Environmental Impact Assessment Report

Ankobra Resources Limited Project
(Sekondi Export Processing Zone)

Sekondi-Takarodi, Ghana

submitted by

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Preface

The Environmental Impact Assessment Report has been prepared by Oil Master Houston and principally funded by Oil Master Houston. In accordance with the Environmental Assessment in Ghana, A Guide, published December, 1996, the Team Consultant Concept has been applied to both the data and information presented in the EIAR.

This document has followed the major topics of the L.I. 1652 document in submitting an Environmental Impact Statement pursant to regulation 13 (2), where a Scoping Report is accepted by the Agency. It has addressed possible direct and indirect impacts of the undertaking on the environment at the pre-construction, construction, operation, decommission, and post-decommission phases.

Actual Botany-Zoology Survey exercises were performed to formulate all data on both the flora and fauna of the proposed site within the Sekondi Export Processing Zone. Data from the Ministry of Health has been included to further indicate the impact to Anoe Village, a community located approximately 300m south of the primary operation zone of the project.

On site visits by the proponent have been made to the proposed site and Anoe Village to further correlate the actual data from the Botany-Zoology Survey. The proposed refinery-petrochemical complex will be virtually self sufficient and an environmentally sound project.

We are extremely grateful for the cooperation received from the government entities of the Republic of Ghana. Those entities include the Ministry of Mines and Energy, Ministry of Environment, Science and Technology, Environmental Protection Agency, Ghana Free Zones Board, Regional Meteorological Authority, Sekondi,Ghana, and the Shama Ahanta East Meteropolitan Assembly.

EIAR Team Consultants

Botany and Zoology Departments University of Ghana	Performed both Botany-Zoology Surveys on the proposed site. This project included the major species of both flora and fauna within the Sekondi Export Processing Zone Also, identified all bodies of water.
Shama Ahanta East Metro. Assembly	Vital data or information on the Anoe Village people, approximately 300m south of the proposed petrochemical-refinery project. All base maps were prepared by Metro. Assembly personnel. Assisted with on-site visits by the proponent.
Ghana Free Zones Board	Many hours in providing administrative consultation on the designation of the land,approximately five hundred (500) acres within the Export Processing Zone.
Ministry of Mines and Energy	Its positive review of the technical data, Ankobra Resources Ltd. as a potential petrochemical-refinery complex in the Sekondi Export Processing Zone.
Vanguard Insurance	This firm has been able to provide the details on the various insurance needs of both the physical assests and personnel. Assisted in noting the health impact of the area and the need of the employees as a high priority for insurance and health care.
Issifu Ali and Company	This firm has served as a representative,Ankobra Resources Ltd, (1) L.I.1652 and its purpose and (2) interfaced and had dialogue with the Ministry of Environment and the EPA concerning the EIAR.
John K. Offeh	A Director, has interfaced with the Ministry of Environment, Science and Technology and EPA concerning the EIAR as related to L.I.1652. Mr. Offeh has represented Ankobra Resources Ltd. as the legal representative. Assisted in the commissioning of the University of Ghana.
S.K. Bhattacharjee	A Director, has worked behind the scene involving technical matters with the refinery general contractors. Also, assisted in the general dialogue with Air Liquide on the construction of a gas plant in Ghana
Roland T. Cain	A Director, principal writer of the EIAR. Coordinated the entire project to include the financing,site visits, and interfacing with various governmental entities in Ghana.

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Notes

Enviromental Impact Assessment Report

Executive Summary:

Ankobra Resources Ltd. project includes a 140,000 bbls. per day crude oil refining and petrochemical unit. Petroleum products include diesel, unleaded gasoline, LPG, Jet Fuel, fuel oil, bitumen products and methanol.. The project will be located in the Sekondi Export Processing Zone, approximately 300 m north of Anoe Village.This environmental assessment addresses the requirement of a state of the art refining unit on a worldwide basis.

This project will employ between 350 to 400 individuals to include 70% to 80% indigenous personnel. The site will initially construct structures between 100 to 120 acres. The Republic of Ghana has a shareholder stake of twenty (20%) percent and the remainder to the consortium (i.e. Ebony Enterprises Ltd (London), Antoine Trading Int'l. Co. (USA), and Oil Master Houston (USA).

The plant will consist of , (1) Distillation tower, (2) Catalytic reforming unit, (3) Alkylation unit, (4) Visbreaking unit, (5) Fluid catalytic (FCC) unit, (6) Unibon unit (7) Hydrodesulfurization unit, and (8) Partial Oxidation Unit. This petrochemical refinery unit will mainly use Nigerian Light Crude Oils such as Bonny Light Crude, Brass River Light Crude Oil, Qua Iboe Light Crude, and Forcados Blend.

All West African crude oils will be delivered by tankers via a pipeline into the Gulf of Guinea. A desalination unit will be used to provide fresh water for the entire complex to include industrial demands by the petrochemical-refinery unit.

Current estimates indicate a construction work force of approximately 300 to 350 workers with approximately 70% to 80% as indigenous workers. Plans include a temporary area of (1) offices, (2) meeting rooms, (3) sleeping quarters (100 to 120), (4) toilets, (5) kitchen, (6) dinning room (100 man capacity), (7) clinic (two surgical rooms), (8) X-ray room, and (10) dental room.

Approximately three (3) schools will be built to accommodate the workers and surrounding villagers. These schools will include the levels of elementary, middle school, and high school for the immediate area.

A permanent township to include houses for about 100 employees to include bachelor quarters. This area will have permanent water lines, sewer lines and natural gas lines for future usage.Potable water will be received from a dedicated pipline, Ankobra Resources Ltd. desalination plant intake from the Gulf of Guinea.

Introduction

Ankobra Resources Ltd. project has been proposed to fill the domestic needs of the Republic of Ghana and international needs in relations to transportation fuels. By the prescribed regulations, any petrochemical-refinery unit located in the Sekondi Export Processing Zone shall sell thirty (30%) percent petroleum product in the domestic market and seventy (70%) percent petroleum product into the international market.

The generation of power, 90 mw generated onsite by Ankobra Resources Ltd. The recycling of steam will be used to generate electricity in the power unit. It has been estimated that about 45 mw will be needed for the petrochemical-refinery unit and a surplus of 45 mw for re-sale possibly for the national grid. In fact, national grid power lines transverse the site and Anoe Village.

Ankobra Resources Ltd. is proposed to be built within the Sekondi Export Processing Zone. The estimated 500 acres are located 300 m north of Anoe Village adjacent to the main highway from Accra to Sekondi, Ghana. The site was selected for (1) lack of visual tributaries or natural water drainage, (2) presence of national electric grid lines, (3) level terrain, (4) railroad line (5) pipeline potential to Gulf of Guinea and (5) land set aside for heavy industrial use.

The configuration will allow the refining of crude oil and methanol production on sound environmental basis. There will be no drilling of onsite wells (i.e. water or disposal) to contaminate the terrain. All units will have internal boilers for burning of intermediate by products and venturi scrubbers for off-gases during the refining process.

Onsite incineration to incinerate wastewater, solids, sludges, and liquids. Continuous monitoring of emissions, gases, and vapors by electronic equipment leaving the immediate petrochemical-refining unit. About 10 to 12 storage tanks onsite and all will have monitoring units for vapors or gas emissions.

West African crude oil will be the principal feedstock for the petrochemical-refinery unit. All crude oil will be delivered by tankers and off loaded at Ankobra Resources Ltd. to a private single-point mooring system anchored off the coast, and from there, transferred to the site less than twenty (20) miles via polypropylene pipeline.

The project will have two major contractors, (1) Petrochemical-refinery complex and (2) Housing-Municipal Structures. Both major contractors have an average of thirty (30) years experience in their respective areas of construction. Each major contractor will have a subcontractor with world wide experience, especially in the construction and engineering of refineries.

The project has been proposed to commence by November, 2000 with contract award and project mobilization within a ninety day period of time. It will be a turnkey basis project, approximately 36 months to complete the 140,000 bbls. per day unit. All refining units will be prefabricated, foundations consist of portland cement, pipeline system, polypropylene pipes prefabricated and process piping measured and constructed offsite.

Ankobra Resources Ltd, project will be financed by a Private Trust Fund as a humanitarian loan to Oil Master Houston as the sole borrower of the funds. This Trust Fund has provided financing for several petrochemical-refinery type projects on a worldwide basis.

Monitoring of the site includes noise, vapor/gas emissions, erosion of soil, vegetative response, indoor air quality conditions, and marine conditions. Monitoring is essential, it is the tool to develop data during the preconstruction, construction, operation, and the decommission phases of the project.

This report has been arranged in format to provide the major topics and subsequent appendices in the following manner.

1.	Section One	Executive Summary
2.	Section Two	Introduction
3.	Section Three	Description of Proposed Project Incudes site description, physical environment, geology, topography, and solids, atmospheric environment, climate, air quality, noise, ground and surface water,coastal environment,lagoons and estuaries, biological and terrestrial areas, wildlife,regional settings,site investigations,and marine environment to give the overview of the site
4.	Section Four	Significant Impacts and Proposed Mitigation
5.	Section Five	Analysis of Alternative
6.	Section Six	Mitigation Plan Includes air emissions, aquatic conditions, social mitigation,residual impacts after mitigation and cost of mitigation.
7.	Section Seven	Environmental Management and Training
8.	Section Eight	Pollutants in Environmental Media,Air,Water,and Land
9.	Section Nine	Health
10.	Section Ten	Monitoring

Map Republic of Ghana

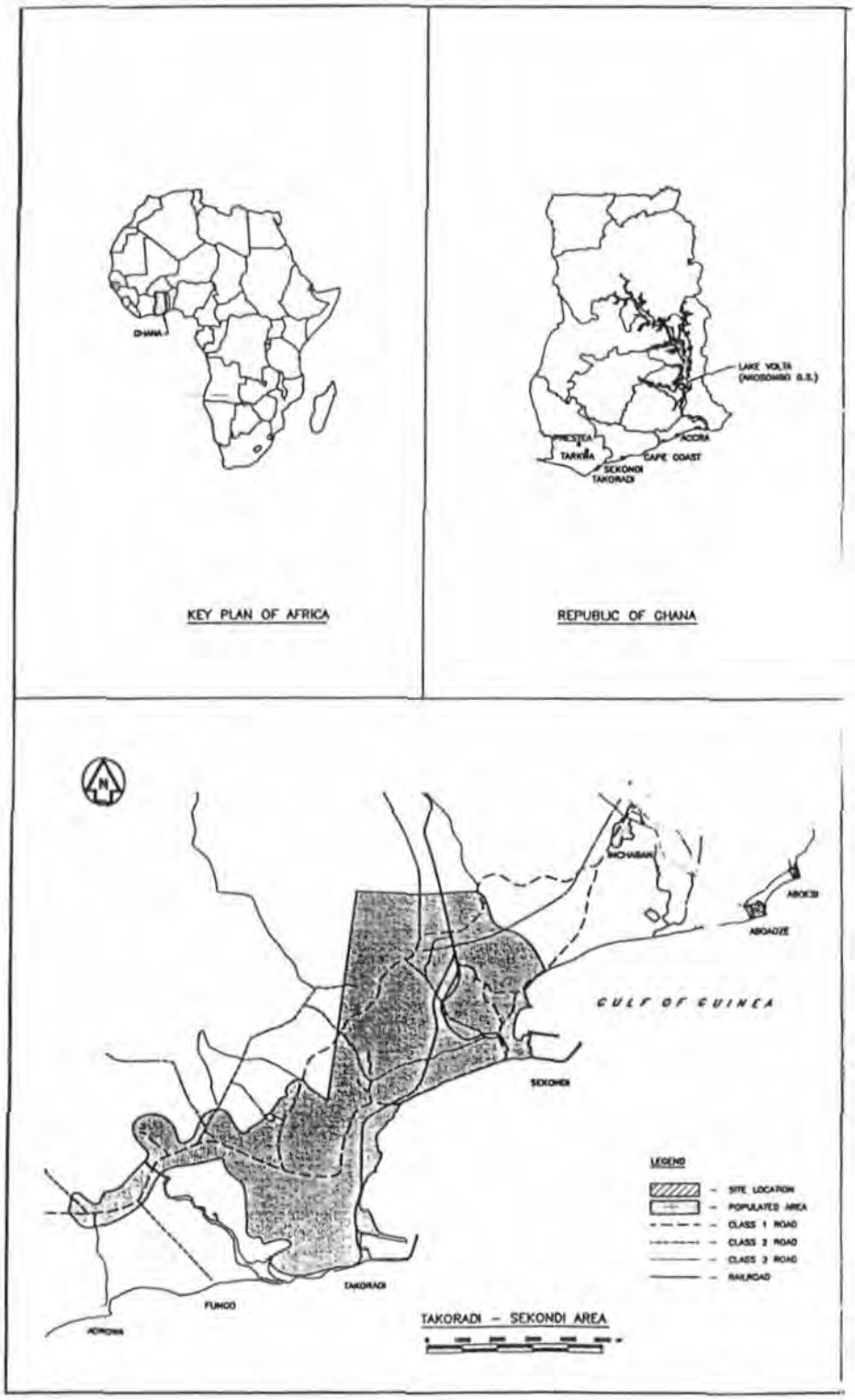


Figure 33, Map Republic of Ghana

Description of the Proposed Project

The proposed Ankobra Resources Ltd. project consist of , (1) Distillation unit, (2) Catalytic Reforming unit, (3) Alkylation unit, (4) Visbreaking unit, (5) Fluid Catalytic (FCC) unit, (6) Hydrodesulfurization unit, (7) Unibon unit, and (8) Partial Oxidation unit.

Unit	Product
Distillation Tower	Light and Heavy Naphtha Kerosine Aviation Fuel Diesel Fuel Heating Oils Gas Oils Fuel Oils
Catalytic Reformer	Naphtha & straight run gasoline
Hydrotreater (naphtha)	High Octane Gasoline (Low sulfur)
Vacuum Unit (Asphalter)	Pitch-asphalt
Partial Oxidation	Methanol

Unit	Acreage
Distillation Tower	1/2 acre; 1/8 acre buffer zone
Catalytic Reforming Unit	1/2 acre; 1/8 acre buffer zone
Alkylation Unit	1/2 acre; 1/8 acre buffer zone
Visbreaking Unit	1/2 acre; 1/8 acre buffer zone
Fluid Catalytic (FCC)	1/2 acre; 1/8 acre buffer zone
Hydrodesulfurization Unit (HDS)	1/2 acre; 1/8acre buffer zone
Unibon Unit	1/2 acre; 1/8 acre buffer zone
Paritial Oxidiation Unit	1/2 acre; 1/8 acre buffer zone
Hydrogen Unit	1/2 acre; 1/8 acre buffer zone
Generators (x 3) Units	1/2 acre; 1/8 acre buffer zone
Tank Farm(Crude/Petroleum Products)	20 acres; 1/2 acre buffer zone

All units must be constructed on a concrete foundation with the ability to contain spills with a modern sewer system, fire fighting equipment, air pollution equipment, and adequate water supply (cooling and fire fighting). Areas will be bermed where containment is essential to providing an environmentally safe condition for both workers and community.

Approximately 10 to 12 storage tanks to inlcude both crude oils and petroleum products are on site. Tankage will be available to both railway and tractor trailers for transport of petroleum products within the Republic of Ghana. Dual pipeline will be used to transport petroleum products to tankers for international shipments.

2.1 General Refining Process:

Crude oil to be offloaded at a single- point mooring (SPM) and piped to shore; maximum tanker size would be 40,000 tons deadweight carrying a cargo up to 38,000 tons, and maximum draft of 16 m. Pipeline to be buried or anchored in seabed to prevent movement and damage. Pipeline shall be buried from an offshore location having a minimum depth of 3m below low water level to the plant fence line.

Crude oils are then pumped from the onsite tankage into distillation tower for both atmospheric and heat fractionation. The distillation tower usually provides such fractions as naphtha(HT), mid. distillation fractions, and vacuum distillation bottoms, see simplified refinery flow diagram (Fig. 1C, Fig.2C,Fig.3C and Fig.4C).

The naphtha (HT) flows into a splitter, gas emissions and hydrocarbon molecules to a catalytic reformer. Gases from the catalytic reformer enter the alkylation unit and produces gasoline.

