwise be disposed of as waste are diverted for productive uses. In this regard, the proponent is committed to ensuring that construction materials left over at the end of construction will be used in other projects rather than being disposed of. In addition, damaged or wasted construction materials including cabinets, doors, plumbing and lighting fixtures, marbles and glass will be recovered for refurbishing and use in other projects. Such measures will involve the sale or donation of such recyclable/reusable materials to construction companies, local community groups, institutions and individual residents or home owners.

The proponent shall put in place measures to ensure that construction materials requirements are carefully budgeted and to ensure that the amount of construction materials left on site after construction is kept minimal.

It is further recommended that the proponent should consider the use of recycled or refurbished construction materials. Purchasing and using once-used or recovered construction materials will lead to financial savings and reduction of the amount of construction debris disposed of as waste.

Additional recommendations for minimization of solid waste during construction of the project include:-

- i. Use of durable, long- lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time.
- ii. Provision of facilities for proper handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements.
- iii. Use of building materials that have minimal packaging to avoid the generation of excessive packaging waste
- iv. Use of construction materials containing recycled content when possible and in accordance with accepted standards.

7.2.5 Generation of exhaust emission

In order to control exhaust emissions the following measures shall be implemented during construction.

- Vehicle idling time shall be minimized
- Equipment shall be properly tuned and maintained

7.2.6 Worker accidents and hazards when handling hazardous wastes

Necessary health and safety rules shall be enforced by the site foreman to ensure that all staff members adhere to these standards and are thus safe. Adequate collection and storage of waste on site and safe transportation to the disposal sites and disposal methods at designated area shall be provided. In addition covers for refuse containers and appropriate personal protective equipment to be used by workers shall also be provided by the proponent.

7.2.7 Populations of disease vectors

Well-designed waste management system and storm water drainage systems have to be put in place so as to ensure that breeding grounds of disease carrying vectors such as rats, flies, mosquitoes, cockroaches etc are effectively controlled. Complete waste collection and handling service will be provided by the proponent.

7.2.8 Possible exposure of workers to diseases

Possible exposure of workers to diseases from building materials and chemicals at construction site shall be mitigated by occupational health and safety standards enforcement which encompasses the inspection of such raw materials to ensure required standards are met.

7.2.9 Worker accidents during construction

Workers accidents especially from gas accumulation in workshop and other confined spaces shall be mitigated by enforcing adherence to safety procedures and preparing contingency plan for accident response in addition, safety education and training shall be emphasized.

7.3 Operation Phase Impacts

During the operation phase all the two distinctive plants will operate separately. The impacts and recommendations for impacts caused by each process are shown below.

7.3.1 OXYGEN/NITROGEN/ARGON/CARBON DIOXIDE FACILITY

The principal impacts, either by amount or by potential consequences on the environment are:

- Use of water and energy in the compression;
- Use of oil;
- Historical use of PCB (polychlorinated biphenyl) or other equivalent substances;
- Emissions of Volatile Organic Compounds (VOC): hydrochlorofluorocarbons (HCFC), chlorofluorocarbons (CFC), chlorinated solvents during maintenance or accidentally from the chillers, and
- Discharges of contaminated water.

7.3.1.1 Air Intake

7.3.1.1.1 Air Emissions

The only air emissions resulting from any of the on-site air separation processes are air gases and impurities in the air returned back to the air. In some instances a small amount of natural gas or electricity, is used in cryogenic plants to provide heat for regenerating pre-purifiers. Very low-levels of air emissions result. However, accidental spills and releases of hazardous products may need to be reported to NEMA depending on the national regulations.

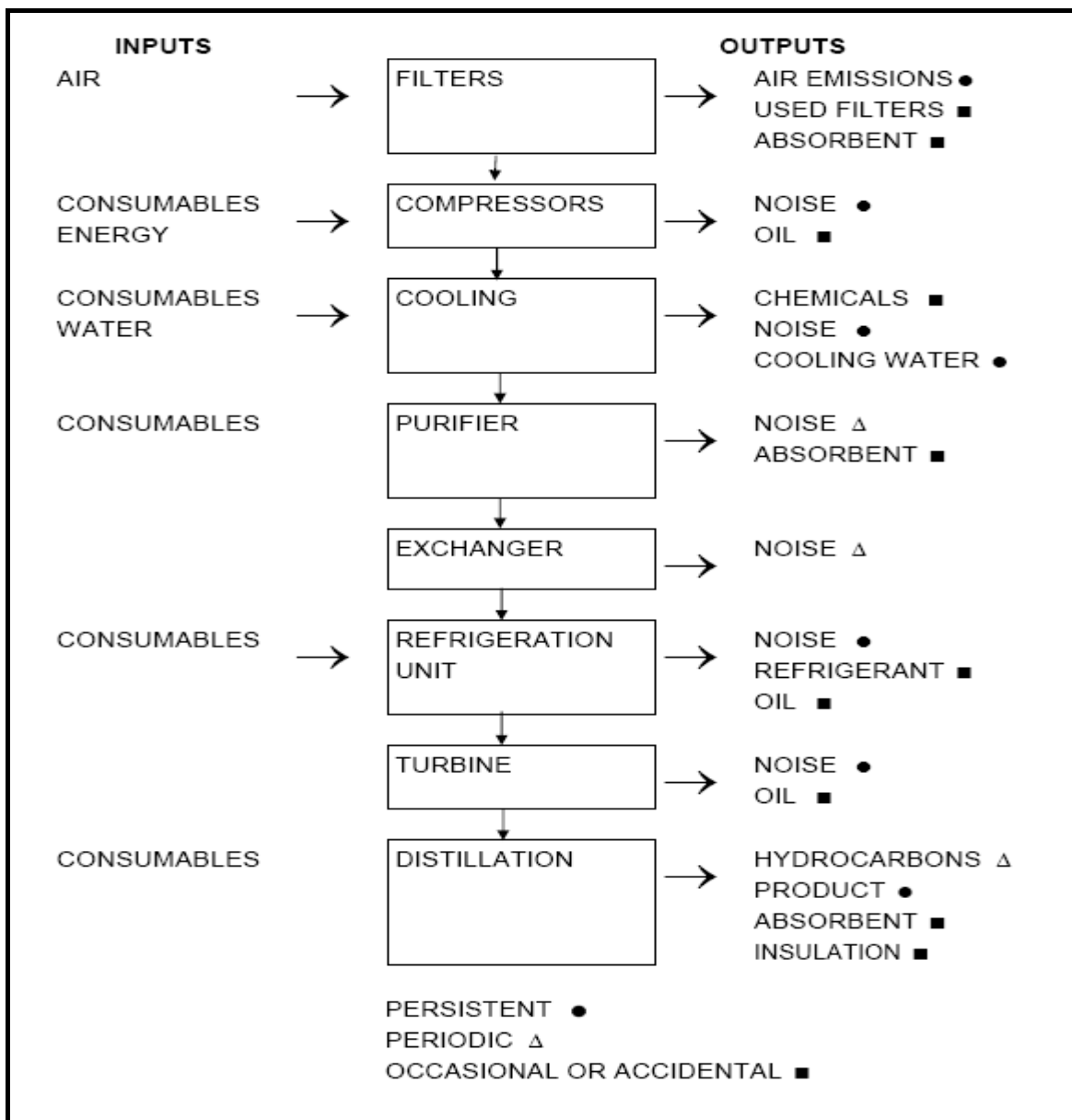


Figure 5: ASU Environmental Impacts

7.3.1.1.2 Air Filters

Air filters are likely to be contaminated by air borne pollutants. Used filters should be disposed of at NEMA authorised facilities.