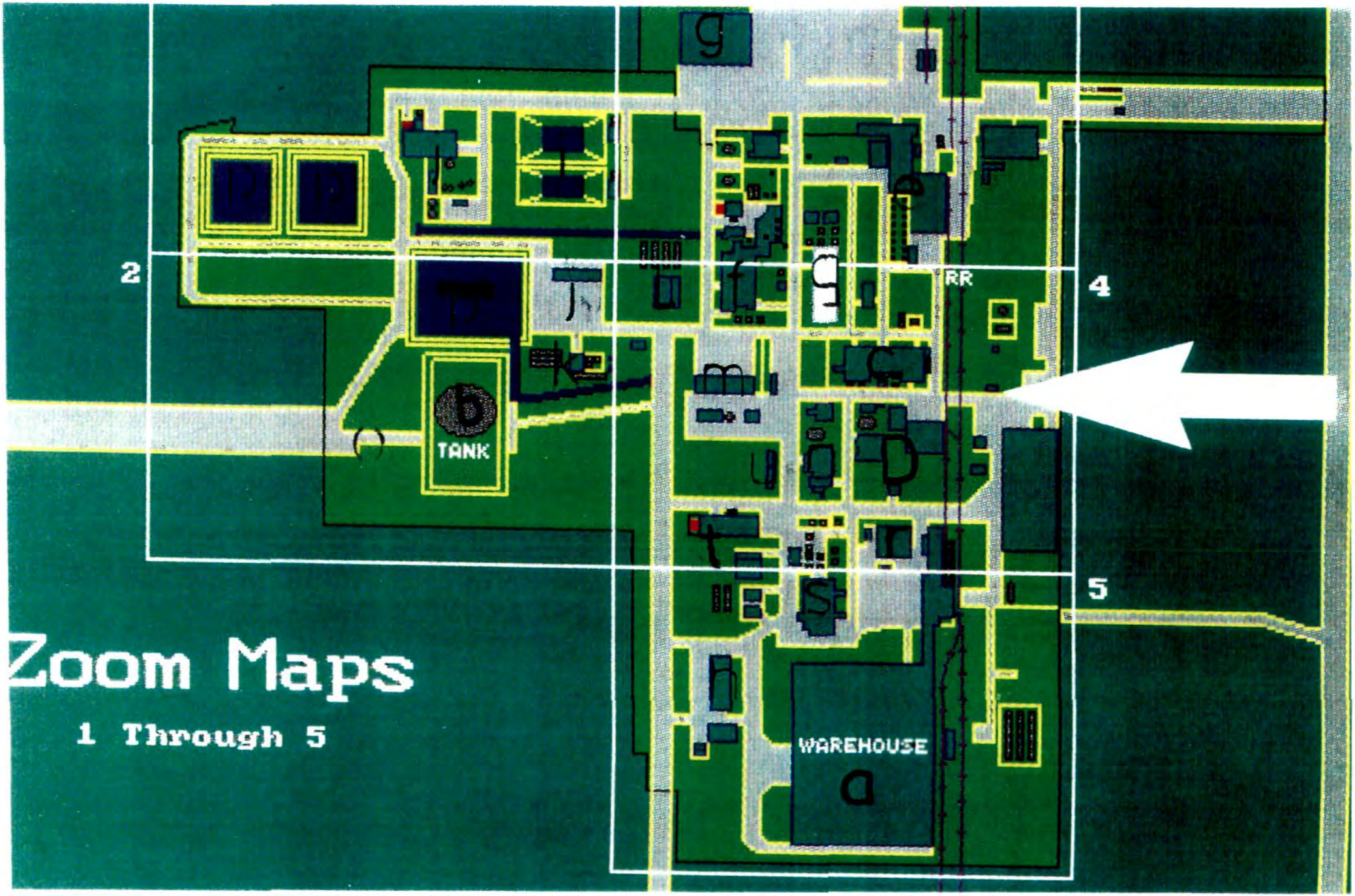
Mid. distillation fractions,enter the hydrodesulfurization unit producing diesel. Vacuum distillation bottoms enter into two (2) paths, the Unibon (hydrogen) to the FCC unit and produces diesel and gasoline. The gas enters the alkylation unit to produce fuel gas.

The other path is the visbreaker to the POX(partial oxidation) producing methanol. Syngas from the POX unit undergoes syngas conversion and enters the Unibon unit into the FCC unit producing diesel.

Approximately 300 to 350 workers will be required during the peak construction period. Most construction activities are related to site preparation, assembly /interconnection of various pre-engineered components and buildings, and installation of utilities and services. Between 350 to 400 permanent workers are needed to operate the petrochemicl -refinery complex.

A permanent site including approximately 100 to 120 houses for both expatriates and indigenous workers. Guest houses will be located in both Accra and Sekondi to accommodate international workers for overnight stays and guest on refinery business.

Ankobra Resources Ltd. main wastewater treatment system will handle its sewage from both the industrial and municipal areas of the site. Biosludge handled onsite with microbial activity in the wastewater treatment system.



Zoom Maps

1 Through 5

ANKOBRA RESOURCES LTD.

A.	WAREHOUSE(S)	
B.	TANK FARM	
	1. Crude Oil	600,000 tons
	2. Intermediate Products	900,000 tons
	3. End Products	500,000 tons
	4. Wastewater/Sludge	500,000 tons
C.	ADMINISTRATIVE BUILDING	
D.	LABORATORIES	
	1. Environmental	
	2. Quality Control	
	3. Petroleum	
	4. Chemistry	
E.	TRAINING BUILDING (S)	
F.	PERSONNEL CHANGING ROOM COMPLEX	
G.	MEDICAL DENTAL CENTER	
H.	AUTOMOTIVE/TRUCK REPAIR CENTER	
I.	TURBINE GENERATORS (ELECTRICAL)	
J.	CONTROL ROOM (S)	
K.	CONTROL ROOM - TANK FARM	
L.	GENERATORS (EMERGENCY)	
M.	TRANSPORT CENTER	
N.	MAINTENANCE BUILDINGS	
O.	PIPELINE(Pipeline under road throughout Free Zone)	
P.	PROCESSING EQUIPMENT	
	1. Distillation Tower	
	2. Catalytic Reforming Unit	
	3. Alkylation Unit	
	4. Visbreaking Unit	
	5. Fluid Catalytic Cracking (FCCU)	
	6. Hydrodesulfurization Unit (HDS)	
	7. Unibon Unit	
	8. Partial Oxidation/Methanol	
Q.	TRAINING FIELD AREA (Fire Fighting Techniques)	
R.	SHIPPING AND RECEIVING BUILDING	
S.	FIRE STATION	
T.	LPG FILLING STATION	
U.	SCALES (TRUCKS)	

Fig. 2

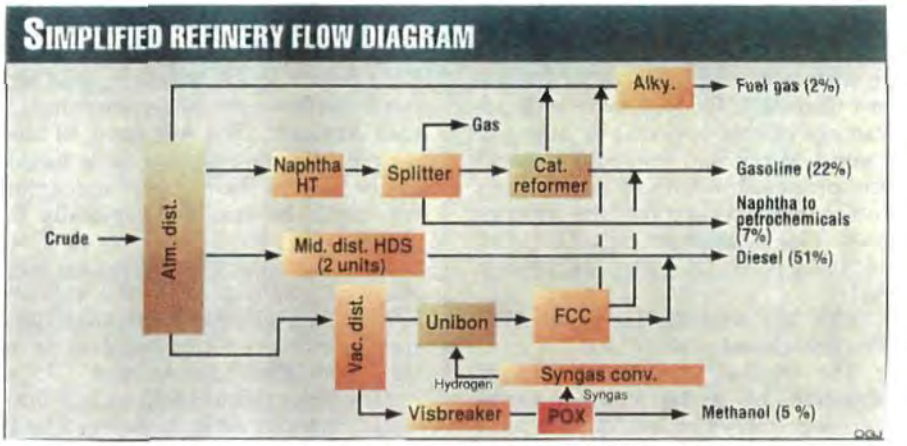


Figure 2C,Simplified Refinery Flow Diagram

Fig 3

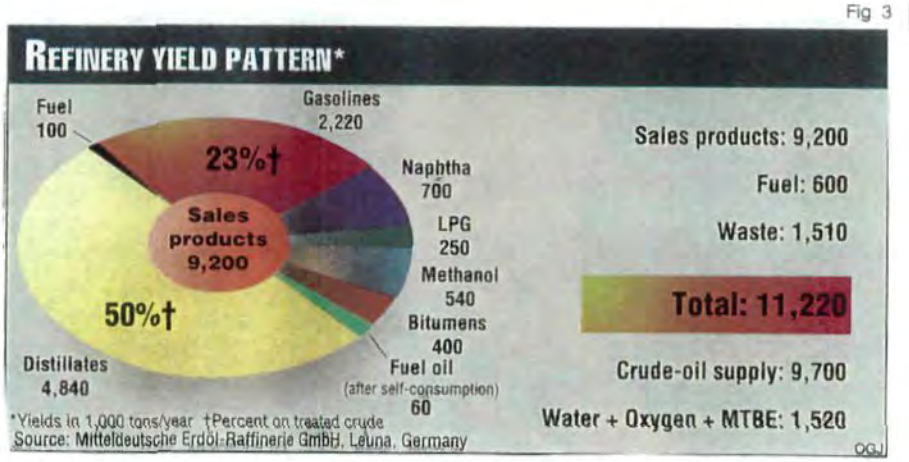


Figure 3C, Refinery Yield Pattern

Fig. 4

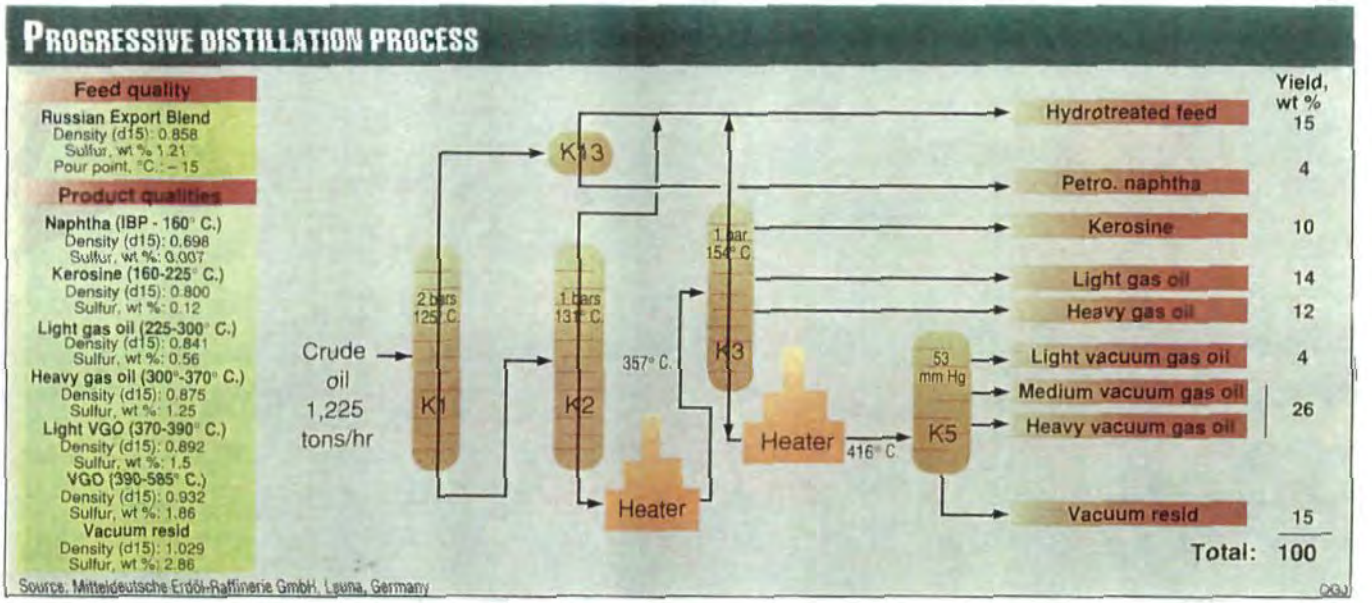


Figure 4C,Progressive Distillation Process

Fig. 1

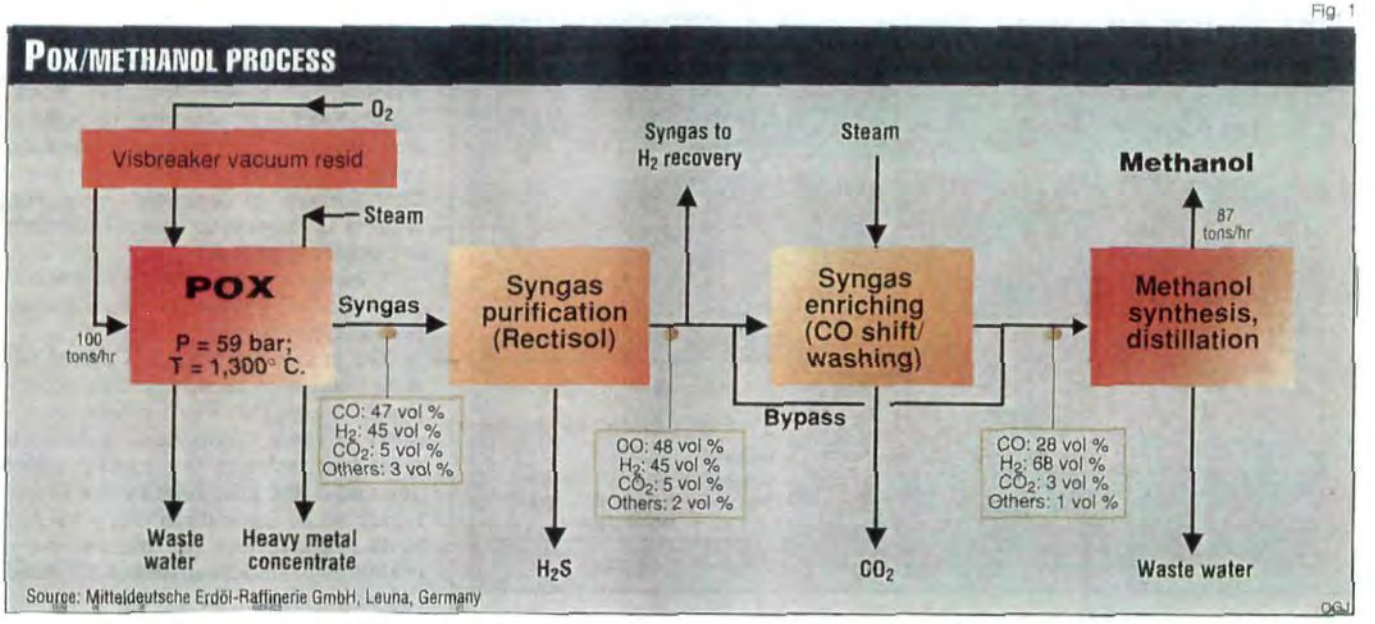


Figure 1C, POX/Methanol Process

Description of the Existing Environment

3.1. Site Description:

Refinery Site: Latitude:	35100N - 36700N	Longitude	192400E - 194200E
Residential Site : Latitude	34400N - 35400N	Longitude	194400E - 195400E
Anoe Village: Latitude	34400N - 34700N	Longitude	192300E - 192700E

1.	North	Bounded by	Industrial Site
2.	East	Bounded by	Farmland
3.	South	Bounded by	Residential (not fully developed)
4.	*West*	*Bounded by*	*Industrial Site / Railway System*

Anoe Village:

Location: Shama Ahanta East Co-ordinates: Longitude 634000
Latitude 114000

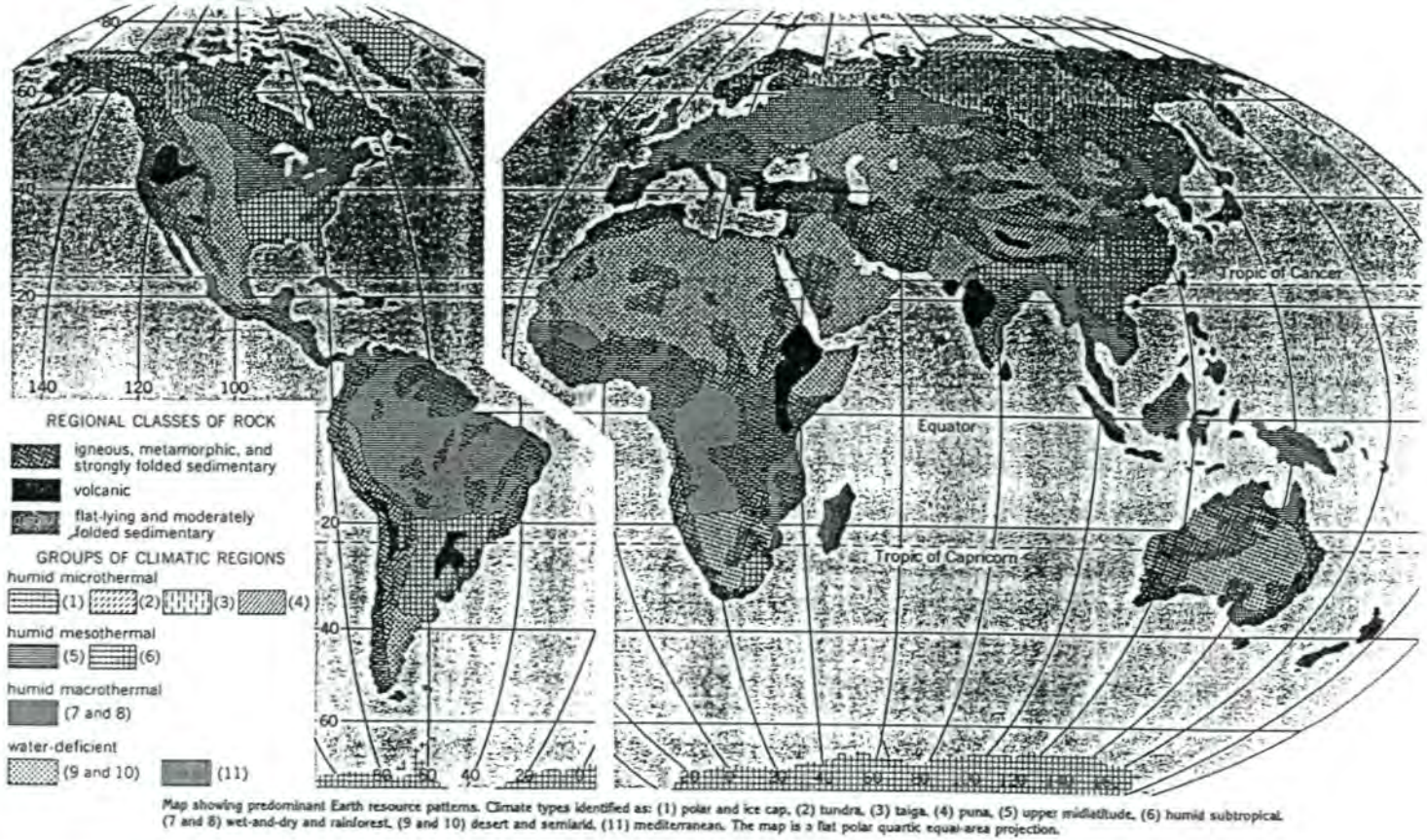
3.2 Physical Environment:

Sekondi Export Processing Zone is located in the southwest, Kibi - Winnera Belt and southwest of Cape Coast as noted on simplified geological maps of Central and Western regions of Ghana . There are no indications of mining activities in this area nor are there any indication of Au and Mn.

3.3 Geology, Topography, and Soils

Ghana lies within the Man Shield which occupies the southern most part of the West African Craton. Volcano sedimentary rocks and granitiods of the Eburnean orogeny make up for the greater part of the lithology and occupy the western part of this country while Voltain (quartizite, grit, congolmerate, shale, and mudstone) sediments of the Palaezoic occupy most of the eastern portion.

Both units are intruded by granitiods distinguished as the Dixie Cove, Cape Coast, and Bongo types. A significant feature of the Birimian Group of Ghana is the existence of five parallel volcanic belts , comprising low grade metamorphosed basilic lavas and separated by basins containing metasedimentary units. Luebe and Hirdes (1986) have proposed that sedimentary and volcanic rocks may generally be synchronous implying that they were deposited contemporaneously as lateral facies equivalents.



Map showing predominant Earth resource patterns. Climate types identified as: (1) polar and ice cap, (2) tundra, (3) taiga, (4) puna, (5) upper midlatitude, (6) humid subtropical, (7 and 8) wet-and-dry and rainforest, (9 and 10) desert and semiarid, (11) mediterranean. The map is a flat polar quartic equal-area projection.

Figure 3a. Map showing Predominate Earth Resources Patterns and Climate Types

Soils exposed in the Sekondi Export Processing Zone, has indicated an eolian type or loess soil, reddish in color and almost a clay consistency. An eolian or loess type soil, maybe characterized as an unstratified soil deposit usually buff or yellowish brown in color and composed of small particles mixed with clay.

Latosolic soils, include many groups of reddish leached soil of the tropics, formerly called laterite. The clays are mainly koalin, iron oxide, and alumina. Even though rich in clay, most of the soils are non-sticky and permeable.

Several types of soils such as alfisol, inceptisol, mollisol, oxisol, spodosol,ultisol, and crustal rock have been compared in there elemental composition. There elemental compositions include silicon, aluminum, iron, calcium, magnesium, sodium, potassium, titanium, manganese, and phosphorus.

Ankobra Resources Ltd. petrochemical refinery project will be in the alfisol zone in the Sekondi Export Processing Zone.

3.4 Atmospheric Environment

The Sekondi Export Processing Zone , currently no industrial activities nor organized farming in the area. Natural growth cycle exhibited by grasses, trees, and shrubs are evident of ambient air quality in the Sekondi Export Processing Zone. Table 2.1, Air Quality Objectives and Guidelines provide values for ambient air conditions.

3.5 Climate

Sekondi Export Processing Zone is an equatorial seasonal forest. The tropical deciduous or seasonal forest occurs in parts of Central and South America, Southern and Western Africa and Indonesia, and North Eastern Asia. The climate associated with these forests is somewhat drier than that which produces tropical rain forests. Also, the year is broken into one or more alternating dry and wet seasons which may be nearly equal length.

Ghana lies entirely within the tropics. Annual mean temperatures throughout the country vary from 79 deg F to 84 deg. F (26 deg. C-29 deg.C). Maximum temperatures,highest in the north, occur about March. Temperatures are lowest about January in the north and August in the South.

Rainfall varies from 30 to 100 inches (76-250 cm) annually. The temperature range, however, is similar to that in areas where tropical rain forest occurs. The southern half of the country has two rainy seasons with peaks about May-June and September-October.

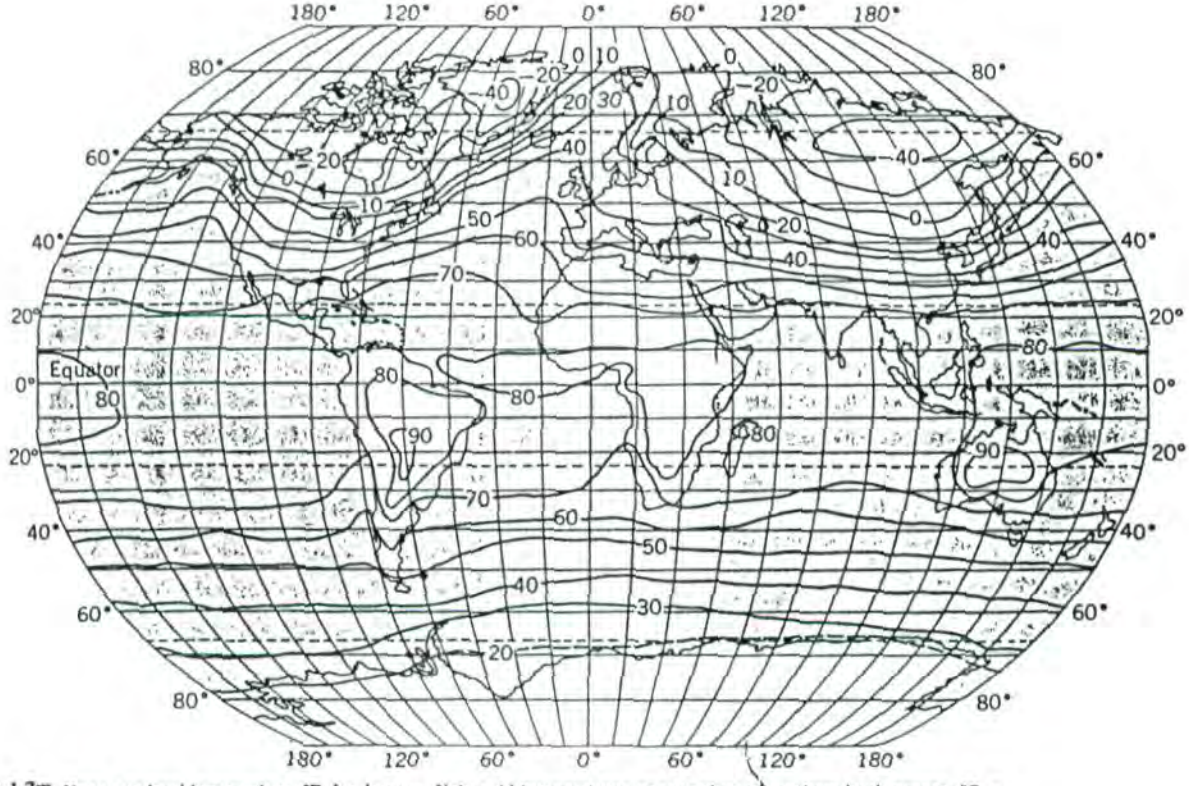


Fig. 1.2m Mean sea-level temperature, °F, for January. Note cold temperatures near centers of northern land masses. °C = (°F − 32) ÷ 1.8.

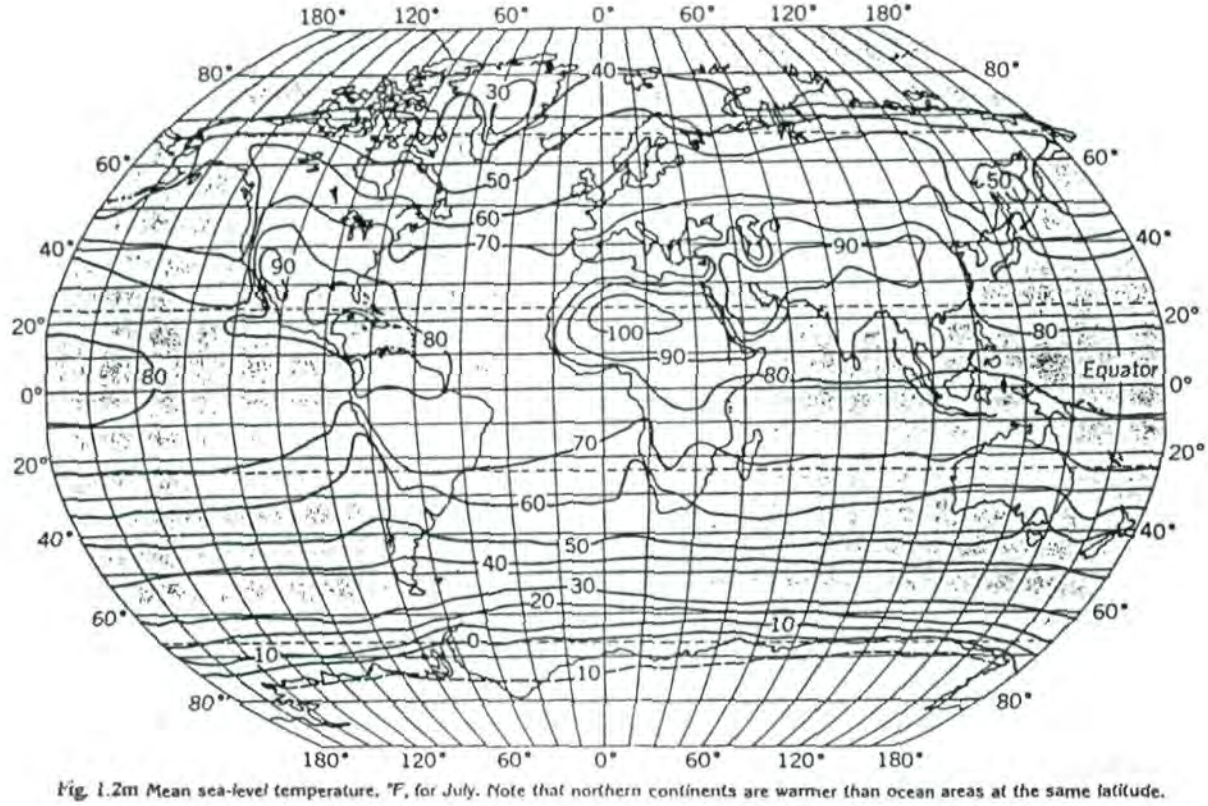


Fig. 1.2m Mean sea-level temperature, °F, for July. Note that northern continents are warmer than ocean areas at the same latitude.

Fig. 5. Mean annual precipitation, in inches, on major land areas. 1 in. = 25 mm.

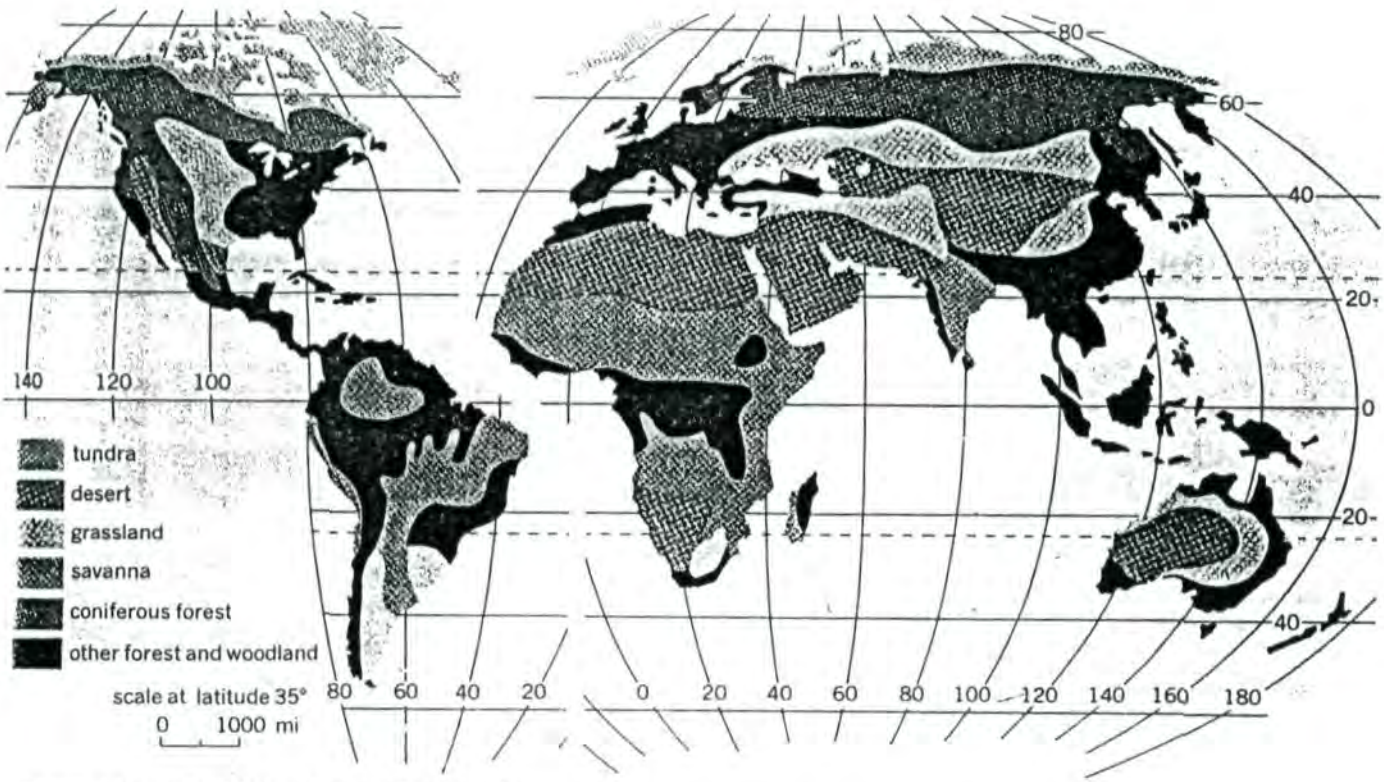


Figure 14. Figure 5 Mean Annual Precipitation
Figure 2 Map of the World Distribution of Physiognomic Vegetative Types

3.6 Air Quality

The air quality concern will be sulfur dioxide emissions. especially with the refining of crude oil. The lower sulfur content of crude, emission rates of sulfur dioxide will be less in accordance with major air modeling projects. Also, the petrochemical-refinery unit will be using sulfuric acid as a strong acid.

Sulfur dioxide is a colorless gas or liquid with sharp, pungent odor; soluble in water,alcohol, and ether; forms sulfurous acid (H(2)SO(3)). Toxic by inhalation,strong irritant to eyes and mucus membrane.

Nitrogen oxides are as follows; (1) Nitrous oxide (N (2))), (2) Nitric Oxide (NO), (3) Nitrogen trioxide (N (2) O (3)), (4) Nitrogen peroxide (N (2) O (4), (5) Nitrogen dioxide NO(2), (6) Dinitrogen pentoxide (N(2) O(5), (7) Trinitrogen tetroxide N(3) O(4) and (8) NO(3) which is unstable.Toxic by inhalation, especially NO(2).

The Simplified Refinery Flow Diagram , shows the presence of syngas and need to convert from the POX (partial oxidation) unit. Syngas or synthesis gas , is any of several gaseous mixtures used for synthesizing a wide range of compounds,both organic and inorganic,especially ammonia (Fig. 1C, 2C, and Fig.4C).

Such mixtures results from reacting carbon rich substances with steam (steam reforming) or steam and oxygen (partial oxidation); they contain chiefly carbon monoxide and hydrogen, plus low percentages of carbon dioxide and usually less than 2.0% nitrogen. Therefore, most of the Nitrogen oxides will be utilized in the syngas conversion phase of petrochemical unit.

Sulfur dioxide will be monitored during stack emissions. Nitrogen oxides by the colorimetery procedure and stack emissions. Both sulfur dioxide and nitrogen oxides will have controls to meet the emission standards of Ghana EPA.

3.7 Noise

The present environment is an urban setting and noise level are normally below the 20-55dBa range. Construction activities at the site will create a greater noise level. The plant design for noise is using a criteria of not more than 55dBa.

Table 9.4 , Noise-Zone Classification shows the noise zone, noise exposure class, day-night average sound level, equivalent sound level, noise exposure forecast, and HUD noise standards. Anoe Village is approximately 300 m from the proposed construction site.

TABLE 9.4

NOISE-ZONE CLASSIFICATION

Noise zone	Noise exposure class	Noise descriptor: DNL[a] day-night average sound level	Noise descriptor: L_{eq} (hour)[c] equivalent sound level	Noise descriptor: NEF[d] noise exposure forecast	HUD noise standards
A	Minimal Exposure	Not Exceeding 55	Not Exceeding 55	Not Exceeding 20	"Acceptable"
B	Moderate Exposure	Above 55[b] But Not Exceeding 65	Above 55 But Not Exceeding 65	Above 25 But Not Exceeding 30	
C-1	Significant *Exposure*	Above 65 Not Exceeding 70	Above 65 Not Exceeding 70	Above 30 But Not Exceeding 35	"Normally *Unacceptable*"[e]
C-2		Above 70 But Not Exceeding 75	Above 70 But Not Exceeding 75	Above 35 But Not Exceeding 40	
D-1	Severe Exposure	Above 75 But Not Exceeding 80	Above 40 But Not Exceeding 80	Not Exceeding 45	"Unacceptable"
D-2		Above 80 But Not Exceeding *85*	Above 80 But Not Exceeding *85*	Above 45 But Not Exceeding *50*	
D-3		Above 85	Above 85	Above 50	

[a]CNEL—Community Noise Equivalent Level (California only) uses the same values.

[b]HUD, DOT and EPA recognize L_{dn} = 55 dB as a goal for outdoors in residential areas in protecting the public health and welfare with an adequate margin of safety.
However, it is not a *regulatory* goal. It is a level defined by a negotiated scientific consensus without concern for economic and technological feasibility or the needs and desires of any particular community.

[c]The Federal Highway Administration (FHWA) noise policy uses this descriptor as an alternative to L_{10} (noise level exceeded ten percent of the time) in connection with its policy for highway noise mitigation. The L_{eq} (design hour) is equivalent to DNL for planning purposes under the following conditions: (1) heavy trucks equal ten percent of total traffic flow in vehicles per 24 hours; (2) traffic between 10 p.m. *and 7 a.m. does not exceed fifteen percent of the average daily traffic flow in vehicles per 24 hours. Under these conditions* DNL *equals* L_{10} − 3 decibels.

[d]For use in airport environs only; is now being superceded by DNL.

[e]The HUD Noise Regulation allows a certain amount of flexibility for non-acoustic benefits in zone C-1. Attenuation requirements can be waived for projects meeting special requirements.

Source: Federal Interagency Committee on Urban Noise, 1980, p. 5.