7.3.1.2 Compression

7.3.1.2.1 Energy

Cryogenic air separation is an energy intensive process; to typically produce one cubic metre of nitrogen or oxygen in a cryogenic air separation unit requires approximately 1 kWh/m³. While a non-cryogenic on-site unit requires less energy per unit it is not suitable for some applications as it does not produce liquid and it cannot match the purity of gas from cryogenic separation.

Most of this energy is used in the compressor to compress the incoming air stream. This high-

energy use results in an indirect environmental impact from the power production plants.

Competitive pressures and environmental concerns have resulted in a continuous improvement in the energy efficiency of Air Separation Units through process innovation, equipment design, maintenance and efficient operating practices.

In addition, increasing integration with the energy systems of the customer and improvements in power plant performance have considerably reduced this indirect impact.

7.3.1.2.2 Noise-Vibrations

The main sources of external noise at a gas production site are:

- compressors and other process equipment at the air separation unit; stationary or mobile pumps on tank trailers for the liquid gases;
- venting of tanks or trailers;
- exceptional venting of high pressure overproduction, and
- Noise is also generated by gases moving at high velocity through pipework.

To be able to prioritise, it is highly recommended to start with making an inventory of the sound levels from the different operations and in different areas including the site boundaries. Noise can be considered as an environmental nuisance and can often be reduced by applying simple techniques (silencers or screens for instance).

To reduce the noise at the ASU the following should be considered:

- When purchasing or designing machinery and equipment, the sound levels shall be considered. The additional cost of choosing equipment with a comparable low sound level is low at this stage. Reducing the sound emission is much more expensive after plant completion. Also consider the Machinery Directive where the basic safety and health requirements are established including sound levels;
- drive vehicles and operate equipment to minimise sound generation, and
- The plant lay-out should be established considering the possibility to minimise sound generation and the sound level at the site boundary, especially adjacent to sensitive areas.

Vibrations are generated by compressors and transmitted to surroundings. Specific civil work requirements may be needed.

7.3.1.2.3 Oil

There are different points of oil discharge:

- from the compressors due to: leaks vapour emission, cleaning; from hydraulic systems, and
- From transformers.

Improvement in design and maintenance of the compressors can reduce these waste sources.

The recommendations for the control and disposal are the following:

- On no account should oil be allowed to enter the drainage system from normal operations. If some oil is mixed with water (cleaning or rain water for instance) separate the oil from the water before disposing of the water to the drainage system (see water treatment paragraph 4.3.4.1);
- install a bund (or pit) at each compressor or transformer installation to collect the oil from leaks and purges;
- do not mix different types of oil waste, keep them by type, and label appropriately;
- return the collected waste-oil to the supplier or to a specialised company, for treatment or recycling, and
- Prevent inhalation of oil vapours by the operators. Generally vapour emission is low due to proper cyclone and/or electrostatic demisters. In some cases vapour emission can be avoided by cooling.

7.3.1.3 Cooling

7.3.1.3.1 Cooling Water

Specific attention shall be given to the water discharge network, and associated liquid effluents.

For example:

- cleaning water (detergent, oil);
- cooling water and cooling tower blow-down; condensates;
- rain water;
- domestic water;
- Water treatment chemicals and sludge from cooling tower or oily water separator, and emergency fire fighting water.

The table below provides some ideas for best practice for activities that use significant quantities of water in ASU processes.

Activity using water	Examples of best practice solutions to minimise water usage and waste water
Boiler Make up water	<ul style="list-style-type: none"> • Avoid excessive chemical feed through tight control of water chemistry. • Consider using automatic blow down equipment (changing from manual to automatic can reduce boiler energy use by 2 - 5% and reduce blow down losses by up to 20%) • Consider improvements to water quality for feed water to reduce blow down rates
Cooling tower	<ul style="list-style-type: none"> • Minimize leaks through preventive maintenance (check for excessive drift and splash) • Reduce controlled losses (e.g. look at bleed losses, concentration cycles) • Maintain proper level of corrosion inhibitors to extend life of equipment • Ensure all float valves are set within operating ranges • Investigate fitting Variable Speed drive motors to cooling tower fans so that cooling system is better matched to system heat load
Cooling tower	<ul style="list-style-type: none"> • Run cooling tower/boiler at optimum concentration cycles to minimize chemical loss, wastewater discharges, and makeup water consumption • Purchase water treatment chemicals in bulk or returnable containers instead of drums, where practical.

Table 7: Best practices for water use in ASU processes

All the wastewater streams shall be clearly identified and kept separate if possible to aid treatment.

Condensed water from air is usually acidic and also may contain metals leaching from piping and solder. In locations where extremely low temperature is possible, cooling towers may not be permitted due to possible black ice formation on near-by roads in winter from water moisture in the forced air of the cooling tower.

Recycled cooling water usually contains chemical treatment products used as biocides and to control corrosion. These include chlorides, phosphonates, polyacrylates, zinc, etc. Some of these chemicals are strictly regulated, because of their bio-toxicity. They may enter the drainage system when the cooling circuit is purged. The use of chromates in new systems is not recommended because of their eco toxicity. It may also contain glycol compounds to prevent freezing in case of very low outside temperature.

Cleaning water may contain solid particles and dust.

The recommendations are the following:

- use water treatment chemicals that do not harm the environment e.g. those that do not contain chromates or mercury, and
- Use the minimum quantity of treatment chemicals necessary to achieve adequate system protection and to make sure that the quality of the discharge complies with local and national regulation limit values.

A special permit from NEMA is normally needed to regulate such discharges and this permit may cover:

- temperature of discharge: the water temperature increase is typically around 6 - 10° C;
- pH of discharge, and
- Concentration of chromate and chromite or other chemicals or metals.

Consequently, water may need to be neutralised before discharge and discharges of chromate, solids and oil should be removed from water before discharging it into the sewage system. Decanting and filtration may be used to improve the water quality before discharge.

Authorities may also require specific monitoring for Legionella hazard, related to aerosols drifting outside the ASU premises. This could include periodic water sampling and Legionella analysis, risk assessment study and/or periodic cleaning of the whole water network.

7.3.1.4 Refrigeration Unit

7.3.1.4.1 Volatile Organic Compounds

HCFC, fluorinated gases and chlorinated solvents can be used as cooling liquids and as solvents. These products are volatile compounds and without proper control part of them may 'disappear' as emissions to the atmosphere.

Some halocarbons have ecological consequences, such as damage to the ozone layer. Some of them will be banned from the market, according to the Montreal protocol and EU regulations, and the suppliers will propose in some cases less hazardous substitutes. Details can be found EMCA, Waste Management and Controlled Substances Regulations

The recommendations are the following:

- refrigerant choice - work with suppliers to use refrigerants with no ozone depleting potential and/or lower Global Warming Potential, in line with the legislation;
- identify all the points on the refrigeration units where leaks can occur ; check there is no leak and eliminate any found; install hermetically sealed units; collect and label all waste and used liquid solvent and return to the supplier for recycling or reuse;
- consider recovering solvent and refrigerant for recycling, and
- Avoid excess use of solvent and review working practices and workmanship habits where solvent is used.

7.3.1.5 Maintenance

7.3.1.5.1 Regular Maintenance

Regular maintenance is vital to keep the plant running as efficiently as possible. The change of consumables and servicing of equipment does generate some wastes, which are detailed below.