Fig.4.11 Table 9.4, Noise-Zone Classification

TABLE 9.5

SUGGESTED LAND-USE-COMPATIBILITY GUIDELINES

Land use		Noise zones/DNL levels in L_{dn}						
SLUCM no.	Name	A 0–55	B 55–65	C-1 65–70	C-2 70–75	D-1 75–80	D-2 80–85	D-3 85+
10	**Residential**							
11	Household units							
11.11	Single units—detached	Y	Y*	25[a]	30[a]	N	N	N
11.12	Single units—semidetached	Y	Y*	25[a]	30[a]	N	N	N
11.13	Single units—attached row	Y	Y*	25[a]	30[a]	N	N	N
11.21	Two units—side-by-side	Y	Y*	25[a]	30[a]	N	N	N
11.22	Two units—one above the other	Y	Y*	25[a]	30[a]	N	N	N
11.31	Apartments—walk up	Y	Y*	25[a]	30[a]	N	N	N
11.32	Apartments—elevator	Y	Y*	25[a]	30[a]	N	N	N
12	Group quarters	Y	Y*	25[a]	30[a]	N	N	N
13	Residential hotels	Y	Y*	25[a]	30[a]	N	N	N
14	Mobile home parks or courts	Y	Y*	N	N	N	N	N
15	Transient lodgings	Y	Y*	25[a]	30[a]	35[a]	N	N
16	Other residential	Y	Y*	25[a]	30[a]	N	N	N
20	**Manufacturing**							
21	Food and kindred products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
22	Textile mill products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
23	Apparel and other finished products made from fabrics, leather, and similar materials—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y	N
24	Lumber and wood products (except furniture)—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
25	Furniture and fixtures—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
26	Paper and allied products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
27	Printing, publishing, and allied industries	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
28	Chemicals and allied products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
29	Petroleum refining and related industries	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
31	Rubber and misc. plastic products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
32	Stone, clay, and glass products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
33	Primary metal industries	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
34	Fabricated metal products—manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks—manufacturing	Y	Y	Y	25	30	N	N
39	Miscellaneous manufacturing	Y	Y	Y	Y[b]	Y[c]	Y[d]	N
40	**Transportation, communication, and utilities**							
41	Railroad, rapid rail transit and street railway transportation	Y	Y	Y	Y[b]	Y[c]	Y[d]	Y
42	Motor vehicle transportation	Y	Y	Y	Y[b]	Y[c]	Y[d]	Y
43	Aircraft transportation	Y	Y	Y	Y[b]	Y[c]	Y[d]	Y

Fig. 4.12 Table 9.5 Suggested Land Use-Compatibility Guidelines

TABLE 9.18

TRANSMISSION LOSS VALUES FOR COMMON BARRIER MATERIALS

Material	Thickness, (inches)	Transmission loss, dBA[a]
Woods		
Fir	1/2	17
	1	20
	2	24
Pine	1/2	16
	1	19
	2	23
Redwood	1/2	16
	1	19
	2	23
Cedar	1/2	15
	1	18
	2	22
Plywood	1/2	20
	1	23
Particle Board	1/2	20
Metals		
Aluminum	1/16	23
	1/8	25
	1/4	27
Steel	24 ga	18
	20 ga	22
	16 ga	15
Lead	1/16	28
Concrete, Masonry, etc.		
Light Concrete	4	38
	6	39

Fig. 4.9 Table 9.18, Transmission Loss Value For Common Barrier Materials

TABLE 9.18

TRANSMISSION LOSS VALUES FOR COMMON BARRIER MATERIALS ***(continued)***

Material	Thickness, (inches)	Transmission loss, dBA[a]
Dense Concrete	4	40
Concrete Block	4	32
	6	36
Cinder Block (Hollow Core)	6	28
Brick	4	33
Granite	4	40
Composites		
Aluminum Faced Plywood	3/4	21–23
Aluminum Faced Particle Board	3/4	21–23
Plastic Lamina on Plywood	3/4	21–23
Plastic Lamina on Particle Board	3/4	21–23
Miscellaneous		
Glass (Safety Glass)	1/8	22
	1/4	26
Plexiglass (Shatterproof)	—	22–25
Masonite	1/2	20
Fiberglass/Resin	1/8	20
Stucco on Metal Lath	1	32
Polyester with Aggregate Surface	3	20–30

[a]A weighted TL based on generalized truck spectrum.
Source: U.S. Department of Housing and Urban Development 1985, p. 27.

Fig.4.10 Table 9.18, Transmission Loss Value For Common Barrier Materials (Continued)

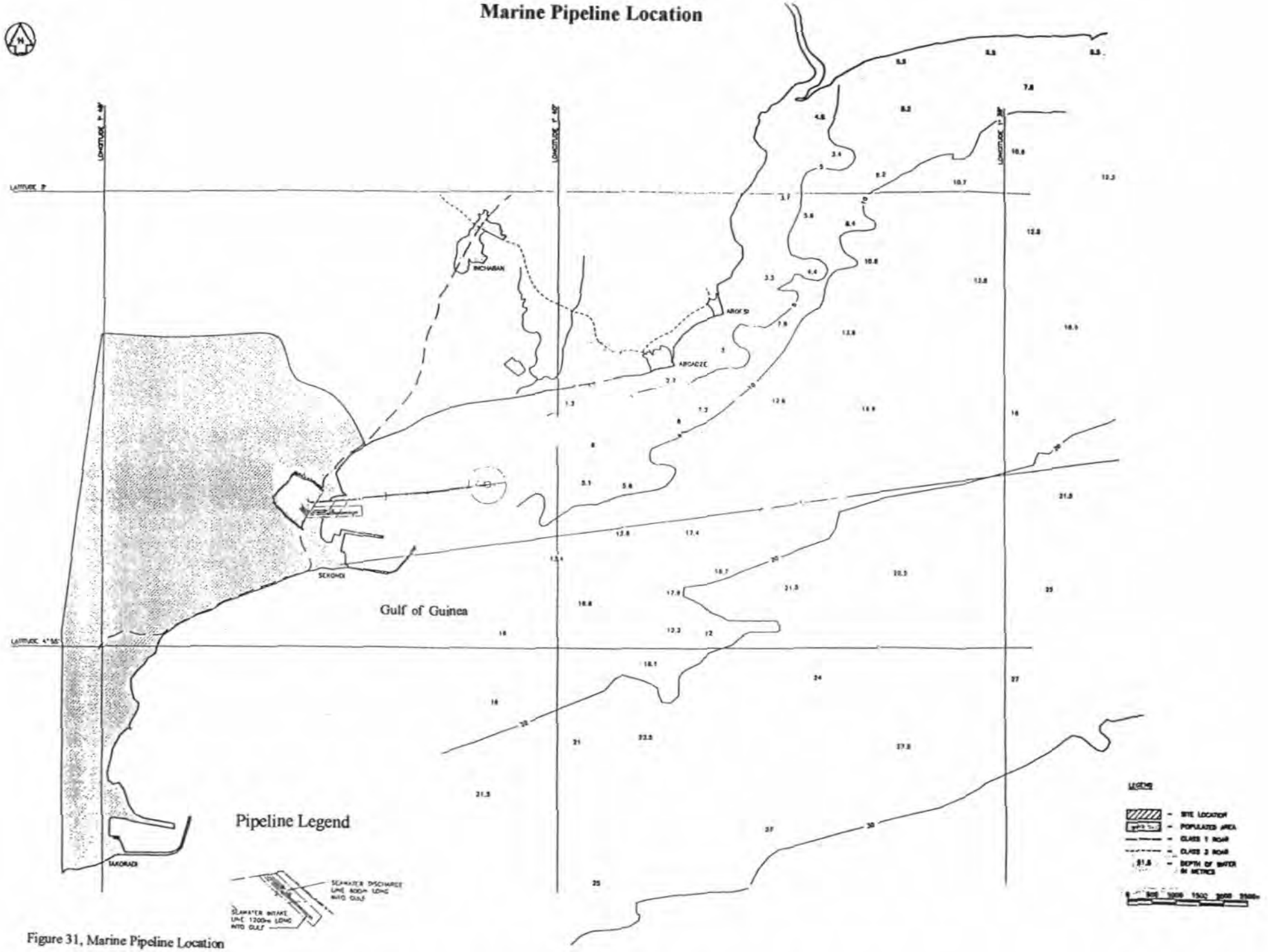


Figure 31, Marine Pipeline Location

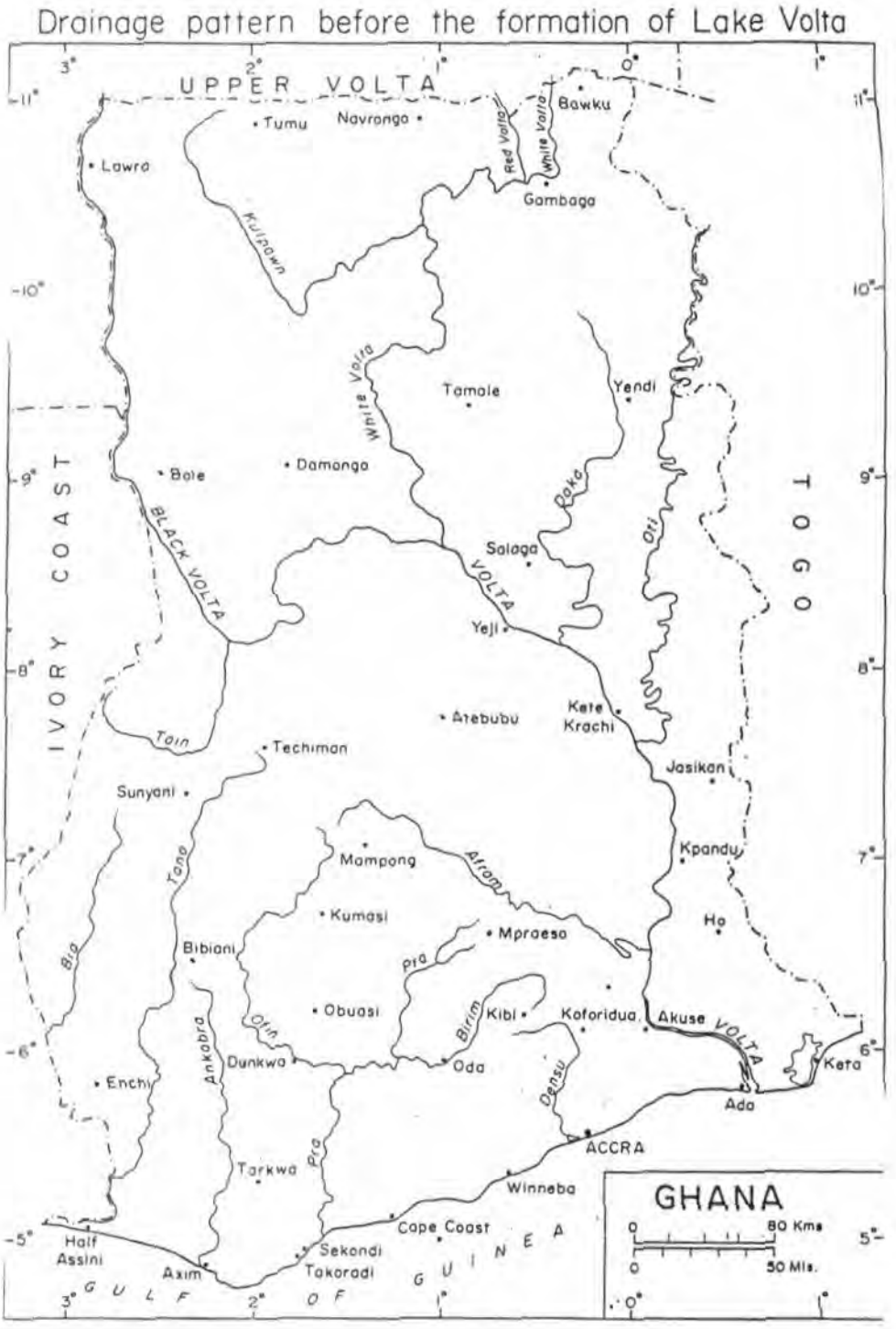


Fig. 5. Drainage Pattern Before the Formation of Lake Volta

Table 9.5, Suggested Land-Use Compatibility Guidelines, SLUCM 28 and 29 shows the acceptance level of noise for both chemical-manufacturing and refineries respectively. Table 9.6, OSHA Noise Exposure Limits For the Work Environment shows the noise levels and permissible exposure (hours and minutes) levels.

3.8 Ground and Surface Water

Both visual examination and photographs have not indicated the presence of surface water. There were no areas of discoloration or moisture indicating ground water present. Maps of the Sekondi, Ghana area does not indicate any known tributaries on the proposed site. Anoe Village has one main water line from the municipal system for drinking and cooking.

Rainfall can infiltrate the subsurface, be intercepted by foilage (initial abstraction), or result in runoff. The rainfall may subsequently "evaportranspirate" (evaporate naturally or through vegetative growth), enter the groundwater, and/or result in surface-water flow.

The runoff flows down gradient (usually from a higher to a lower elevation) into creeks, streams, lakes,and rivers,and eventually into the oceans (unless it evaporates, infiltrates the subsurface,or it is withdrawn along the way). The investigation on the land did not indicate the presence of either creeks, streams, or lakes by the University of Ghana on the proposed site for Ankobra Resources Ltd. project (Appendices II).

3.9 Coastal Environment

Ghana 's coastline is generally unindented, with no natural harbors. A heavy surf has created beaches that, especially in the east, form a barrier to the outflow of the rivers, resulting in brackish lagoons that communicate with the sea only at high tide. Coastal waters are those waters less than 5.5 m in depth and which have a salinity > 1500 mg/L.

The discharge and intake pipelines will go under the public road into the seabed, Gulf of Guinea. These pipelines will include waste water and dual pipelines for petroleum products/crude oil. Intake pipelines for fresh water for the Ankobra Resources Ltd. project from the Gulf of Guinea (Fig. 31,Marine Pipeline Location).

The seabed slopes gently to the edge of the continental shelf about 70 to 75 km from the southern boundaries of the Ankobra Resources Ltd. project. There is a sloping depth of 10m to approximately 45 to 48 feet in accordance with the Harbor engineer, Takoradi Port Authority.

The bottom substratum, inshore of the 10m contour, consists of fine sandy and clay rock with outcrops changing to mud and sand in deeper water. Currents are generally west to east, varying from 0.25 m/s to 1 m/s. There is likely a counter clockwise gyre to the east of the site in Shama Bay,affected by the discharge from the Pra River. The tidal range is between 1-2m and strong tidal currents are absent.

However,the shore is prone to constant swells generated in the open water of the Gulf of Guinea and beyond. Along the coast of Ghana, sea surface temperatures and salinities are characterized by seasonal major and minor upwelling periods. During the major upwelling, sea temperatures fall below 25 deg. C and salinity increases.

Peak of primary (phytoplankton) and secondary (zooplankton) production correspond to the major upwelling period. During the period most fish also spawn. The major pelagic stock offshore include Sardinella species (flat and round sardines) anchovy and tuna. A shrimp breeding/ nursery area has been identified directly offshore south of the proposed site (Fig. 32, Aquatic Spawning Area).

3.10 Lagoons and Estuaries

An estuary has been defined as the wide mouth of a river where the tide meets the current; a firth. A shallow body of water usually connected with the sea, a lake or a river has been defined as a lagoon. There are no estuaries or lagoons in the area of the intake pipelines for both fresh water nor petroleum products/ crude oil. Also, no estuaries or lagoons in the area of the discharge of wastewater or petroleum products.

3.10 Biological Environment

Ankobra Resources Ltd. project is a land base crude oil refining operation The land based biological environment is of great concern as related to the Biogeochemical cycles (nutrient cycles). These series of biochemical pathways by which the earth's inorganic elements (1) are made available for use by living organisms, (2) find their way into the food chain, and (3) are later broken down to begin the cycle again.

Primary producers- are organisms,mostly green plants, that draw on the sun's energy to make the fuel for others to use.

Consumers- are those beings who eat the food produced by plants, starting with plant-eating (herbivorous) organisms and extending into a chain of larger, animal-eating (carnivorous) organisms.

Decomposers-are microorganisms that break down the remains of dead plants and animals for eventual recycling within the biosphere.

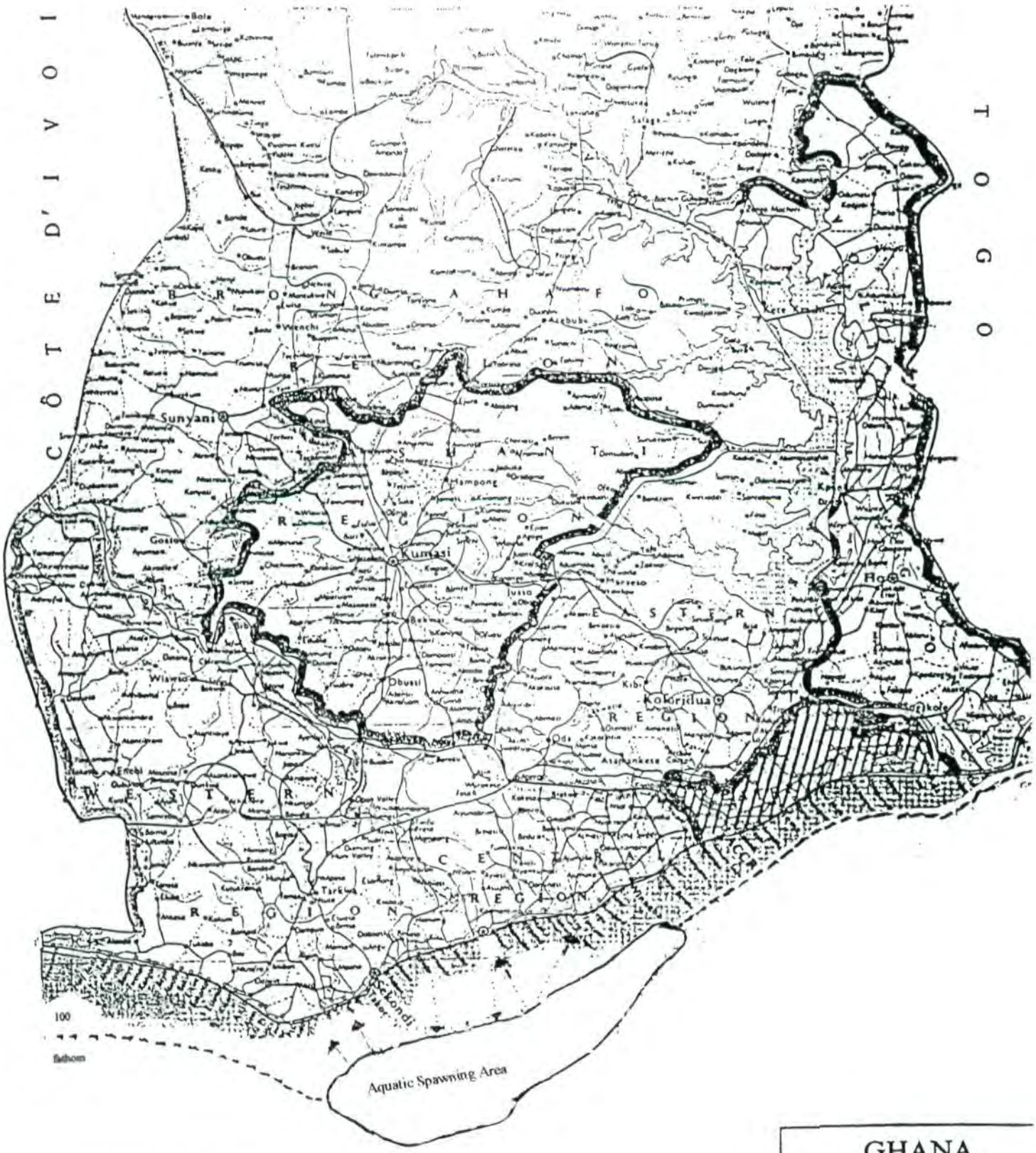


Figure 32, Aquatic Spawning Area

In Appendices II, the University of Ghana, Botany Department completed a Botany-Zoology Survey as a baseline condition for the land based operation. Table 1-Plant Species of Proposed Export Processing Zone-Sekondi shows the different types of trees, herbs, climbers, shrubs and grasses as possible "primary producers"(Appendices II).