7.3.1.5.2 Consumables

The storage of consumables should be reviewed to minimize the quantity of substances, spare parts, etc. used and stored at the site. It is recommended to:

- have Safety Data Sheets available for all chemical substances at the site and ensure that storage areas and vessels are properly labelled;
- storage of large volumes of oil, organic solvents or other hazardous substances should have secondary containment and weather protection ;

- Have absorption material available to clean spill on the floor, and include response to environmental events such as major leakage of oil in the emergency plan.

7.3.1.5.3 Catalysts

If catalysts are used, they usually contain biologically hazardous metal substances and shall be either recycled by returning to the supplier or disposed of by NEMA certified waste disposal companies.

7.3.1.5.4 Battery and Electrical Cells

Most batteries and electrical cells contain hazardous compounds. According to the kind of chemicals and composition, they shall either be:

- returned to supplier for recycling, or
- disposed of by NEMA certified waste disposal companies

7.3.1.5.5 Metal Waste

Biologically hazardous metal substances wastes (for example mercury, cadmium, lead and their compounds) are strictly regulated and shall be disposed of by NEMA certified waste disposal companies. Scrapped metals should be segregated into ferrous and non-ferrous and recycled.

7.3.1.5.6 Insulation Material

- Do not remove, unless strictly necessary.
- Non-hazardous recovered insulation material shall be returned to the supplier or disposed of by certified waste disposal companies.
- In the disposal of rockwool the possibility of this exhibiting natural radioactivity should be taken into account.
- Care should be taken when undertaking maintenance activities so that there is no release of perlite due to pressure changes in the cold box.

7.3.1.5.7 Silica Gel/Aluminium Gel/Molecular Sieve

Used gel or molecular sieve should be checked for oil or other contamination. Uncontaminated absorbent can be disposed of as non-hazardous waste. Consideration should be given to return it to the supplier.

7.3.1.6 Storage

7.3.1.6.1 Waste Storage

All waste which will be recovered, recycled or treated by a specialized company, or which will be disposed of at NEMA authorized facilities shall be stored and transported by authorized transporters in suitable containers clearly labelled to identify the composition of the waste. Liquid waste storage facilities should be banded to a capacity capable of safely containing at least the contents of the largest single container.

Different kinds of waste shall not be mixed but shall be separated in different containers according to their type and the treatment they will receive.

The storage itself shall be organized in such a way that there is no risk of mixing the containers (separations in specific area, marking, records etc).

7.3.1.7 Visual

Consideration should be given to the visual appearance of the plant in relation to its location and the 'green space' inside the plant.

7.3.2 ACETYLENE FACILITY

The basic philosophy is the minimisation of wastes, emissions and nuisances of any kind and their safe and clean disposal. By considering the potential wastes which a new process could generate or when engineering a plant, future problems can be avoided. This analysis is a crucial element of Environmental Impact Assessment that is strongly recommended before any decision on industrial plant investment.

Wastes should not be mixed but collected separately to aid further recycling, reuse or recovery.

Material safety data sheets for all chemical substances shall be held on site and used to determine the best way to handle the chemical substances.

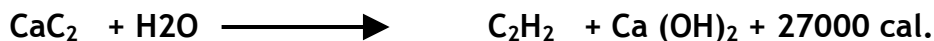
Acetylene is produced by two different methods

- Reaction of calcium carbide with water in special generators,
- As a gaseous by-product from cracking crude oils.

The main method of production for the gas industry and for the proposed Perfect Purity Gases Company Plant is by the first method, due to the lack of availability of the by-product

material where the acetylene is required and the economics of production. The second method is generally used for production of acetylene as a chemical intermediate.

Consequently, this Project Report document describes only the first mentioned process, i.e. the exothermic reaction between calcium carbide and water:



Hydrated lime, Ca (OH)_2 , is also produced as a by-product. After separating from the carbide lime, excess water can be reused in the process and the lime can be recovered for use in various industrial or agricultural activities according to applicable local legislation.

Due to the fact that technical grade CaC_2 contains various impurities from the raw products used in its manufacture, coal and limestone, acetylene also contains impurities such as ammonia and phosphine.

The generated acetylene is purified, compressed, dried and filled into gas cylinders that are stored on site prior to distribution.

The main environmental impacts from acetylene plants are described below, following the step by step production process. The figure 7 below illustrates the acetylene production process.