Organisms such as snail, millipedes, grasshopper, ants, bees,dragonflies, frogs and toads, tortoises/turtles are considered as herbivorous. Pythons, Royal Pythons, Cobras, Mambus and Vipers,and Adders are considered carnivorous. Both the herbivorous and carnivorous organisms are considered as consumers.

Microorganism are ubiquitous and are found in the soil , plants and animals on the proposed site of Ankobra Resources Ltd.

3.12 Terrestrial Vegetation

In accordance with Appendices II, the terrestrial vegetation included herbs, trees, climbers, shrubs, and grasses. The medicinal uses were given as roots as sedative, seeds as anthelmintic, stypic, anti-rheumatic, anti-diabetic, lactogenic; diuretic and haemostatic after childbirth.

3.13 Wildlife

Both invertebrates and vertebrates were found on the proposed site for the petrochemical-refinery operation. Some of the invertebrates included snail, millipeds, butterflies, grasshoppers, ants, bees, and dragonflies. The vertebrates include frogs and toads, tortoises/turtles, lizards, skinks, lizards, monitor, chameleons, snakes(cobras, adders, and pythons) and birds(see Appendices II).

3.14 Regional Setting

The Sekondi Export Processing Zone on a regional basis is a part of the Sekondi-Takoradi,Ghana area. Mainly, both Sekondi and Takoradi are influenced by the Gulf of Guinea in terms of its economy and natural habitat. The regional economy is primarily based on the activity of the port and the auxillary industries needed to support an international port.

The fishing of aquatic organisms such as fish and shrimp are economical factors in the Sekondi-Takoradi area. Land based farming has been a significant factor in the regional economy in providing basic subsistence to the family unit.

3.15 Site Investigations

Since the petrochemical-refinery unit is land based, site investigations have been limited to the baseline survey of both flora and fauna. In the site investigations by the University of Ghana, it was noted that no creeks, wetlands, water, lakes, oceans and dams were present on the proposed site (Appendices II).

By the same site investigation it was noted that no inhabitants or dwellings were noted on the site. Natural growth of trees, shrubs, climbers, and grasses were present.

3.16 Littoral and Subtidal Benthic Community

Both the littoral and subtidal benthos communities are prioritized by their economic value to the community. Mainly, shrimp and sardinella species have been followed due to the concern of warm water discharge in possible spawning areas. Ankobra Resources Ltd. wastewater treatment plant will recycle from 70% to 90% of water and returned to the processing area as cooling waters. The residual 10% to 30% of wastewater can be incinerated on site by onsite incinerators.

All wastewater discharged in the Gulf of Guinea will be returned from the wastewater treatment plant, sampled, and allowed to further cool in the tank farm. Any discharged water into the Gulf of Guinea will be on the basis of an unusual rain for the storage capacity
and stormwater (ambient temperature) not needed for make up water in the system.
All stormwater sampled and analyzed before discharged into the Gulf of Guinea.

The following table summarizes the Florida criteria for coastal and open water conditions.

	Coastal Waters		**Open Waters**
	Summer	**Remainder of Year**	**All year**
Maximum allowable discharge temperature	33 deg C	32.2 deg. C	36.1 deg. C
Allowable increase above ambient temperature	1.1 deg. C	2.2 deg. C	9.4 deg. C

Our objective is zero discharge into the Gulf of Guinea from any water source originating on the site. The wastewater pipeline is a secondary system used in overcapacity of water.

Trace Metals

	Mercury	Lead	Cadmium	Zinc	Copper
Sea water (ng/L)	< 20	-	-	-	-
Sediment (mg/kg)	0.002	6.35	-	1-80	2-20
Algae (mg/kg)	0.02-20	1-2	< 0.1	2-5	1-2
Shrimp (mg/kg) (Penaous sp.)	< 0.02	0.9-2	< 0.1	5.6-6.3	2-6
Fish (mg/kg)	< 0.02	< 0.2-0.65	< 0.1-0.3	0.5-16	<0.2-5.6
WHO Concentrations for fish flesh Limit (mg/kg)	0.5				

3.17 Sociocultural Environment

The sociocultural environment in the Anoe Village displays the traditional lifestyle to include the extended family unit. Both the older and younger groups of the village are together while the middle aged adults are working in the fields or at the market. Traditionally, the village chief tends to govern the people of the village.

Anoe Village does not display any significant historical or archaeological resources. Many of the dwellings are made of cinder block and not of traditional building materials.

The majority of the individuals in Anoe Village are children. Most of the elder women are cooking while the small children are doing chores under the supervision of their elders. The young men of the village are in the area looking for work to maintain the family unit.

3.18 Population and Demographics

The Anoe Village number approximately three hundred eighty-seven people located 300m south of the proposed site. Approximately 80% of the population are children. Major disease is malaria, which account for 10% of the regional population's top ten diseases.

Top Ten Diseases in Shama East Metropolitan District (1992)

Disease	Cases	Percentage-Population
Malaria	35,616	10.0
Upper Respiratory Infection	7,652	2.3
Accident & Fractures	4,730	1.4
Disease of the Skin	4,031	1.2
Disease of the Oral Cavity	3,262	1.0
Diarrhoeal Disease	3,207	0.9
Ear Infection	2,986	0.9
Hypertension Heart Disease	2,048	0.6
Intestinal Worms	1,298	0.4
Total	71,580	21
Total District Population	340,000	

3.19 Ethnic Religions and Cultural Background

Using language as the criterion, as many as 50 separate ethnic groupings might be distinguished,but some of these are very small. The major distinction today is between the poorer and less developed peoples of the northern Ghana,speaking languages of the Gur subfamily of the Niger-Congo language family, and the people of the richer and more advanced south, who speaks languages of the Kwa subfamily.

To the south, the dominant culture is that of the Akan,who speaks a number of closely related dialects,of which the most important is Twi (language of Ashanti) and Fanti (Fante). The major religions in Ghana are (1) Animism, (2) Christanity, and (3) Islam. Christanity has shown a greater number in the Shama East Metropolitan District.

3.20 Historical Resources

Anoe Village did not display any historical resources for the immediate area. This area mainly exhibited a typical village that was land based. The Anoe Village did not cater to the tourist traffic nor carried on commerce of any historic resources in the area.

The urban area showed remnants of agriculture activities that are now idled. The railway presence simply laid grounds for future industrialization in the area.

3.21 Aesthetics and Tourism

Most petrochemical-refinery complexes are not known for their aesthetic qualities. All surrounding land mass area, specifically the 100 to 120 acres primarily will be landscaped.

Planting of trees and grasses are part of the aesthetic measures needed for a pleasing acceptance of the petrochemical-refinery complex. All buildings will remain at the two story level, building materials to blend in with other modern buildings of the Sekondi-Takoradi area. The main petrochemical-refinery complex, processing area will have a standard wall to reduce the sight of the piping and processing units from the general public.

Ankobra Resources Ltd. petrochemical-refinery complex will not be a tourist attraction in the Sekondi-Takorai area. The complex will have approximately 350 to 400 workers on site performing task that will require their full attention to a specific job.

3.22 Infrastructure

The proposed site for the Ankobra Resources Ltd. project does not have the infrastructure to support a petrochemical-refinery complex. There is a major power line, part of the national grid transversing the proposed site.

Approximately 500 acres have been designated without (1) natural gas pipeline system, (2) water pipeline system, (3) electrical power generating capacity, and (4) waste water treatment or sewage system. Anoe Village, located 300m south of the proposed site does not have (1) electricity, (2) gas pipeline, and (3) sewage system available for its 387 inhabitants.

3.23 Education

Presently, Anoe Village has 387 inhabitants,approximately 80% of the population are children of school age. Anoe Village has one school at the elementary level for school age population.

Fig. 16. Volta Lake and Transmission Lines

Ankobra Resources Ltd. will build these schools,elementary, middle school, and high school for both expatriate and indigenous school age children.Presently, Anoe Village has an elementary school for the local school age children.

3.24 Land Tenue and Land Ownership

Approximately 500 acres have been designated to Ankobra Resources Ltd. by the Ghana Free Zones Board for a 140,000 bbls. per day petrochemical-refinery complex to be located in the Sekondi Export Processing Zone. The previous stool land has set aside as a government "Free Zone" and administered by the Ghana Free Zone Board. Institutions

An annual leasing fee is payable to the Ghana Free Zones Board in accordance with L.I.1618. Ankobra Resources Ltd. is obligated to pay a one time compensation for crops to the farmers. The one time compensation fee for crop renumeration has been estimated by the Land Evaluation Board, a fraction over $ 1,000,000USD.

3.25 Land Use

The previous land use for the designated 500 acres of land was basically agriculture. Mainly, citrus type fruits and some sugar cane has been noted by the University of Ghana site investigation.

The five hundred (500) acres of land have been set aside as a Free Zone by the Republic of Ghana for industrial usage. Initial investigation has indicated that the proposed site has the basic criteria for the construction /operating phase of the petrochemical-refinery complex. List of basic criteria for Ankobra Resources Ltd. to build a petrochemicl-refinery complex.

1. Land mass,consist of various clays,generally level,and without human dwellings or other buildings on site. Surface clay will not be a problem,foundation will be at the 40 to 50 feet level. The area geologically, has volcanic rock as base rock.

2. The Gulf of Guinea, less than twenty (20) miles by pipeline measurements to the proposed site. Pipeline will take the path of public roads, at 3 m in depth, and not on private property leading to to the Gulf of Guinea.

3. Acreage that has not been contaminated by previous industrial usage.

4. No previous infrastructure,electricity, natural gas, water, and sewage system.

5. Surrounding areas in the Western Region, ample labor pool for employment.

TABLE 9.15

LAND-USE CLASSIFICATION

Land-use classification	Noise sensitivity	Max L_{dn} level, dBA	Land use
1	High	65	Residences, hospitals, schools, parks, retail stores, professional offices, scientific research facilities
2	Moderate	75	Most industrial facilities, parking lots, wholesale trade building-materials retail, and construction services, golf courses, water-based activities, livestock
3	Low	85+	Agriculture, utilities, rail transit, highways

Source: Compiled using data from U.S. Department of the Army, 1990.

TABLE 9.16

NOISE-CONTOUR AREA VS. LAND-USE DETAIL

Degree of detail	Area of contours	Size of grid	Source
High	9.3 km^2	60 m × 60 m	Industrial, roads
Moderate	12.8 km^2	250 m × 250 m	Pistol range, highway construction
Least	>12.8 km^2	500 m × 500 m	Aircraft, blast

Source: Golf and Novak, 1977, p. 33.

Fig. 4.13 Table 9.15, Land-Use Classification
Table 9.16, Noise-Contour-Area vs Land-Use Detail

3.26 Fisheries

The designated area of Five hundred acres, Sekondi Export Processing Zone, did not exhibit commercial fishing by the inhabitants of Anoe Village. There were no estuaries nor lagoons on the beach south of the Sekondi Export Processing Zone. Ankobra Resources Ltd, is a land based petrochemical-refinery complex. Anoe Village is not a fishing village to our present knowledge.

3.27 Industry

Ankobra Resources Ltd. proposed site does not include any industries within the Sekondi Export Processing Zone. All acreage is open, exhibiting tropical grasses,trees,shrubs,and climbers. There are no cinder block manufacturing or other commercial activities on the proposed site. Anoe Village does not indicate any industries,which is 300m south of the proposed site in the Sekondi Export Processing Zone.

3.28 Agriculture

Agricultural activities on the proposed site have been noted in previous years by local people and mainly people of Anoe Village. Basically, citrus fruits and some sugar cane plants were noted by the University of Ghana site investigations.

The adult males of Anoe Village are farmers according to the conversation held during site visits at the village. Currently, the farmers are not working the land and the land is idle from any agricultural activities.

3.29 Sandcrete Block Manufacturing

As previously stated, the entire five hundred (500) acres are idle from any activity,either industrial, services or manufacturing. The manufacturing of sandcrete blocks were not noted either on the proposed site nor Anoe Village.

3.30 Public Health

Public Health concerns are the major diseases within the Shama Ahanta East Metropolitan District. Malaria has the largest number of cases in the region of a population of 340,000 people. It has a debilitating effect on any victim and in an industrial society very costly for any employer.

The second most ailment is upper respiratory infections in the Shama Ahanta East Metropolitan District. Heavy foilage surrounds the Anoe Village, pollen,spores from fungi may be the causative agent for many respiratory infections.

The third ailment is accident and fractures are equally important to the employers of Shama Ahanta East Metropolitan District. Training programs are mandatory at the Ankobra Resources Ltd. petrochemical-refinery complex to prevent accidents and fractures.

Efforts will be made to determine the breeding areas,especially in the 100 to 120 acres for the malaria causative agents. Eradication of the malaria causative agents will be a priority in relations to Public Health affairs. Demarcation of the surface will eliminate the presence of fungi spores within the 100 to 120 acrea area for processing equipment and buildings.

3.31 Coastal Pollution

In 1990, an Environmental Action Plan (EPC,1990a) was drafted in Ghana,which included a coastal zone management plan. The fragile marine and coastal ecosystem are identified as sensitive areas that are subject to coastal erosion and the effects of marine-based pollution, as well as the effects of land-based activities.

The coastal zone also contains important resources for tourism and mineral development. Ghana has some proposed limits for fresh water quality,but no established water quality criteria for marine situations. The Environmental Protection Council (1993), they have proposed that discharges of warm water into the sea not exceeding 33 deg. C, with a temperature rise of not more than 5 deg. C at the beach or landfall. Discharges must be controlled to not cause adverse effects to the coastal waters.

Oil spills are the major concern for coastal pollution as a petrochemical-refinery complex. Also, of equal concern is the discharge of waste water from the petrochemical-refinery complex into the coastal waters.

Personnel will be trained to handle oil spills occurring in the Gulf of Guinea. Training will include personnel receiving on site training from sources,such as Corpus Christi University or an European source of recognition in the field of marine oil spills.

Ankobra Resources Ltd. will own a marine vessel, equipped with tools, supplies, and equipment to remove oil spills on an emergency basis. Also, the marine vessel will be in the area of the single-point mooring system (SPM) during the loading and exporting of petroleum products from the petrochemical complex. Storage of the waste water before being discharged into the Gulf of Guinea greatly reduces the temperature.

3.32 Waste of Human Origin

The waste of human origin will include motor oils, greases, plastics, metal cans,and other biodegradeable materials. Chemical degradation maybe enhanced especially motor oils, which the pH will change and production of acids,similar to combustion engines.

Biodegradeable materials or chemicals,i.e. soaps,bleaches, fabric softners,and detergents are possibly water soluble. The spawning areas of the Gulf of Guinea are sensitive to these types of chemicals and mainly will be toxic to both fish and shrimp.

3.33 Waste of Industrial Origin

Sekondi Export Processing Zone does not have any industries presently in the 12,000 acre enclave. Waste of industrial origin from the proposed petrochemical-refinery complex will be discharged as waste water. Table 7.3.3. Raw Wastewater loadings in Net Kilogram/ 1000 M(3) of Feedstock Throughout by Subcategory in Petroleum Refining, indicate the Topping Subcategory, Cracking Subcategory, and Petrochemical Subcategory as related to the Ankobra Resources Ltd. project.

Characteristics such as (1) flow, (2) BOD, (3) COD, (4) TOC, (5) TSS, (6) Sulfides, (7) Oil and grease, (8) phenols, (9) ammonia,and (10) chromium are noted before waste water is discharged into the Gulf of Guinea. Each subcategory shows a range and median as raw waste water loading before going to the waste water treatment facility.

3.34 Oil

"Coastal Zone Indicative Management Plan" (Agyepong et al, 1990), that was prepared for the Action Plan identifies the major issues in the coastal areas of Ghana. It identifies the unique ecological areas requiring protection and suggest areas that have the potential to support future urban, industrial,and/or tourism development. The Action Plan was funded by the World Bank,and has been approved by the Ghana Environmental Protection Agency.

Oil spills at the point of the single-point mooring system (SPM) are of great importance and concern to both the Ghana Environmental Protection Agency and Ankobra Resources Ltd. The SPM is to be fitted with double-walled hose, that contains an alarm system between the two walls, to minimize the chances of total hose failure.

Financial assistance as needed and participation as requested by the Ghana National Oil Spill Contingency Plan Organization. Ankobra Resources Ltd will own an oil response vessel which will be fitted with oil recovery and clean up equipment. Attendance at the single-point mooring system (SPM) during offloading /disconnect flange procedure is mandatory.

3.35 Farm Land Loss

Presently, the proposed site for the petrochemical-refinery complex does not have any residences, no squatters on the proposed plant site. Ankobra Resources Ltd. will

Notes

voluntarily assist residence of Anoe Village in Joint Venture Partnership in raising poultry as (1) egg layers and (2) boilers. An estimated figure of $1,000,000 USD and fraction of will be paid to the Land Evaluation Board for compensation as crop renumeration to the farmers.

4. Significant Environmental Impacts and Proposed Mitigation

4.1 Present Environment

Factor	Direct	Indirect	None
soil		x	
water		x	
waste water		x	
air	x		
noise	x*		
groundwater			x

* only during construction and above ambient noise conditions

Negative and Positive Effects

Impacts	Environmental	Social	Economic	Cultural
Air (monitored)	x			
Water (desalination)	x			
Sewage	x	x		
Groundwater (Management)	x			
Landscape/Erosion	x		x	
Indigenous Employment			x	
Basic Utilities		x	x	
Power Generation		x	x	
Refined Products		x	x	
Re-imbursement/Crops		x	x	
Training Indigenous		x	x	
Auxillary Industries		x	x	
Civic Center				x
Housing/Indgenous		x		x
Medical/Dental Center		x		x
Dual pipeline			x	
Docking Facility			x	
Railway Facility			x	

Direct and Indirect Impacts of the Undertaking

Factors	Direct	Indirect	Cumulative	Short / Long	Permanent	Temporary
Air	x				x	
Water		x			x	
Land	x				x	
Flora	x				x	
Fauna	x				x	
Communities	x				x	
Noise	x					x
Vibrations	x					x
Odour		x		x		x
Health		x	x			
Traffic		x		x		
Social		x			x	

4.2 Pre Construction Environment

Both positive and negative impacts will be present during all phases of the project. The following impacts have been considered for the Pre Construction phase; soil sampling, water sampling, air sampling, groundwater identification,and population (village).

	Pre Construction			
Impact	Air	Water	Soil	Groundwater
Soil sampling			x	
Water sampling		x		
Air sampling	x			
Groundwater (Management)*				x
Population(Village)	N/A	N/A	N/A	N/A

* only if groundwater is present,after Landsat studies.

There should be no significant impacts during the pre-construction phase of the project. Mainly, environmental studies will be done for a duration of twelve (12) months before the actual construction phase.

The use of Landsat pictures on the surface, and 3-D digital data for the sub-surface of the morphology and showing the presence of underground water. Groundwater present can be detected in the pre-construction phase of this project.

4.3 Construction Environment

Construction

Impact	Air	Water	Soil	Groundwater
Removal of Debris	x		x	
Layout of Foundation	x		x	
Pouring of Concrete	x		x	
Digging of Pipeline	x		x	
Building of Offices Warehouses,Terminals Laboratories,admin. bldg., & Tank farm	x		x	
Placing Processing Equipment:	x*			
Distillation Tower				
Catalytic Reforming				
Alkylation				
Visbreaking				
Fluid Catalytic Cracking				
Hydrodesulfurization				
Unibon				
Partial Oxidation (Methanol)				
Population(village)	x**			

* only when open air welding of pipes,all units are pre-fabricated outside of Ghana

** the nearest villlage is three hundred (300) meters south of the proposed site

During the construction phase of the project, the major concern will be the dust and noise being generated as related to the nearby village. The prevailing wind will be a major factor with both the dust and noise.

Monitoring of both the air and dust during the construction period on a daily basis is a part of the environmental study. Also, noise will be monitored in the immediate construction area to include Anoe Village, approximately 300 meters. Air samples will be taken during the construction phase of the petrochemical- refinery complex project.

Heavy construction equipment will move soil as planned by the contractors. All soil moving will be related to the laying of the Portland Cement foundation and actual placement of modular processing equipment.

Previous site investigations by the University of Ghana did not indicate a presence of surface water. The terrestrial environment will be disturbed by the demarcation process of the land.

During the construction phase, the marine habitat will be disturbed only at the time of placing piles in the Gulf of Guinea for the single-point mooring system(SPM). Proper construction techniques will be used to minimize the disturbance of aquatic life in the Gulf of Guinea.

The sociocultural environment,mainly disturbed by noise generated by heavy construction equipment. Dust clouds should not be able to reach the 300m distance to Anoe Village, unless the prevailing winds are very active at that time.

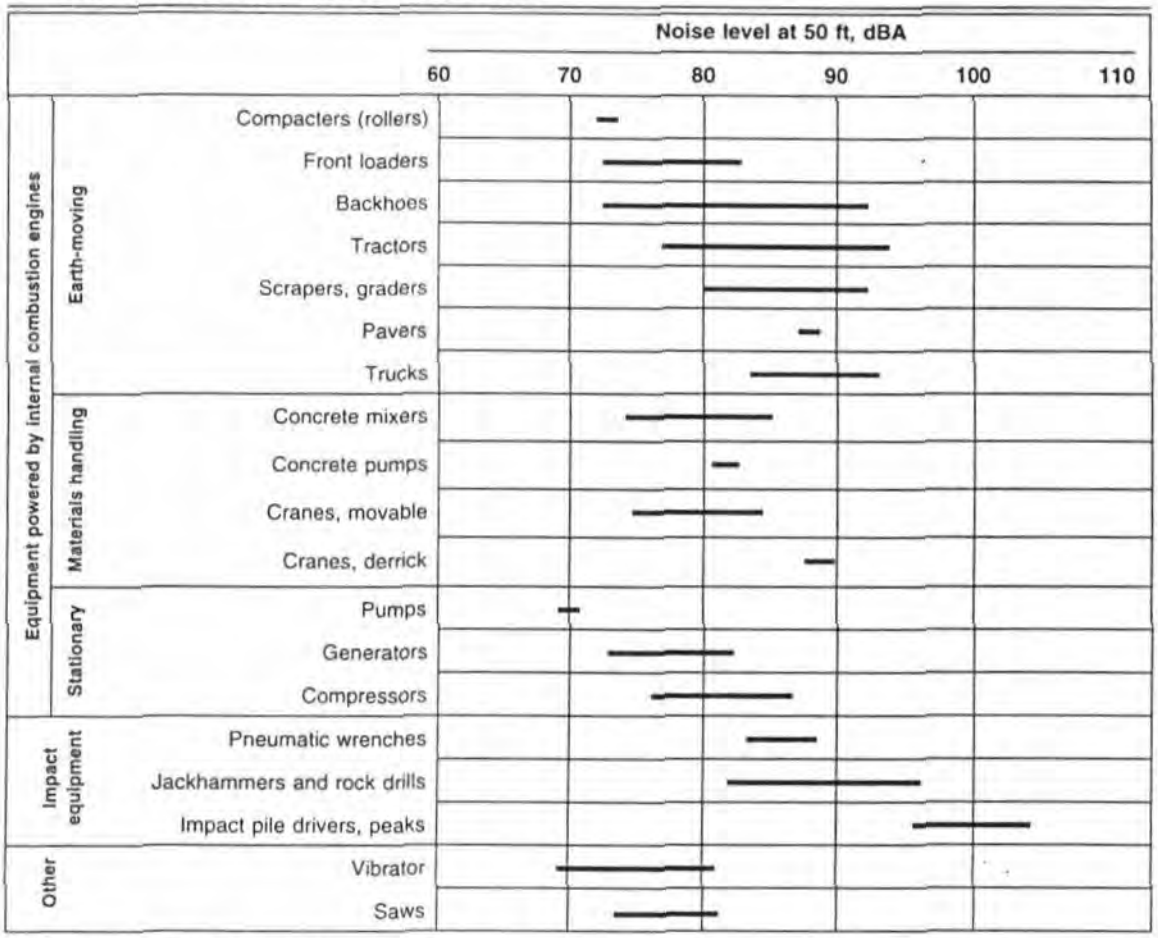
4.4 Predicted Effects and Proposed Mitigation During Construction

Proposed Mitigation

Environmental Factor	Predicted Effects	Mitigation
Atmospheric Environment	increased air pollution due to dust and some debris	take air samples,lightly moisten soil to reduce dust from entering the atmosphere and reduce the speed of the construction equipment,if it is a factor
Groundwater / Surface Water	no indication of groundwater or surface water at this time	
Terrestrial Environment	removal of trees,shrubs,climbers, and grasses in the immediate processing area	areas of removal of foilage designated for processing and building,mass destruction of foilage is not permitted
Marine Habitat	disturbance of small areas of the Benthos while driving piles for the single-point mooring system(SPM)	use proper engineering and construction techniques to minimize disturbance of the Benthos
Socioculture Environment	elevation of noise level due to heavy construction equipment	purchase all heavy equipment at the 20dBa - 55dBa range.
	Possible dust clouds at the 300 m south range	Take air samples in the immediate processing area and Anoe Village on a scheduled basis.Moisten the roads lightly to reduce dust clouds and reduce speed of heavy construction equip.

TABLE 9.9

CONSTRUCTION-EQUIPMENT NOISE RANGES



Note: Based on limited available data samples.
Source: U.S. Environmental Protection Agency, 1972, p. 2-108.

Fig. 4.8 Table 9.9, Construction-Equipment Noise Ranges

Construction Debris	cardboard boxes,and some wooden strappings are generated at the construction phase.	burn all construction debris in onsite incineration unit
Storage of Fuel	spills at the pump station loading unleaded gasoline or diesel onto soil	all pumping stations will be bermed and contaminated soil remediated and burned on site
Pipeline	excessive noise and possible dust to nearby area	use heavy equipment to not exceed 85dBA /wetdown soil.

4.5 Operational Phase

The operational phase of the petrochemical-refinery project will be monitored on a daily basis. Impacts to the air and water will be limited especially non recyclable water will be incinerated. The population or village will be impacted due to the prevailing winds that will carry gases for air emissions.

Operations

Impact Units	Air	Water	Soil	Groundwater
1. Distillation	x	x		
2. Catalytic Reforming	x	x		
3. Alkylation Unit	x	x		
4. Visbreaking	x	x		
5. Fluid Catalytic Cracking	x	x		
6. Hydrodesulfurization	x	x		
7. Unibon	x	x		
8. Partial Oxidation/Methanol	x	x		
9. Population (village)	x	x		

The above processing units (crude oil) impact the air quality,only when off-gases are present as air emissions. Opsis monitoring equipment will be used to monitor both NOx and SOx, CO, and particulate emissions by the processing units(crude oil).

All processing units(crude oil) will not generate waste water. The waste water treatment plant will recycle 70% to 90% of the waste water. Our tank farm will have storage capacity between 400,000 gallons to 500,000 gallons of recycled waste water.

All stormwater will be sampled, analyzed, recycled for make up water on an as needed basis. A 500,000 gallon storage tank will be available for stormwater collected on the proposed site.

The plant will use a 25,000 gallon per day portable water treating system for drinking water. Personnel using on site showers will be considered a part of the sanitary water demand at that time.

4.6 Predicted Effects and Proposed Mitigation During Operations

Proposed Mitigation

Environmental Factor	Predicated Effects	Mitigation
Sociocultural Environment	increased NOx and SOx gases may affect the foilage, i.e trees,shrubs,climbers,and grasses in Anoc Village. Population health as related to increased NOx and SOx gases	Anoe Village will have Opsis monitoring equipment at its boundary for NOx and SOx gas emissions. Re-calibrate equipment or modify process to reduce gas emissions.
Operational Debris	cardboard boxes and some wooden strappings are generated during the operational phase	burn all operational debris in onsite incineration unit
Storage of Fuel	spills at pump station during the loading of unleaded gasoline and diesel onto soil	all pumping stations will be bermed and contaminated soil remediated and burned on site
Oil Spills-Plant	loading of crude oil into the atmospheric tower due to flange problems or operator	use small vacuum trucks to pick up the crude oil and contaminated soil to burn. Also, clean Portland cement area,contaminated water or surfactant burned
Oil Spills-Marine(SPM)	loading of crude oil to plant side flange and disconnect of flange from plant side	use marine vessel with clean up capacity of crude on water or petroleum product
Seismic Hazards	potential of seismic activity to disturb benthos activity and the piles for the single-point mooring system(SPM)	seismic activity will be monitored on a regular basis to determine the effects to the Benthos community and single-point mooring system (SPM).
Pipeline Location	contamination of the aquatic spawning areas	SPM located 0.5 to 1.0 miles down current of the known current of spawning areas

4.7 Post Operation Phase

Removal of processing equipment and pipelines will greatly reduce the emission of organics (i.e. VOC's) from the petrochemical refinery complex site.Removal of the site's incinerator unit(s) will be last to further destroy any gases or chemicals that have the ability to concentrate the site or may cause medical problems to the surrounding population.

Summary Predicted and Proposed Mitigations

Environmental Factors	Predicted	Proposed Mitigations
Demarcation of topsoil Clearing and grading Zones	excessive noise roads within the Free Zone excessive dust loss of topsoil loss of trees interference with the natural drainage of the site.increase erosion. loss of farm plots	Compensation of farmer's crops use machinery that not exceed the 85dBA.Landscape area to accept building of Portland cement type foundations and reduce erosion.
Delivery of Materials	traffic congestion at the Takoradi Port.	private docking facilities to be built as soon as possible. Use of off hours to avoid main morning or afternoon traffic.
Construction Work Force	local vs non-local personnel competing for construction jobs.	Independent contractor will provide safety and health courses to local workers in the Sekondi-Takoradi area for general construction work.
Batch Plant Concrete and Asphalt	contamination to the soil within the Free Zone	both concrete and asphalt sites are graded and crushed rock or gravel used. All loading trucks will load with catch basins (metal grates) with a concrete foundation and removal of contaminant is easy .
Land Disposal of Excavated Materials	depreciation of the aesthetic beauty of Free Zone	Landscaping of soil and rocks to build areas on site and assist in reduction of erosion
Construction Debris	potential fire hazard to the Free Zone	All construction debris placed in metal containers either for approved landfill site or on-site incineration
Liquid Waste	potential fire hazard to the Free Zone	All liquid waste is drummed and properly labeled for on-site incineration.

TABLE 9.8

TYPICAL RANGES OF ENERGY-EQUIVALENT NOISE LEVELS (IN dBA) AT CONSTRUCTION SITES

	Domestic housing		Office building, hotel, hospital, school, public works		Industrial parking garage, religious amusement and recreations, store, service station		Public works roads and highways, sewers, and trenches	
Phase	I[a]	II[b]	I	II	I	II	I	II
Ground clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

[a] I, all pertinent equipment present at site.
[b] II, minimum required equipment present at site.
Source: U.S. Environmental Protection Agency, 1972, p. 2-104.

Fig.4.7 Table 9.8, Typical Ranges of Energy-Equivalent Noise Levels (in dBA) At Construction Sites

TABLE 9.6

OSHA NOISE EXPOSURE LIMITS FOR THE WORK ENVIRONMENT
(Noise exposures in dBA)

Noise	Permissible exposure (hours and minutes)
85	16 hrs
87	12 hrs 6 min
90	8 hrs
93	5 hrs 18 min
96	3 hrs 30 min
99	2 hrs 18 min
102	1 hr 30 min
105	1 hr
108	40 min
111	26 min
114	17 min
115	15 min
118	10 min
121	6.6 min
124	4 min
127	3 min
130	1 min

Note: Exposures above or below the 90 dB limit have been "time weighted" to give what OSHA believes are equivalent risks to a 90 dB eight-hour exposure.
Source: Marsh, 1991, p. 322.