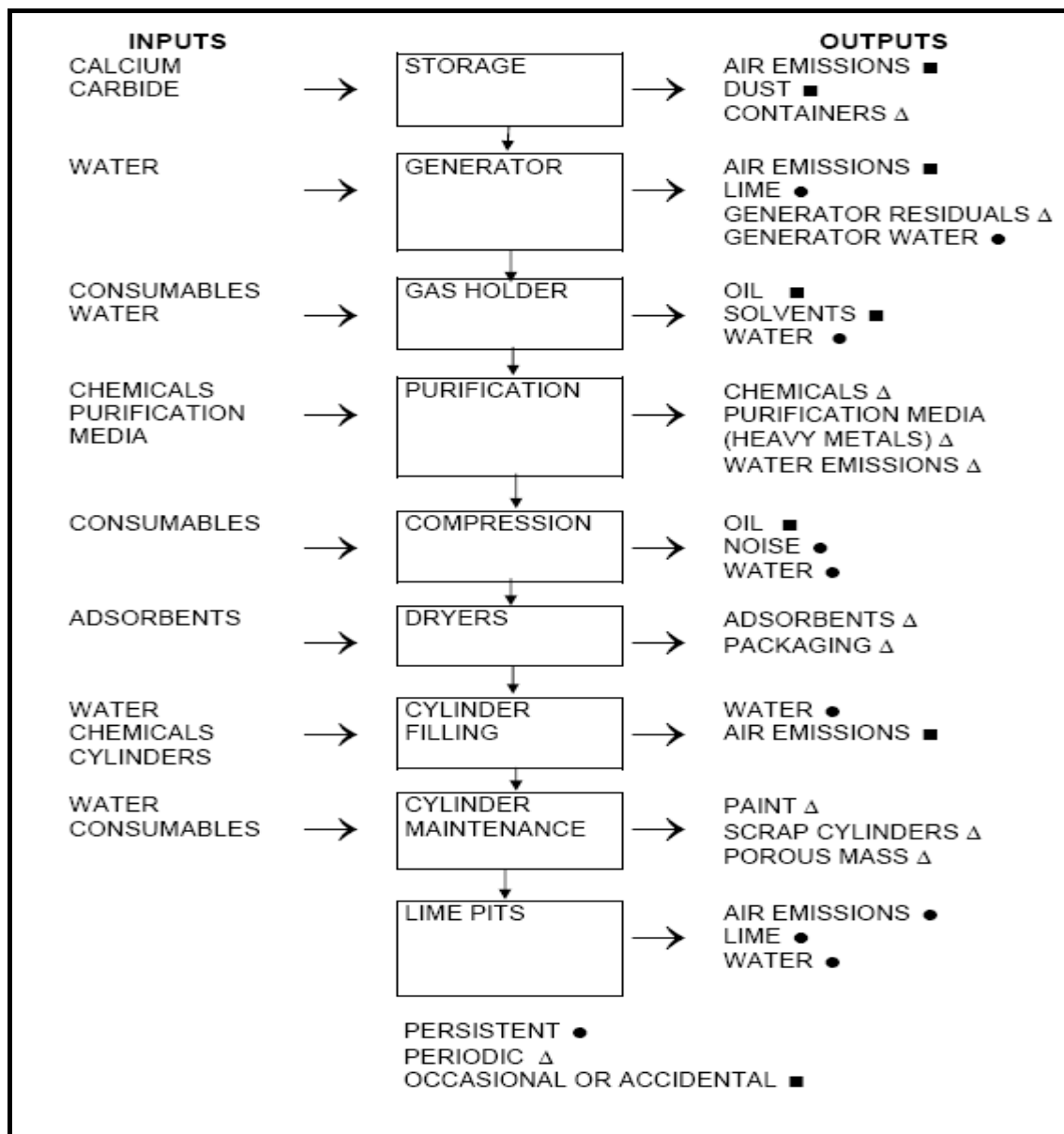


Figure 7: Acetylene Plants Environmental Impacts

7.3.3 Raw Material Storage

7.3.3.1 Calcium Carbide

7.3.3.1.1 Calcium Carbide Containers

Calcium carbide is transported and stored in weatherproofed containers (drums, bags or returnable bins) to keep the carbide dry, to prevent the conversion of calcium carbide to acetylene.

Where these containers are reused they need to be regularly inspected to ensure they are in good condition, in line with good practice or national regulations. They shall be stored in the correct location so as to prevent corrosion or damage.

Even when containers have been mechanically emptied they always contain carbide residuals (dust). Calcium carbide dust will generate acetylene when in contact with moisture.

Where containers are reused the small amounts of residual carbide are a potential safety and environmental hazard.

If a calcium carbide container has to be disposed of it should be clearly marked and segregated and the following procedure should be adopted.

One acceptable method to remove the dust from the container is to wash it out with sufficient water and to leave the container open for some days to vent with air. This water has to be disposed of to the lime pit. Before the container is sent for disposal it should be checked that no acetylene is left in it. The container may then be reused or recycled as scrap metal.

7.3.3.1.2 Calcium Carbide Drums

Drums that have been emptied should be stored without their tops for at least 24 hours in a designated area either outside or under cover or roof.

Returnable drums and barrels should preferably be sent back without the tops refitted. If however the top is replaced, great care is needed to ensure that no acetylene is present or can be generated.

Non-returnable drums will have a scrap value and should be recycled as scrap metals.

7.3.3.1.3 Calcium Carbide Dust

Disposal of pure dust directly in to water in the lime pit is extremely hazardous and has been known to cause explosions. Carbide dust should be disposed of by spreading it thinly on an open surface and allow it to air slake (react with moisture in the air). Alternatively it may be hosed down with copious amounts of water. The residues must be drained into the lime pit.

7.3.3.2 Chemicals

7.3.3.2.1 Purifier Material

Sulphuric acid and sodium hydroxide shall be stored in dedicated containers on an impervious surface with secondary containment. Dry purifiers contain ferric/ferrous chloride and traces of mercury. The spent chemicals require disposing of by an approved contractor.

7.3.3.2.2 Solvents

Acetone or DMF (Dimethylformamide) shall be stored in above ground or underground

storage tanks that are regularly inspected and maintained by qualified personnel.

7.3.3.2.3 Storage Tanks

Storage tanks should be designed to be fit for purpose to the appropriate national or company standard and shall be regularly inspected and maintained by competent personnel.

When filling a tank the operator must attend the filling at all times. By installing overflow alarms, the risk of major spills could be further reduced. Minor spills could occur when filling or emptying the tank and proper precautions such as using spill plates over drains should be taken to avoid any environmental damage caused by this.

7.3.3.2.4 Underground Storage Tanks

These should be avoided on new facilities

7.3.3.2.5 Above Ground Storage Tanks

Above ground storage tanks also risk contamination of soil and water if the tank starts to leak although the control of tank leakage is less complicated than for underground tanks. Even a dripping valve could easily contaminate several cubic meters of soil. Spill plates should be used.

Large storage tanks are frequently used for fuel while the smaller ones may contain oil, antifreeze and other substances. It is important to avoid spills and to label the tanks regardless of the size.

7.3.4 Acetylene Generator

7.3.4.1 General

The procedure for charging the generator depends upon the type of system and shall be laid down in specific working manuals and instructions. Two types of generator are used: the 'open' generator, where acetylene escapes from the generator during carbide charging, and the 'closed' generator, where the charging system is sealed. The open generator causes more emissions of acetylene and other gases (see section 7.13.14). Operating details such as;

- Working pressure
- Temperature range
- Carbide charging capacity
- Maximum production rate

All generator systems contain an interceptor that is generally fitted between generator and

gasholder. It consists of a small tank containing water through which acetylene is bubbled. It is used as a hydraulic non-return valve as well as a device to prevent a flame travelling back from the gasholder to the generator.

7.3.4.2 Calcium Carbide Residuals

Calcium carbide residuals normally contain non-reactive materials e.g. stones, iron, ferrosilicon, coke, etc which are infused with lime. Carbide should be purchased in consistent quality to reduce impurities. Difficulties in disposal of calcium carbide residuals arise from the lime. Due to the alkaline properties of lime it may not be possible to dispose of calcium carbide residuals on normal landfills without special treatment. This is due to the very high values of pH and conductivity of the residual-water mixture.

To dispose of calcium carbide residuals on a landfill, permission from the competent authority may be necessary. Alternatively the material can be used for road and parking place construction by mixing it into the concrete and thus encouraging recycling.

7.3.4.3 Lime

Lime storage and loading areas shall always be watertight (basins, tanks, silos etc.) to avoid soil and groundwater contamination. Additionally they shall be open to the atmosphere to avoid the hazard of generation of explosive air/acetylene mixtures.

Using a filter press or a centrifuge to remove excess water can reduce the volume of lime, which makes transport easier and more economical.

Examples of uses include:

In industries where spent acids and waters with low pH-value need to be neutralised (lime is an excellent neutraliser).

- Sewage water treatment.
- Flue-gas purification.
- Use as corrector of pH-value of soil (agriculture).
- Building trade (mortar processing).
- Chemical processes.

It is a common practice to neutralise sulphuric acid from the acetylene purification in the lime pits. In this case the content of calcium-sulphate must not exceed approximately 2% SO_4 in solid $\text{Ca}(\text{OH})_2$. If the concentration is greater than 2% the lime can not be used in sewage water treatment and the construction industry.

Lime slurry should be considered as a product and not as a waste, because it is possible to market it for different uses. Regular analysis should be carried out to promote lime as a product.

Lime can be classified as a by-product and not a waste provided if it meets the recommended tests for example when:

The intention is not to 'discard' the lime from the process but to market it, the lime is produced to a specification and has a safety data sheet according to product legislation.

Lime can be used directly without further processing, which should mean it is not classified as waste if it has a certain beneficial application.

In the unlikely event of no available use for the lime it has to be disposed of as waste according to the Environmental Management Coordination Waste Management Regulations.

Lime slurry contains small quantities of dissolved acetylene, which can be released if vacuum pumping systems are used to load road tankers. This requires careful consideration.

7.3.4.4 Generator Water

Water that is used in the acetylene generator (excluding the water that remains with the lime) should be re-circulated after separation from lime. Rainwater can also be used as generator water after having been properly filtered and checked.

The lime-water must never be drained uncontrolled into the sewage water system or ground water. Releasing limewater into the drainage or public sewage water system will cause problems due to its high pH-value.