Fig. 4.6 Table 9.6, OSHA Noise Exposure Limits for the Work Environment

	cont. acquifer or groundwater	
Handling & Storage of Fuels & Hazardous Materials	potential fire hazard to the Free Zone Groundwater or acquifer contamination	Fuels are stored in metal tanks above ground in a bermed area. The bermed area is designed to hold up to 10% of the total capacity of the tankage. Hazardous waste is either drummmed or separate tanks for bulk hazardous waste. International labelling,bermed is isolated within 100 to 200 feet of any combustible or flammable types of material or flares Bermed area designed to hold 10% capacity of waste liquid. Fire procedures noted in case of an emergency. Only personnel trained in hazardous waste disposal will work the area.
Waste Disposal-Solid Waste	potential acquifer groundwater contaminant or fire hazard	Use the same procedures for containment and storage for hazardous waste.
Atmospheric Environment	increase of SOx,NOx, particulates to the Anoe Village people	Use of pollution control equipment,i.e. the Calvert Scrubber in the incineration unit, electropercipitator in the refinery unit, and scrubber system in the power generating plant.
Groundwater/Surface Water	potentially a health hazard to the employees and Anoe Village	Removal of groundwater areas or divert to stormwater basins to treat in waste water treatment facility and the same with surface water areas.
Terrestrial Environment	potentially a health hazard to the employees and Anoe Village on the causative agent of Malaria	mapping of potential breeding areas of the causative agent for Malaria. The eradication of causative agent of Malaria. Permanent field station for containment and eradication of the causative agent of malaria.
Sociocultural Environment	change from the village life to an industrial community	industrial employment and educational facilities to assist the Anoe Village to make the transistion from a village existence to an industrial community.
Pipeline System	excessive dust excessive noise potential leaks	Wet down of soil for excessive dust. Use heavy equipment that rate about 85dBA and use of off hours to avoid

	and contamination of soil and seabed	disturbing the community by not doing any night construction activities Use of electronic equipment to monitor the entire pipeline system for leaks.
Site Drainage	potentially a health hazard to the employees and Anoe Village. Enhance the condition of erosion on-site.	The site is designed to contain all rain water in stormwater sewers. Landscaped areas to avoid natural run-offs or drainage from the sites. Planting of trees and shrubs decreases the erosion process. All areas in the processing zone, tank farm, pipeline connections,wastewater treatment facility, biosludge areas are bermed.
Fresh Water Supply	contamination of the local acquifer and divert local water from crops in the area	no water wells will be drilled on the proposed site of the petrochemical -refinery site. A desalination unit is used for supply of all waters to the petrochemical-refinery complex.
Sewage Treatment	biosolids are a health hazard to the employees and Anoe Village ,when the basin method is used	biosolids will be treated in a closed system with microorganisms and other mechanical devices to remove the biosolids at the proper process interval and treated.
Oil Spill-Plant	potentially a fire hazard Groundwater/acquifer contamination risk.	All essential operating areas with crude or petroleum product are bermed for containment. Removal of oil spills in either drummed containers or small vacuum trucks. Incineration of waste on-site.
Oil Spill-Marine	potentially damaging to the acqautic areas of spawning.	Use of marine vessel to remove the oil sheen on an immediate basis. The use of absorbents and pumping gear if needed. Marine vessel in area of the SPM when unloading of petroleum products or crude oil.
Seismic Hazards	potentially damaging to the constructed pipelines and spill of crude oil or petroleum products into the Gulf of Guinea	Design of the each pipeline system to avoid much of the seismic activity in the Gulf of Guinea and avoid the acoustical shock in the area. All pipeline structures are designed with some elasticity of movement within a given tolerance.
Marine Habitat	potentially destroy the sensitive spawning area for both fish and shrimp in the Gulf of Guinea	Knowledge of acquatic spawning area used in the construction of the SPM to be located downcurrent of the area. Both intake and discharge pipelines

		constructed to avoid direct contact with the known acquatic spawning area.
Seawater System Intake	potentially damaging to acquatic life, i.e. plankt-ons ,which supports such life (fish/shrimp)	the Seawater System Intake is designed to exceed the known area of the acquatic grounds within the Gulf of Guinea. A micromesh filter is fitted to reduce the entrapment of any acquatic life,i.e. planktons.
Seawater System Discharge	potentially damaging to acquatic life,i.e. plank-ons,which supports such life (fish/shrimp)	the petrochemical-refinery complex has heat exchangers in specific units and uses "counterflow" technique to exchange heat through a "metal" medium. All wastewaters from the petrochemical -refinery process is subjected to wastewater treatment before used as make up or cooling waters in the system. Any waters discharged into the Gulf of Guinea is from "storage tanks" and no waters discharge above 33 deg C at the beach or landfall.
Burning Fuel	air emissions from the burning of fuel is a health hazard to the employees and Anoe Village	the power generating plant will burn No.2 fuel to generate electricity. Scrubbers are used to reduce the emissions of SOx,NOx, particulates in the air. Power units designed to emit steam.
Local Community & Services	reduce the local area food supply, housing facilities,medical/dental facilities,transportation fuels, and basic utilities	the petrochemical-refinery site will import a major portion of food items. Temporary housing for 100 to 120 workers on-site. Temporary medical/dental centers with two surgical suites for emergencies. On-site transportation fuels purchased directly from a refinery source. All basic utilities are furnished with the temporary office space, housing,kitchen(s),and meeting areas.
Aesthetics	damaging of the natural surroundings,i.e trees, shrubs, and grasses. Natural terrain becomes unattractive to the eye.	all natural surroundings are carefully spared without damaging many trees, shrubs, or grasses. Areas are planned and landscaping techniques applied to remain pleasing to the eye.

The desalination unit will be used by the local government,if operational and cost effective to continue to operate. The pipeline connections to the site will be decommissioned.

All land will undergo soil analysis for both chemical and biological pollutants during the decommission phase of the project. Removal of all processing equipment and recycling of other units or metals to be smelted. Landscaping of surface to point of the original background is the objective during the decommission phase.

In the decommission phase,monitoring units will remain in place and functioning. Botany and Zoology specimens examined and classified,and followed up in a six month period of time. The general communities topography examined and activities needed to return to original conditions.

The decommission phase will bring about a blending of the primary petrochemical-refinery zone and the habitat, almost to its natural setting. Planting of natural grasses and trees to include landscaping to serve as natural barriers if needed.

During the decommission phase, a study will be made to determine the baseline condition. Compare the present baseline conditions to the original condition of the flora to determine the general health, growth rate, and quantity of each species to maintain a healthy environment.

Also, during the decommission phase, the outer boundary fence line will not be removed immediately until the final environmental study has been completed and report submitted to the proper governmental authorities. The controlled area in terms of the ongoing environmental monitoring and the active primary petrochemical-refinery zone, should be delineated for at least a six month period of time.

4.8 Post-Decommission Plan

The local communities will benefit from the desalination unit. Pipelines connecting to public water systems providing fresh water on a daily basis.

During the post decommission phase, air models for air dispersion performed to insure that ambient air levels of air do exist for the communities. The area close to its natural setting for its habitat, should bring back the normal functions of breeding, seeking shelter,and hunting for food by mammals.

Monitoring during the post-decommission phase is essential for its natural growth. The area should display many of the natural features to include full growth of the indigenous flora.

The post decommission period, should be used to monitor the area in terms of growth as related to the flora and fauna present in the 500 acres of land. A time frame to declare the whole area closed to the original background in terms of flora and fauna should be made.

5. Analysis of Alternative

5.1 Initial Analysis

As previously stated, the proposed five hundred (500) acre site located in the Sekondi Export Processing Zone has met the basic criteria to construct and operate the petrochemical-refinery complex. An analysis of alternatives would involve, (1) changing of the petrochemical-refinery configuration, (2) area of petroleum products and crude oil, (3) storage site changed, and (4) all buildings and ancillary structures changed to mitigate negative impacts related to air ,water, land, and the population(Anoe Village), (5) the. purchasing of a present petrochemical-refinery unit (60,000 bbls./day) and (6) locating in Cote d' Voire, Benin, Togo, or Nigeria.

5.2 Updated Analysis of Alternatives

Fig. 1. Air mass source regions,January,shows the intertropical air mass covering the southern half (50%) of Africa and Ghana inclusive of such air-mass source. It has been noted that the intertropical air mass moving in a westerly direction to the open sea to the northern areas (land mass) of South America. The Sekondi Export Processing Zone will not be significantly affected by air mass regions, January in the dispersions of gas emissions(NOx and SOx).

Fig. 2 Air mass source regions, July shows the intertropical air mass covering mainly South Africa. The northern portion of the intertropical air mass is north of the West African coastline, i.e. Ghana, Cote De Ivoire, Guinea, and Senegal.

Therefore, both air masses, January and July will not significantly cause any changes in the dispersion models for gas emissions (NOx and SOx) within the Sekondi Export Processing Zone. Changing of the petrochemical-refinery complex configuration, area of petroleum products and crude oil storage tanks,and re-arranging of all buildings are not needed and necessary to effectively mitigate any negative impacts as related air emissions.

5.3 Air Emissions and Air Quality Analysis

Ankobra Resources Ltd. petrochemical-refinery complex proposed site has been considered of ambient conditions. The troposphere air contain the various gases,water vapor, and chemicals. The basic troposphere air contains:

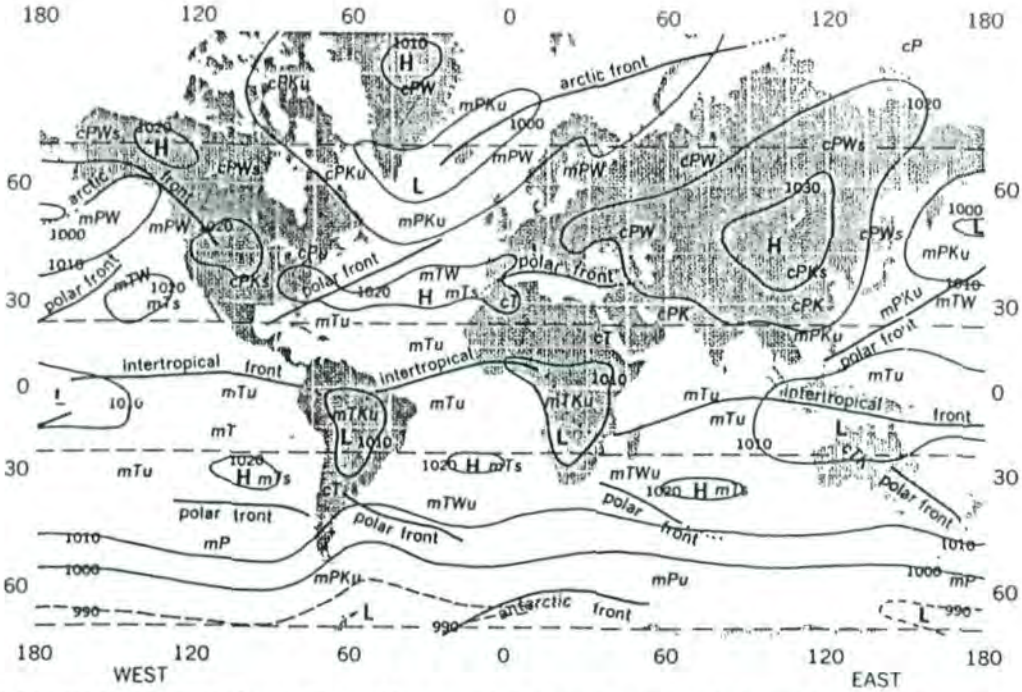


Fig. 1. Air-mass source regions, January. High- and low-atmospheric-pressure centers are designated *H* and *L* within average pressure lines numbered in millibars (such as 1010); 1 millibar = 10^2 Pa. Major frontal zones are labeled along heavy lines. (*After H. C. Willett and F. Sanders, Descriptive Meteorology, 2d ed., Academic Press, 1959*)

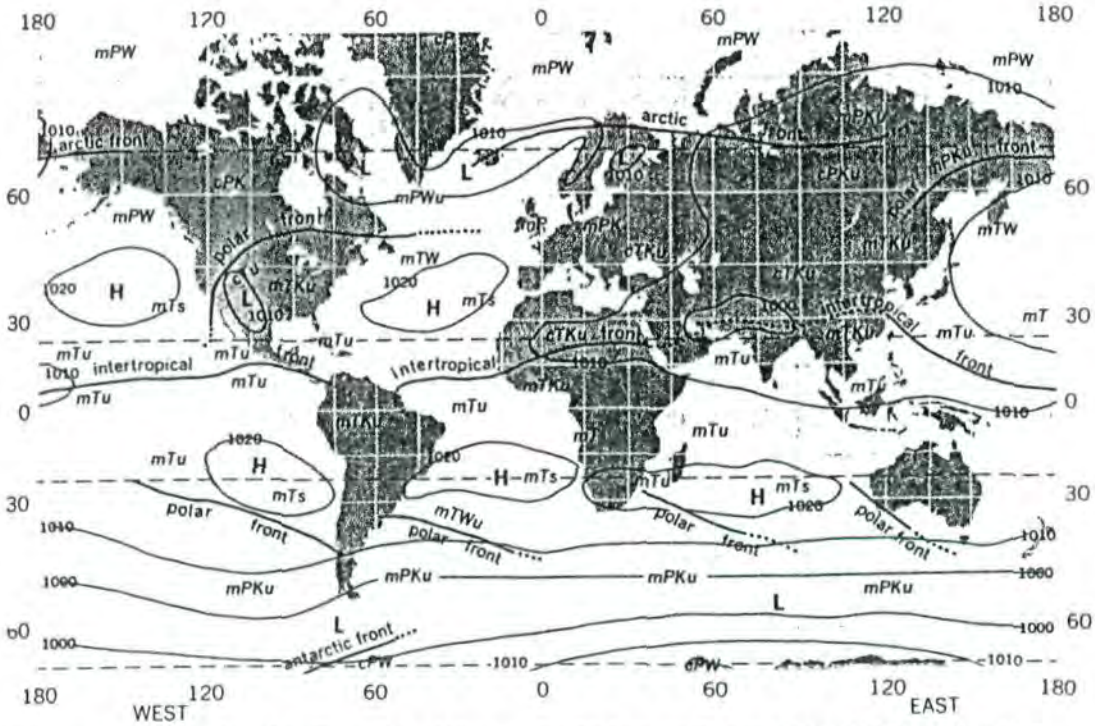


Fig. 2. Air-mass source regions, July. The symbols which are used in this figure are the same as those for Fig. 1. (*After H. C. Willett and F. Sanders, Descriptive Meteorology, 2d ed., Academic Press, 1959*)

Figure 11. Figure 1. Air-mass Source Region-January
Figure 2. Air-mass Source Region-July

Gases	Nitrogen, Oxygen,Argon
Liquid	*Water vapor*
Chemicals	Carbon dioxide, Neon, Helium
	Methane,Kryton,Hydrogen
	Nitrous oxide,Carbon monoxide
	Xeon,Ozone,Nitrogen dioxide, sulfur dioxide,Hydrogen sulfide,
	Ammonia, Formaldehyde, Nitric acid, Methyl Chloride
	Carbonyl sulfide,Freon 11,Freon 12, and Carbon tetrachloride

5.3.1 Meteorological Data-Takoradi Air Force Base

Wind Speed (m/s)	Possible Stability (class)
< 3	A,B,C,D,E,F
3-4	B,C,D,E
4-6	C,D
>6	C,D

5.3.2 Turbulence and the Mixing Process

Diffusion in the atmosphere is dependent upon mean wind speed and the characteristics of the atmospheric turbulence. These factors determine the stability characteristics of the atmosphere. Turbulence consists of horizontal and vertical eddies that mix the pollutant with air surrounding it. Thus in a smoke plume,the turbulence decreases the concentration of the pollutants in the plume and increases the concentration in the surrounding air.

When turbulence is strong, the pollutants are dispersed more rapidly. Strong turbulence exists in an unstable atmosphere in which vertical motion is enhanced. Maximum instability occurs in the summer on a clear sunny day in the early afternoon.

5.3.3 Atmosphere Turbulence

Turbulent eddies are formed in the atmosphere by convection and by geographic and man made structures. Convection occurs when air is heated from below by the warm surface of the earth and by the buildings and pavement covering it.

Mechanical eddies result from the shearing forces produced when the wind blows over the surface of the earth. At ground level the wind speed is zero,and it reaches a maximum usually at many thousands of meters above the surface.

Therefore most of the mechanical eddies are far above the ground level of the employees or Anoe Village people to receive direct effect of air emissions. The prevailing winds will carry such air emission on westerly direction toward the Gulf of Guinea.

Table 5.2 Pasquill-Gifford Stability Categories

Surface Wind (Measured at 10m)		Day-Time Insolation			Night-Time Cloudiness	
					Thinly Overcast or > 4/8	< 3/8
(m/sec)	(mph)	Strong	Moderate	Slight	Cloudiness	Cloudiness
< 2	4.5	A	A-B	B	-	-
2-3	4.5-6.7	A-B	B	C	E	E
3-5	6.7-11.2	B	B-C	C	D	E
5-6	11.2-13.4	C	C-D	D	D	D
>6	13.4	C	D	D	D	D

* The *degree of cloudiness* is defined as that fraction of sky above the local apparent horizon that is covered by clouds

NOTES:

1. Insolation is the rate of radiation from the sun received per unit of earth's surface.
2. Strong insolation corresponds to sunny mid-day in summer. Slight insolation corresponds to similar conditions in mid-winter
3. For A-B,B-C, etc. take the average of A and B values.
4. Night refers to the period from 1 hour before sunset to 1 hour after dawn
5. Regardless of wind speed, the neutral category D should be assumed for overcast conditions *during the day or night and for any sky conditions during the hour preceding or following night.*

1 mph = 0.4470 m/sec
1 m/sec = 2.237 mph

A = extremely unstable
B = moderately unstable
C = slightly unstable
D = neutral
E = slightly stable
F = moderately stable

The data from the Takoradi Air Force has indicated mainly stable conditions, which means less mixing of pollutants in the area. Sekondi Export Processing Zone is close to the Takoradi Air Force Base, which indicates the ability to meet ambient air standards as presently indicated for sulfur dioxide,nitrogen dioxide,carbon monoxide, and suspended particulate matter (total) and (PM (10)).

Ghana Limits:

Sulfur dioxide

Ambient Concentration

maximum 24-h concentration (microgram/m (3)) 200

Nitrogen Oxides (expressed as NO (2))	
Ambient Concentration	
average 24-h concentration (microgram/m (3))	320
Carbon Monoxide (CO)	
Ambient Concentration	
average concentration over 1-hr period (mg/m (3))	10
Suspended Particulate Matter (Total)	
Ambient Concentration	
average 24-h concentration (microgram/m (3))	260

5.4 Fuel Types

West African crude oils, Bonny light, Brass River, Forcados,and Qua Iboe. Specifications for each West African crude oil type has been listed below.

	Bonny Light	Brass River	Forcados	Qua Iboe
Specific Gravity	0.8398	0.8157	0.8708	0.8398
A.P.I.	37.0	41.90	31.0	36.19
B.S.W.	0.06%Vol	0.05%V0l	0.13%Vol	0.25%Vol
Water Content	0.2%Vol	0.10%Vol	0.05%Vol	0.29%Vol
Pour Point	Below 400F	Below 150F	Below 250F	Below 400F
Sulphur Content	0.14WT%	0.07WT%	0.2WT%	0.14WT%

The electrical power generation system will use fuel oil, specifically No. 2 fuel oil. Listed are general characteristics of No. 2 fuel oil (Fig.38).

5.5 Technologies

The 140,000 bbls. per day petrochemical-refinery complex technologies include license processing from UOP,Inc. Process license at a cost of $ 30,000,000 USD, UOP,Inc.

All units such as Distillation Tower, Catalytic Reforming unit, Alkylation unit, Visbreaking unit, Fluid Catalytic Cracking unit, Hydrodesulfurization, Unibon unit, and Partial Oxidation/Methanol unit are modular in design. There will be very little on-site fabrication of any unit except for welding of piping to the processing units.