Before draining the water, the local sewage water authorities shall be asked for permission and a proper method (depending on the sewage water composition) must be agreed. This water may also contain ammonia, which is highly toxic to fish, so it also must not be discharged directly to rivers.

7.3.4.5 Generator Cleaning Residuals

The generator may be cleaned mechanically or by using acids. Solid residuals of mechanical cleaning consist of slaked lime and can be disposed of in the lime pits. If acids are used for cleaning the spent mixture must be disposed of by an authorized waste disposal contractor or can be neutralized in the lime pits under the same circumstances as spent sulphuric acid.

7.3.5 Gas Holder

Some generation systems use a gasholder. The purpose is to match the production of acetylene from the generator to the compressor demand. A gasholder usually consists of a rising bell that is immersed in water that forms a gas seal. The bell rises and falls to balance the production by controlling the calcium carbide feed to the generator.

7.3.5.1 Water

Gasholder water contains small amounts of acetylene and ammonia that should be taken into consideration when emptying the gasholder for maintenance or other reasons. Gasholder water should be emptied into the lime pit.

7.3.5.2 Oil

In some cases oil is used as fluid in gasholders instead of water. If, due to contamination, oil cannot be reused in the gasholder it should be handled according to the recommendations in sections 7.3.8.1 and 7.3.8.2.

7.3.6 Purification

Acetylene contains impurities, i.e. phosphine, ammonia, hydrogen sulphide and organic sulphides. Purification involves the removal of these components by scrubbing and/or oxidation. Purification takes place in relatively narrow and tall washing towers to ensure an intensive contact between cleaning agent and gas or by passing the gas through beds of solid purification material. Sulphuric acid, sodium hydroxide and sodium carbonate are mostly in use as purification agents.

7.3.6.1 Sulphuric Acid

Spent sulphuric acid must never be drained into the sewage water system. Sulphuric acid should either be:

- Returned back to the producer of sulphuric acid for purification and reuse.
- Neutralized in the lime pits.
- Disposed of by a NEMA Registered specialist.

When neutralizing the acid with lime the following has to be considered:

- Only small amounts of acid should be neutralized in large amounts of lime to avoid emissions of hydrogen-sulphide and phosphine and to prevent foaming in the generator when water from the lime pits is reused for acetylene generation.

- The sulphuric acid must be fed into the lime such that both substances are mixed instantaneously, e.g. into the lime pipe between the generator and the lime pit, or underneath the surface of the lime in the pits. The neutralization in the lime pipe, between the generators and the lime pit, is possible only when the generators are in use.

7.3.6.2 Sodium Hydroxide (NaOH) & Sodium Carbonate (Na₂CO₃)

The sodium hydroxide and sodium carbonate can be diluted in the lime pits. The concentration shall be kept low.

7.3.6.3 Sodium Purification Media

Solid purification media that use ferric chloride (FeCl₃) and ferric oxide (Fe₂O₃) as active agents often contain catalysts such as mercuric chloride (HgCl₂) or cupric chloride (CuCl₂). These materials must be disposed of in accordance with relevant waste regulations

7.3.7 Compression

Acetylene is compressed in multi stage compressors. The compression is also an important stage in the drying process because most of the water separates out. Despite acetylene being dry when leaving the sulphuric acid cleaning device it becomes humid again after having passed the cleaning tower containing sodium hydroxide or sodium carbonate, which are dissolved in water.

During compression a small quantity of acetylene emission is possible. It can be reduced by regular inspection and maintenance of the compressor equipment. Acetylene is dried by passing through vessels containing drying material such as calcium chloride, in some plants of an older design, or silica gel, alumina gel, molecular sieve or similar which can be regenerated. Maximum operating pressure is 25 bar gauge.

7.3.7.1 Oil

Precautions must be taken to prevent oil from entering drainage systems.

- Oil shall not be mixed with other substances if it can be avoided e.g. water, soil, and solvents.
- Oil shall always be collected in a barrel or drum and be delivered for recycling.
- A bund (or secondary containment system /pit) on each compressor or transformer installation should be installed to collect potential leaks and purges.
- Oil drums should be stored above a catch pot.

7.3.7.2 Water-Oil Mixtures

When using water-soluble emulsifiers for cleaning purposes the water emulsions have to be disposed of in a way acceptable to the authorities in the particular countries. Sometimes it may be possible to dispose of the emulsion by draining it into a suitable sewage water drainage system.

When no emulsifiers are used oil and water must be separated in special oil-water separators. Water can then be discharged into the drainage water system, and the oil should be recycled, see section 7.3.8.1.

7.3.8 Dryers

7.3.8.1 Silica Gel/Alumina Gel

Used gel should be checked for oil contamination. Uncontaminated gel can be disposed of as non-hazardous waste. Consideration should be given to return it to the supplier.

7.3.8.2 Calcium Chloride

The normal way to dispose of the calcium chloride is to dilute it with the lime sludge in the lime pits, but when the lime is delivered to a water treatment plant the calcium chloride shall be diluted to a level of the chlorine ion concentration that does not adversely affect the functioning of the water treatment plant. The maximum level has to be agreed upon with the treatment plant operator.

7.3.8.3 Sodium Hydroxide

See section 7.3.7.3

7.3.8.4 Packaging Materials

Packing materials (Raschig rings, Berl saddles, etc.) should be rinsed, where practicable, with suitable cleaning agent before being reused or disposed of on a normal landfill. The cleaning agents should be disposed of according to their properties and in accordance with this document.

7.3.9 Cylinder Filling

Acetylene is dissolved under pressure in cylinders, which contain proved porous mass and a solvent that is either acetone or DMF (dimethylformamide). During cylinder filling no significant emission of acetylene occurs. For safety reasons every cylinder is weighed after filling to ensure that it is correctly filled.

7.3.9.1 Cooling Water

Recycling of cooling water is recommended.

As long as cooling water does not contain any impurities it is allowed to drain it into the rainwater drainage or sewage water system in accordance with national or local regulations, e.g. requirements for pH-value or temperature. (Companies in various countries need permission for this).

If cooling water is contaminated with oil or other chemicals (closed circuit cooling system) the procedure of draining the cooling water into the sewage water system has to be arranged in accordance with methods accepted by the local authorities.

Often chemicals such as biocides are added to prevent the development of legionella and other anti-fouling chemicals may also be added. Care shall be taken to prevent operator exposure to breathing overspray water containing these biocides, as they are hazardous to health.

Additionally, rainwater can be used for cooling water.

7.3.9.2 Ethanol/Glycol

Cooling waters containing ethanol or glycol must comply with local authority requirements before drainage into the sewage water system.

7.3.9.3 Acetylene Emissions

Acetylene is an organic gas that contributes to the formation of photochemical oxidants and predicted warming of the atmosphere. It is therefore classified as a Volatile Organic Compound (VOC). Specific legal requirements on VOC emissions reporting may exist depending on the country.

Acetylene from overfilled cylinders or from cylinders being prepared for testing should always be discharged into a closed piping system and returned to the gasholder or compressor.

As a general principle of environmental protection and for safety reasons only very small amounts of acetylene should be allowed to escape into the atmosphere. When starting the generator, acetylene emissions to the atmosphere due to quality specifications have to be kept at the minimum.

7.3.9.4 Acetone form Return Gas

In some plants the acetone from the return gas is washed out with water in a scrubber. This

water may be drained into the lime pits.

7.3.10 Cylinder Maintenance

7.3.10.1 Scrap Metal

It is necessary to separate the different scrap metals. Steel, copper alloys and other nonferrous metals must be separated. Scrap metals should be sent to a specialized dealer for recycling.

7.3.10.2 Scrap Cylinders

Scrapped acetylene cylinders should be treated in accordance with the Waste Regulations, Guidelines for the management of waste acetylene cylinders.

7.3.10.3 Paint

Paint, solid or liquid, is normally considered hazardous waste and consequently it should be disposed of in accordance with national regulations.

7.3.11 General

Any material containing oil, oil binders and oily cloths have to be disposed of as hazardous waste in accordance with local regulations, e.g. burning in an incinerator plant or deposition on a licensed landfill site.

Valves, membranes, metallic packing materials, flame arrestors etc. should be handled as scrap metals.

7.3.12 Noise

The main sources of external noise at an acetylene site are:

Manual handling, use of vehicles Compressors and pumps

7.3.13 Air Emissions

Estimating the air emissions from an acetylene plant should be undertaken periodically.

7.3.14 Emergency Plan

The main hazards of acetylene are

- the extremely high flammability,
- the possibility to form explosive mixtures with air in a wide range and
- Its property of decomposition under various circumstances with the consequence of a fire or an explosion.

To prevent such an event all acetylene plants shall be equipped with an emergency

shutdown system to stop all electrical machinery. An emergency water deluge system must also be provided to cover the cylinder filling and indoor storage areas. Water deluge systems must be designed to avoid oil and chemical storage areas so that their operation does not spread contamination. They must not be installed over the generators or in the carbide storage areas. Their purpose is to cool hot cylinders in the event of a fire or internal decomposition.

The gas company employees and contractors must be aware of the site emergency plans, trained and competent in the requirements. The emergency plan should contain, e.g.:

- Actions in the event of the emergency shutdown system activating.
- Actions in the event of environmental events such as major leakage of lime, chemicals or oil in the emergency plan.
- The location of absorption material to clean up spills on the floor. Actions in the event of a major gas leak.
- Actions in the event of fire in the carbide store, the generator, the compressors and filling plant, the solvent bulk storage area and the cylinder storage areas.
- Actions to contain contaminated fire water runoff.
- Action in the event of dispersal of hazardous materials e.g. asbestos.

The emergency plan should be regularly tested with drills, simulations etc.

7.4 Decommissioning Phase Impacts

7.4.1 Efficient solid waste management

Solid waste resulting from demolition or dismantling works will be managed as described in Section 7.2.4.

7.4.2 Reduction of dust concentration

High levels of dust concentration resulting from demolition or dismantling works will be minimized as described in Section 7.2.1.

7.4.3 Minimization of noise and vibration

Significant impacts on the acoustic environment will be mitigated as described in Section 7.2.2

8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1 Significance of an ESMP

Environmental Management Plan (ESMP) for developing projects is usually to provide a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition the ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done. The EMP is a vital output of an Environmental and social Impact Assessment as it provides a checklist for project monitoring and evaluation.

8.1.1 Construction Phase

The necessary objectives, activities, mitigation measures, and responsibilities construction of the two workshops, office block and power house to prevention, minimization and monitoring of significant negative impacts and maximization of positive impacts associated with the construction phase of the proposed development are outlined in Table 7 below.

Table 8: Construction Phase Environmental and Social Management Plan

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
Excessive Noise and vibration	<ul style="list-style-type: none"> Construction works should be carried out during working hours, as from 8.00 am-5.00pm Machinery and equipment should be well maintained to reduce noise Workers should be provided with PPE's e.g. ear muffs when operating noisy machinery 	Contractor/Prop onent	Continuous during constructio n
Increased dust emissions	<ul style="list-style-type: none"> Workers should be provided with PPE's e.g. nose masks and goggles during construction Regularly sprinkling water on areas generating dust 	Contractor/Prop onent	Continuous during constructio n

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
Drainage Problems	<ul style="list-style-type: none"> • Design should ensure surface flow is drained suitably into the public drains during construction • Drainage channels should be installed in all areas that generates or receives surface water e.g. car park, along the building block edges of the roofs • Provide a rain water harvesting system 	Contractor/Prop onent	One-off
Health Risks	<ul style="list-style-type: none"> • Use of PPE's by workers including masks, gloves, ear muffs etc. 	Contractor/Prop onent	One-off
Accidents and Occupational Risks	<ul style="list-style-type: none"> • The implementation of safety measures and emergency plans to contain accident risks associated with construction activities • All staff are trained on use of any unfamiliar machinery and equipment that may pose danger to the user before they use them • Provision of PPE's including safety boots, overalls, helmets goggles, earmuffs, masks, gloves etc. • Shield the areas under works to reduce noise and dust propagation • A fully equipped first aid kit • Provision of Workmen's Compensation insurance cover • Provision of sanitary facilities • Provision of bill board at entrance gate of the Plant notifying of the c Appropriate warning signage 	Contractor/Prop onent	Continuous during constructio n

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	<p>within facility</p> <ul style="list-style-type: none"> • Provide dust bin bags to avoid direct contact with wastes during construction activities • All works should be supervised by an expert including electrical , structural engineers, chemist etc 		
Security and Fire Risks	<ul style="list-style-type: none"> • Protecting the site from a fire outbreak will be achieved through sound engineering, reliable operations, trained employees, good preventive and predictive maintenance techniques and commitment to safety. • The proponent and contractor should provide firefighting equipment during the construction phases • Sensitize workers on fire risks and ensure they have access to communication facilities for quick emergency response • Use fire proof materials e.g. silk paint • Provide emergency numbers at strategic points including for 	Contractor/Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	Police, Ambulance, Proponents <ul style="list-style-type: none"> • Provision of security guards during construction and operation phases • Provide a secure area/room to store valuable items of workers 		
More Solid and Liquid Waste Generation	<ul style="list-style-type: none"> • Non usable solid waste materials generated during construction shall be transported to a NEMA designated dumping site • All waste pipes should have cleaning eyes accessible from outside • Engage a reputable, NEMA approved solid waste handler for appropriate disposal. 	Contractor/Prop onent	Continuous
High water demand	<ul style="list-style-type: none"> • Avoid excessive use water at site and encourage reuse and recycling • Rainwater harvesting system should be provided • Provide notices and information signs on means and needs to conserve water • Install water conserving taps that turn off automatically when water is not in use 	Contractor/Prop onent	Continuous
Increased Energy Use	<ul style="list-style-type: none"> • Switch off all electrical appliances and lights when not in use • Provide notices and information signs on means and” needs to conserve electricity e.g. Switch Off Lights When Not In Use” • Optimize operations of electrical 	Contractor/Prop onent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	equipment to enhance energy conservation <ul style="list-style-type: none"> • Use energy saving bulbs/fluorescents for general lighting • Make use of alternative sources of energy such as solar power. • Provide an emergency generator which should be installed in a sound proof area. 		
Traffic Risks	<ul style="list-style-type: none"> • Ensure that all vehicles supplying materials to the site are insured and road worthy • Set aside parking area for delivery trucks • Put up signboard informing of construction activity at entrance of proposed site • Provide a security guard at entrance to control movement of traffic in and out of the compound 	Contractor/Proponent	Continuous One-off

8.1.2 Operation Phase

The necessary objectives, activities, mitigation measures, and responsibilities pertaining to prevention, minimization and monitoring of significant negative impacts and maximization of positive impacts associated with the operation phase of the proposed development are outlined in Table 8 below.

Table 9: Implementation Phase Environmental and Social Management Plan

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
Excessive Noise and	<ul style="list-style-type: none"> • Lagging of plant connection pipes 	Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
vibration	<ul style="list-style-type: none"> • Use of PPE's including ear muffs, plugs • Consider noise levels when purchasing machinery • Plant layout should be established taking into consideration minimal sound generation • Sound proof potential noisy areas • Take inventory of noise levels for different operations and areas • Do not remove any insulation materials 		
Air Pollution	<ul style="list-style-type: none"> • Ensure use of best technology of gas plants • Report to NEMA of any accidental gas releases • Ensure workers use appropriate masks • Air emissions from plant should be monitored and analysis undertaken periodically 	Proponent	Continuous
Oil Leaks	<ul style="list-style-type: none"> • Improve maintenance and design of compressors • Oils should not enter drainage system • Provide a spillage control drainage system within workshops that is independent of drainage leading to sewer system • Provide bunding for each compressor and transformer • Used oils should be stored in 	Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	<p>labeled drums and over a catch pot area</p> <ul style="list-style-type: none"> • Engage a NEMA approved used oil disposer • Provide necessary PPE's to prevent inhalation of oil vapors • Avoid vapor emission by cooling • Oils should never be mixed with other substances • Provide adequate oil water separator in water soluble emulsifiers are not used. 		
Water wastage and Contamination	<ul style="list-style-type: none"> • Minimize leaks from plant by preventive maintenance • Reduce controlled loses • Ensure all float valves are set within operating ranges • Run Cooling/boiler tower at optimum concentration cycles to minimize water discharge • Use water treatment chemicals that do not harm environment • Use minimum quantity of water treatment chemicals • Utilize decanting and filtration before discharging waste water to water body • Monitor and undertake water quality tests periodically including for heavy metals, pH, temperature, etc to ensure effluent is of acceptable quality • Recycle water used cooling water 	Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	<p>as long as it does not have impurities</p> <ul style="list-style-type: none"> • Use rain water for all cooling of plants • Do not release lime water to water bodies • Care should be taken to prevent operators from exposure to breathing water containing harmful chemicals e.g biocides 		
Excessive Solid Waste	<ul style="list-style-type: none"> • Purchase chemicals in bulk or in returnable containers instead of drums • Scrap metals should be segregated between ferrous and non-ferrous • Engage a NEMA licensed waste disposer for all wastes • Ensure packaging materials are thoroughly cleaned and reused • Wastes containing oil binder, oily clothes etc. should be disposed in suitable incinerator or by a NEMA approved disposer 	Proponent	Continuous
Excessive liquid wastes	<ul style="list-style-type: none"> • Liquid waste storage tanks should be banded to 110% capacity of tank • Different liquid wastes should be segregated, marked and recorded before appropriate disposal by 		

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	<p>NEMA approved disposer</p> <ul style="list-style-type: none"> • Avoid storage use of UST's • Provide AGST with spill gates, overfill alarms , bunding and spill plates • All spent cleaning mixtures should be disposed by a NEMA approved disposer • Sulphuric acid should be neutralized in lime pit 		
Hazardous Wastes	<ul style="list-style-type: none"> • Use refrigerants with no ozone depleting potential • Ensure proper maintenance of refrigeration unit • Recover solvent and refrigerant for recycling • Avoid excessive use of solvent • Provide gas detectors in closed rooms • Provide appropriate ERP and necessary equipment for chemical spillages • Provide safety data sheets for all chemical substances at site • Waste storage areas should be properly labeled • Provide secondary containment 	Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	<p>be protected</p> <ul style="list-style-type: none"> • Check for contamination of desiccant • Dispose uncontaminated desiccant as uncontaminated waste • DMF should be store in labeled AGST • Store lime in water tight containment • Use lime to neutralize sulphuric acid from acetylene purification • Ensure regular analysis of lime and consider it a byproduct and not a waste • Do not dispose calcium carbide directly to water 	Proponent	Continuous
Occupational Risks	<ul style="list-style-type: none"> • Ensure regular inspection and maintenance of entire plant • Provide adequate warning signage • Provide emergency assembly point • Provide automatic fire fighting system • Provide adequate fire extinguishers • Provide fully equipped first aid 	Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	kit <ul style="list-style-type: none"> • Ensure all workers are trained in basic first aid, firefighting and handling of chemicals • Ensure all lights and electrical fittings are flame proof. 		
Excessive energy use	<ul style="list-style-type: none"> • Ensure use of best technology of gas plants to minimize energy use • Regularly service and maintain plants 	Proponent	Continuous
Environmental Management Plan	Provide an ERP that should have the following; <ul style="list-style-type: none"> • Action in event of emergency or environmental events e.g. fires and spillages • Location of absorption spillage materials, fire extinguisher locations, emergency exits and assembly points • Action to contain fire water run-off • Action in the event of disposal of hazardous materials • Should be regularly tested with drills and simulations. Provide an emergency shutdown system to stop all electrical	Proponent	Continuous

ENVIRONMENTAL ISSUE	MITIGATION MEASURES	RESPONSIBLE PARTY	TIME FRAME
	machinery		
Contamination and wastage of gas products	<ul style="list-style-type: none"> • Ensure careful filling of cylinders to avoid loses • Check for impurities in all gas products before dispatch to customers • Overflowed cylinders or cylinders for testing should always be discharged into closed piping system and returned to compressor • Only small amounts of all gases produced should be allowed to escape into atmosphere 		
Poor anaesthetics	<ul style="list-style-type: none"> • Paint entire premises and appropriately utilize any 'green area' 		

8.1.3 Decommissioning Phase

In addition to the mitigation measures provided in Tables 7 and 8, it is necessary to outline some basic mitigation measures that will be required to be undertaken once all operational activities of the gas plant project have ceased. The necessary objectives, mitigation measures, allocation of responsibilities, time frames and costs pertaining to prevention, minimization and monitoring of all potential impacts associated with the decommissioning and closure phase of the gas plant project are outlined in Table 9 below.

Table 10: Decommissioning Phase Environmental and Social Management/Monitoring Plan

Recommended Mitigation Measures	Responsible Party	Time Frame	Cost (Ksh)
1. Demolition waste management			
1. All buildings, machinery, equipment, structures and partitions that will not be used for other purposes must be removed and recycled/reused as far as possible	Contractor, Proponent	One-off	As per budget
2. All foundations must be removed and recycled, reused or disposed of at a licensed disposal site	Contractor, Proponent	One-off	As per budget
3. Where recycling/reuse of the machinery, equipment, implements, structures, partitions and other demolition waste is not possible, the materials should be taken to a licensed waste disposal site	Contractor, Proponent	One-off	As per budget
4. Donate reusable demolition waste to charitable organizations, individuals and institutions	Contractor, Proponent	One-off	As per budget

Recommended Mitigation Measures	Responsible Party	Time Frame	Cost (Ksh)
2. Rehabilitation of project site			
1. Implement an appropriate vegetation programme to restore the site to its original status	Contractor, Proponent	One-off	As per budget
2. Consider use of indigenous plant species in vegetation	Contractor, Proponent	One-off	As per budget
3. Trees should be planted at suitable locations so as to interrupt slight lines (screen planting), between the adjacent area and the development.	Contractor, Proponent	Once-off	As per budget

9.0 ENVIRONMENT, HEALTH AND SAFETY (EHS)

9.1 EHS Management and Administration

The EHS is a broader and holistic aspect of protecting the worker, the workplace, the tools / equipment and the biotic environment. It is an essential tool in determining the EIA project. The objective of the EHS on the proposed project is to develop rules that will regulate environmentally instigated diseases and occupational safety measures during construction and the operation phases of the proposed project by:

- Avoidance of injuries.
- Provision of safe and healthy working environment for workers comfort so as to enhance maximum output.
- Control of losses and damages to plants, machines, equipment and other products.
- Enhance environmental sustainability through developing sound conservation measures.

9.2 The Guiding Principles to Be Adopted By the Contractor

The company will be guided by the following principle: -

- It will be a conscious organization committed to the promotion and maintenance of high standards of health and safety for its employees, the neighbouring population and the public at large.
- Ensuring that EHS activities are implemented to protect the environment and prevent pollution.
- Management shall demonstrate commitment and exercise constant vigilance in order to provide employees, neighbours of the project and the environment, with the greatest safeguards relating to EHS.
- Employees will be expected to take personal responsibility for their safety, safety of colleagues and of the general public as it relates to the EHS management plan.

9.3 EHS Management Strategy to Be Adopted By the Contractor

The following strategies will be adopted to achieve the above objectives:

- Create an Environment Health and Safety Management committee and incorporate EHS as an effective structure at various levels and units to manage and oversee EHS programs in all construction and operation phases of the project
- Maintain an effective reporting procedure for all accidents.
- Provide appropriate tools and protective devices for the success of the project.
- Encourage, motivate, reward and support employees to take personal initiatives and commitment on EHS.

9.4 Safety Requirement at the Project Site

The following safety requirements are both for Construction and Operation Period

(a) The Contractor

The contractor will ensure that:

- Safe means of entry and exit exist at the proposed project site.
- Ensure adequate briefing of job at hand on the safe system of work before commencement of work
- The EHS coordinator must be in attendance at all times throughout the duration of the project.
- The EHS consultant must maintain constant assessment of the risk involved as the work progresses
- A safety harness must be worn before entry into all confined spaces

- An EHS consultant must be posted at the entrance of the project site to monitor progress and safety of the persons working at the construction site.

(b) The Traffic / Drivers

Within the construction premises, the following traffic rules will be observed: -

- Observe speed limits and all other signs and obey traffic rules.
- Use the vehicle for the purpose to which it is intended only.

c) Fire Hazard at the Construction Site

The proponent shall provide:

- 4Nos 9litres Co₂/water fire extinguishers next to each hose reel
- Emergency light within the premise
- Automatic alarm to cover the project
- 5000gallons water reserve tank for hose reel
- Smoke and heat detectors in all the floors
- All car parking floors to be provided with sprinkler system engineers details
- Fire resistant doors to fire escape staircases to be one hour fire resistant with automatic door closers
- Electric fire alarms system with secondary power supply from stand by generator
- All internal partitioning materials to be half hour fire rating
- 100mm. wet riser with one landing valve on each appropriate point
- 9kg. dry powder fire extinguishers
- Fire instructions and fire exit signs

9.5 Welding at the Construction Site

It is the responsibility of the contractor during construction to: -

- Ensure that welding clamp is fixed such that no current passes through any moving parts of any machine.
- Ensure that all welding clamps are in good operating condition and conduct current without arcing at the point of contact.
- Ensure that welding clamps are free from any contact with explosive vapours i.e. Oil spillage, Fuel tanks, Coal dusts and miscellaneous combustible material (e.g. Cotton rags, filter bags, rubber belting, and wood shavings).
- Ensure that any slag or molten metal arising from welding activities does not start up fires by:
 - ✓ Clearing combustible material to a distance of at least 3 meters away from the working area or covering area with metal or asbestos sheet.
 - ✓ Appropriate fire extinguisher is to be kept available for immediate use at all times

9.6 Emergency Procedures during Construction and Operation

In the event of an emergency during construction, the workers shall:

- Alert other persons exposed to danger.
- Inform the EHS coordinator.
- Do a quick assessment on the nature of emergency.
- Call for ambulance on standby.
- When emergency is over the EHS coordinator shall notify the workers by putting a message: “ALL CLEAR”
- Provision of emergency power (Generator)

In the event of such an emergency during operation the workers shall: -

- ✓ Alert other persons exposed to danger.
- ✓ Ring the nearest police station
- ✓ Call for ambulance on standby.

Table 11: EMERGENCY RESPONSE PLAN

Aspect of Danger	Response Plan	Responsibility
Fire	<ul style="list-style-type: none"> • Use available fire extinguishers to fight the fire • Set shut down systems active all time • Have digital fire/smoke detectors • Call the Police 999 • Call Machakos County fire fighters. • Call Station operator / Proprietor • Workers to assemble at the Fire Assembly Point 	Plant Manager on Duty
Serious Injury/ Loss of life	<ul style="list-style-type: none"> • Apply first Aid • Call the Police 999 • Call for Ambulance Services • Call Station operator / Proprietor 	Station Manager on Duty
Theft/ Robbery	<ul style="list-style-type: none"> • Call the Police 999 • Contact Private Security Provider concerned • Call Station operator / Proprietor 	Station Manager on Duty

10.0 CONCLUSION AND RECOMMENDATIONS

The proposed Perfect purity gases company limited plant will have numerous positive impacts including creation of employment; availability of industrial gases, improved infrastructure, Increase in industrial activities and Increase in Revenue among others as has been outlined within the report.

The negative environmental impacts that will result from establishment of the project which include increased population without commensurate services and facilities; increased pressure on infrastructure; air pollution; water pollution and generation of hazardous wastes among others have been mitigated.

The proponent of the proposed project shall be committed to putting in place several measures to mitigate the negative environmental, safety, health and social impacts associated with the life cycle of the project.

It is recommended that in addition to this commitment, the proponent shall focus on implementing the measures outlined in the ESMP as well as adhering to all relevant national and company environmental, health and safety standards, policies and regulations that govern establishment and operation of such projects.

It is also recommended that the positive impacts that emanate from such activities shall be maximised as much as possible. It is expected that these measures will go a long way in ensuring the best possible environmental compliance and performance standards.

REFERENCES

- Kenya gazette supplement Acts 2000, Environmental Management and Coordination Act Number 8 of 1999. *Government printer, Nairobi*
- Environmental Management and Coordination (Controlled Substances) Regulations 2007
- Environmental Management and Coordination (Waste Management) Regulations 2006
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- Kenya gazette supplement Acts *Forest Act* by government printer, Nairobi
- Kenya gazette supplement Acts *Land Planning Act (Cap. 303)* government printer, Nairobi
- Kenya gazette supplement County Government act, 2012 government printer, Nairobi
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- www.eiga.eu, Environmental Impacts of Air Separation Units, European Industrial Gases Association AISBL, 2011, Brussels
- www.eiga.eu, Environmental Impacts of Acetylene Plants, European Industrial Gases Association AISBL, 2011, Brussels

APPENDICES

Copy of:

- Title deed
- Change of user approval
- Approved architectural plans
- Certificate of incorporation
- Pin certificate
- Machine detail sheets
- EIA public participation questionnaires
- Minutes of public Baraza
- List of attendants of the Baraza
- EIA license for perimeter wall construction
- Firm of expert registration certificate and practising license
- Lead expert NEMA EIA/EA license
- EIK license for lead expert
- Sketch map to the site