Petrochemical-Refinery Units:

1. Distillation Tower
2. Catalytic Reforming Unit
3. Alkylation Unit
4. Visbreaking Unit
5. Fluid Catalytic Cracking Unit
6. Hydrodesulfurization Unit
7. Unibon Unit
8. Partial Oxidation/Methanol

Table 1. Detailed Requirements For Fuel Oils*

(From ASTM Designation: D 396-67, Book of ASTM Standards)

Grade of Fuel Oil	Flash Point, deg. F (deg. C)	Pour Point, deg. F (deg. C)	Water and Sediment, per cent by volume	Carbon Residue on 10 per cent Bottoms, per cent	Ash, per cent by weight	Distillation Temperatures, deg. F (deg. C)			Saybolt Viscosity, sec				Kinematic Viscosity, centistokes				Gravity, deg. API	Copper Strip Corrosion
						10 per cent Point	90 per cent Point		Universal at 100° F (38° C)		Furol at 122° F (50° C)		At 100° F (38° C)		At 122° F (50° C)			
	Min	Max	Max	Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
No. 1 — A distillate oil intended for vaporizing pot-type burners and other burners requiring this grade of fuel	100 or legal (38)	0	trace	0.15		420 (215)		550 (288)					1.4	2.2			38	No. 3
No. 2 — A distillate oil for general purpose domestic heating for use in burners not requiring No. 1 fuel oil	100 or legal (38)	20[e] (−7)	0.10	0.35		[d]	540° (282)	640 (338)	(32.6)[f]	(37.93)			2.0[e]	3.6			30	
No. 4 — Preheating not usually required for handling or burning	130 or legal (55)	20 (−7)	0.50		0.10				45	125			(5.8)	(26.4)				
No. 5 (Light) — Preheating may be required depending on climate and equipment	130 or legal (55)		1.00		0.10				150	300			(32)	(65)				
No. 5 (Heavy) — Preheating may be required for burning and, in cold climates, may be required for handling	130 or legal (55)		1.00		0.10				350	750	(23)	(40)	(75)	(162)	(42)	(81)		
No. 6 — Preheating required for burning and handling	150 (65)		2.00[e]						(900)	(9000)	45	300			(92)	(638)		

* Recognizing the necessity for low-sulphur fuel oils used in connection with heat-treatment, nonferrous metal, glass, and ceramic furnaces and other special uses, a sulphur requirement may be specified in accordance with the following table:

Grade of Fuel Oil	Sulphur, max, per cent
No. 1	0.5
No. 2	0.7
No. 4	no limit
No. 5	no limit
No. 6	no limit

Other sulphur limits may be specified only by mutual agreement between the purchaser and the seller.

[b] It is the intent of these classifications that failure to meet any requirement of a given grade does not automatically place an oil in the next lower grade unless in fact it meets all requirements of the lower grade.

[c] Lower or higher pour points may be specified whenever required by conditions of storage or use.

[d] The 10 per cent distillation temperature point may be specified at 440° F (226° C) maximum for use in other than atomizing burners.

[e] When pour point less than 0°F is specified, the minimum viscosity shall be 1.8 cs (32.0 sec, Saybolt Universal) and the minimum 90 per cent point shall be waived.

[f] Viscosity values in parentheses are for information only and not necessarily limiting.

[g] The amount of water by distillation plus the sediment by extraction shall not exceed 2.00 per cent. The amount of sediment by extraction shall not exceed 0.50 per cent. A deduction in quantity shall be made for all water and sediment in excess of 1.0 per cent.

Fig. 38. Table 1 Detailed Requirements For Fuel Oils

NOTE:

Fuel Oil No. 5 and 6 are the normal bottoms found in refinery units that do not have a redundant visbreaker and/or vacuum units for the heavy fractions during crude oil refining. Therefore, incineration is the method of choice for disposal.

Crude Oil Assay:

Bonny Light Crude Oil Nigeria

Crude		Kerosine	
Gravity	API: 37.6	Yield	15.4 vol. %
Sulfur,wt. %	0.13 wt %	TBP range,F	347-482
Vis. at 100 F	SUS: 36.0	Gravity	40.2 API
Pour Point F:		5 Sulfur	0.030 wt. %
C(4) and lighter	2.2 vol. %	Smoke point (IP)	19 mm
Vanadium	<0.5 ppm	Freezing point,C	-47
Nickel	4 ppm	Aniline point,F	136
Car. residue	1.1 %	Diesel index	55
(Conradson)		Pour point,F	-70
Light naphtha(debutanized)		Light gas oil	
Yield	6.4 vol.%	Yield	23.2 vol. %
TBP range,F	60-167	TBP range,F	482-662
Gravity	79.9 API	Gravity	33.2 API
Sulfur	0.0002 wt %	Sulfur	0.13 wt. %
Paraffins	77 vol. %	Cetane index	51
Naphthenes	21.5 vol. %	Diesel index	53
Aromatics	1.5 vol. %	Pour point,F	20
Research ON,clear	78	Vis. at 100 F	SUS:40.3
Research ON,+ 3ml TEL/US gal	93.5		
Heavy naphtha		Heavy gas oil	
Yield	22.0 vol. %	Yield	23.1 vol. %
TBP range F	167-347	TBP range,F	662-977
Gravity	53.6 API	Gravity	25.4 API
Sulfur	0.003 wt.%	Sulfur	0.21 wt. %
Paraffins	34 vol. %	Nitrogen (total)	1,150 ppm
Naphthenes	55 vol. %	Vanadium	<0.1 ppm
Aromatics	11 vol. %	Nickel	<0.1 ppm
Characterization factor:	11.7	Aniline point,F	190
Aniline point ,F	120	Pour point,F	105
		Vis. at 210 F	SUS:48.1
Residual oil			
Range, F: +			
Yield	7.7 vol. %		
Gravity	11.8 API		
Sulfur	0.39 wt. %		
Vis. at 210 F	SUS: 2,030		
Carbon residue	12.0 wt. %		
Vanadium	3 ppm		
Nickel	40 ppm		

Fig. 5.1c Crude Oil Assay

5.5.1 Distillation Tower

Distillation is a common method for the fractionation of petroleum. Separation by distillation takes place accordingly to volatility, not necessarily according to molecular weight.

The theory of distillation has occuppied several large texts and is discussed only briefly here. Thus, if liquid is contained in closed space, it emits vapor until a pressure of the vapor is reached that is related to the temperature of the system,the vapor is then said to be saturated.

The vapor pressure if a liquid substance in contact with its own liquid is constant and is independent of the amount of liquid and of vapor present in the system. The vapor pressure is usually expressed in terms of the height of a necessary column/ in millimeters and in inches that produce an equivalent pressure.

The vapor pressure of a liquid increases with temperatures, and when the vapor pressure is equal to the total pressure is equal to the total pressure exerted on the surface of the liquid,the liquid boils. Thus, the boiling point of a liquid may be defined as the temperature at which the vapor pressure of the liquid is equal to the external pressure of the liquid surface.

This external pressure may be extended by atmospheric air, by other gases, by vapor and air, and so on. The boiling point at a pressure of 760 mm air is usually referred to as the normal boiling point.

5.5.2 UOP* Fluid Catalytic Cracking Process

The fluid catalytic cracker (FCCU) unit process is a process for the conversion of straight run atmospheric gas oils, vacuum gas oils, certain atmospheric residues, and heavy stocks received from other olefins rich in light gases.

The product gasoline has an excellent front end octane number and good overall octane characteristic. Further, FCCU gasoline is complemented by the alkylate produced from gaseous olefins by-product because alkylate has superior octane and excellent sensitivity.

In a typical FCCU, the cracking reaction are carried out in a vertical reactor riser in which a liquid oil stream contact a hot powdered catalyst. The oil vaporizes and to lighter products as it moves up the riser and carries the catalyst powder with it.

The reactions are rapid, and only a few seconds of contact are necessary for most applications. Simultaneously with the desired reactions, coke, a carbonacecous material having slow rate of hydrogen to carbon (H/C), deposits on the catalyst and render it less catalytic active.

The spent catalyst and the converted products are then separated,and the catalyst passes to a separate chamber, the regeneration, where the coke is combusted to rejuvenate the catalyst. The rejuvenated catalyst then passes to the bottom of the reactor riser,where the cycle begins again.

Process Description:

Reactor and regeneration. In the reactor, the feed stock is cracked to an effluent containing hydrocarbon ranging from methane through the highest boiling point material in the feed stock plus hydrogen sulfide. In the regeneration, the circulating spent catalyst is rejuvenated by burning the deposited coke with air at high temperature.

Main fractionator-Here the reactor effluent is separated into various products. The overhead includes gasolines and lighter material. The heavier products,heavier naphtha, and cycle oil are separated as sidecuts, and slurring oil is separated as a bottom product.

Gas-concentration unit-In this reaction usually referred to as unsaturated-gas plant, the unstable gasoline and higher products from the main fractionator overhead are separated into feed gas *C (3) - C (4)* for alkylation or polymerization and debutanized gasoline that is essentially ready for use except for possible chemical treating.

In general, conversion, which is typically defined as 100 minus the liquid volume percentage of products heavier than gasoline is never carried to completion. Some main column bottoms materials, referred to as clarified oil or slurry oil, is a product usually used for fuel blending, light cycle oil recovered as a sidecut product, is generally used for home heating, although a fraction might be suitable for diesel fuel blending stock.

Gasoline Mode- The most common mode of operation of the FCCU is aimed at the *maximum production of gasoline. This mode is better defined as an operation* producing a high gasoline yield of a specific octane number.

This condition requires careful contact of reaction severity, which must be enough to convert a substantial portion of the feed but not so high as to destroy the gasoline that has been produced. This balance normally is achieved by using an active and selective catalyst and enough reaction temperature to produce the desired octane. The catalyst circulation rate is limited and reaction time is confined to a short exposure. Because of the severity is carefully, controlled, no cycle of uncovered components is normally needed.

UOP FLUID CATALYTIC CRACKING PROCESS

TABLE 3.3.3 Fresh FCC Catalysts

	A	B	C	D
Average bulk density, g/mL	0.56	0.73	0.78	0.42
Surface area, m^2/g	251	127	306	529
Composition, wt %:				
Alumina	28.9	32.7	61.5	21.9
Rare earths	2.7	2.6	0.0	1.9

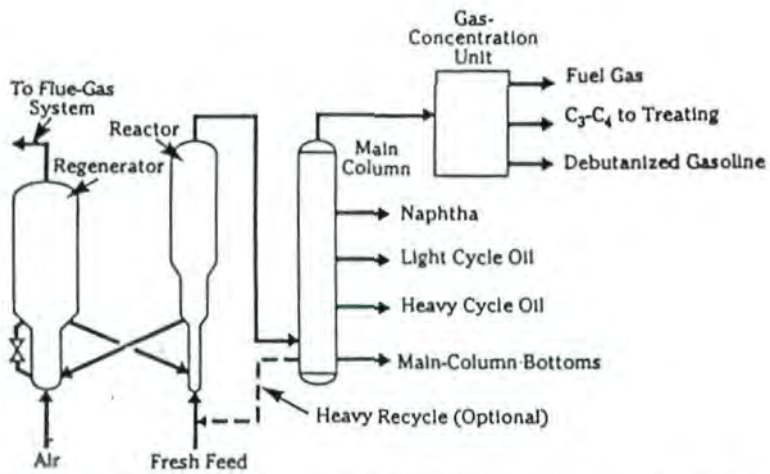


FIGURE 3.3.7 Overall flow diagram for a UOP FCC complex excluding flue gas system option.

TABLE 3.3.2 Effect of Catalyst Activity*

	Amorphous	Low-activity sieve	Moderate-activity sieve	High-activity sieve
Conversion, LV %	63.0	67.9	76.5	78.9
Gasoline, LV %	45.1	51.6	55.4	57.6
RONC	93.3	92.6	92.3	92.3

*Basis: Middle East sour gas oil, 23.7°API gravity (sg = 0.912), 11.84 UOP K factor, 2.48 wt % sulfur.

Note: RONC = research octane number, clear; °API = degrees on American Petroleum Institute scale.

Fig. 5.2c Table 3.3.3. Fresh Catalysts
Table 3.3.2. Effect of Catalyst Activity

5.5.3 UOP* HF Alkylation Technology

The UOP* HF Alkylation process for motor fuel production catalytically combines light olefins,which are usually mixtures of propylenes and butylenes,with isobutane to produce a branched-chain paraffinic fuel. The alkylation reaction takes place in the presence of hydrofluoric acid (HF) acid under conditions selected to maximize alkylate yield in quality

The alkylate product possesses excellent antiknock properties. Alkylate is a clear burning low sulfur gasoline blending component that does not contain olefins or aromatic compounds. Alkylate also has excellent lead response, which is important in locations where leaded gasoline is still produced.

The process was initially used for the production of high octane aviation fuels from butylenes and isobutane. The contribution of the alkylation process is critical in the production of quality motor fuels. The process provides refiners with a tool of unmatched economy and efficiency one that will assist in maintaining or strengthing their position in the production and marketing of gasolines.

However, where environmental regulations have reduced the allowable vapor pressure of gasoline, isopentane is being removed from gasoline, and refiner interest in alkylating this material into light olefins, particularly propylene, is growing. The actual reaction taking place in the alkylation reactor are many and are relatively complex. The equation is Fig. 1.4.1 illustrate the primary reaction production that may be expected for several pure olefins.

Process Description:

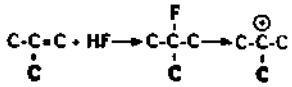
The alkylation of olefins with isobutane is complex because it is characterized by simple additions as well as by numerous side reactions. Primary reaction products are the isometric paraffins containing carbon. However, secondary reaction such as hydrogen transfer, polymerization, isomerization, and destruction alkylation also occur, resulting in the formation of secondary products both lighter and heavier than primary product.

To minimize and consumption and ensure good alkylate quality, the feeds to the alkylation unit should be dry and of low sulfur content. Normally, a simple desiccant-drying system is included in the unit design package.

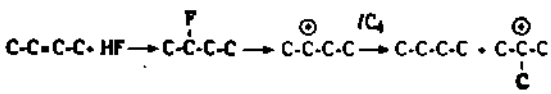
Feed treating in a UOP Merox unit for mercaptan sulfur removal can be economic* adjunct to the alkylation unit for those applications in which the olefins feed is derived from catalytic cracking or for other operation in which feeds of significant sulfur content

TABLE 1.4.1 Compositions of Alkylate from Pure-Olefin Feedstocks

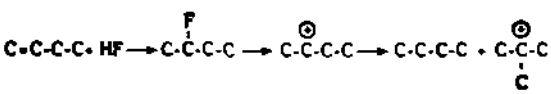
Component, wt %	Olefin			
	C_3H_6	i-C_4H_8	C_4H_8-2	C_4H_8-1
C_5 isopentane	1.0	0.5	0.3	1.0
C_6's:				
Dimethylpentanes	0.3	0.8	0.7	0.8
Methylpentanes	—	0.2	0.2	0.3
C_7's:				
2,3-dimethylpentane	29.5	2.0	1.5	1.2
2,4-dimethylpentane	14.3	—	—	—
Methylhexanes	—	—	—	—
C_8's:				
2,2,4-trimethylpentane	36.3	66.2	48.6	38.5
2,2,3-trimethylpentane	—	—	1.9	0.9
2,3,4-trimethylpentane	7.5	12.8	22.2	19.1
2,3,3-trimethylpentane	4	7.1	12.9	9.7
Dimethylhexanes	3.2	3.4	6.9	22.1
C_9+ products	3.7	5.3	4.1	5.7



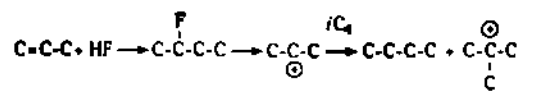
(1.4.5)



(1.4.6)



(1.4.7)

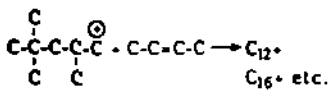


(1.4.8)

FIGURE 1.4.2a HF alkylation reaction mechanism—initiation reactions.

ALKYLATION AND POLYMERIZATION

Polymerisation



(1.4.14)

Cracking Disproportionation

$$C_{12}^{+} \longrightarrow C_5^{+} + C_7^{+} \qquad (1.4.15)$$

Hydrogen Transfer

$$C_3H_6 + iC_4H_{10} \longrightarrow C_4H_8 + C_3H_8 \qquad (1.4.16)$$

$$C_4H_8 + iC_4H_{10} \longrightarrow C_8H_{18} \qquad (1.4.17)$$

Overall Reaction:

$$C_3H_6 + 2\ iC_4H_{10} \longrightarrow C_3H_8 + \text{Trimethylpentane} \qquad (1.4.18)$$

FIGURE 1.4.2*d* HF alkylation reaction mechanism—other.

UOP HF ALKYLATION TECHNOLOGY

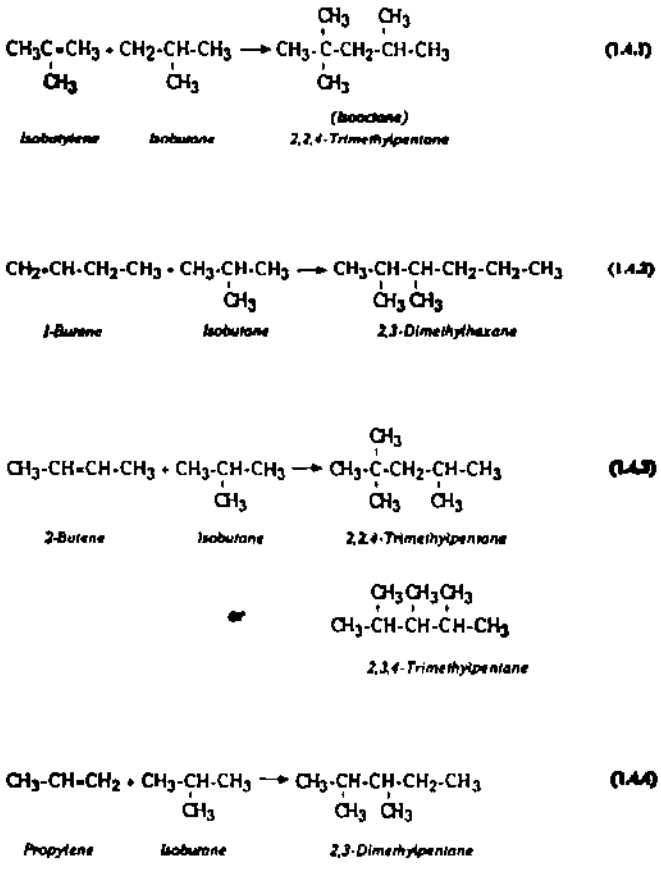


FIGURE 1.4.1 HF alkylation primary reactions for monoolefins.

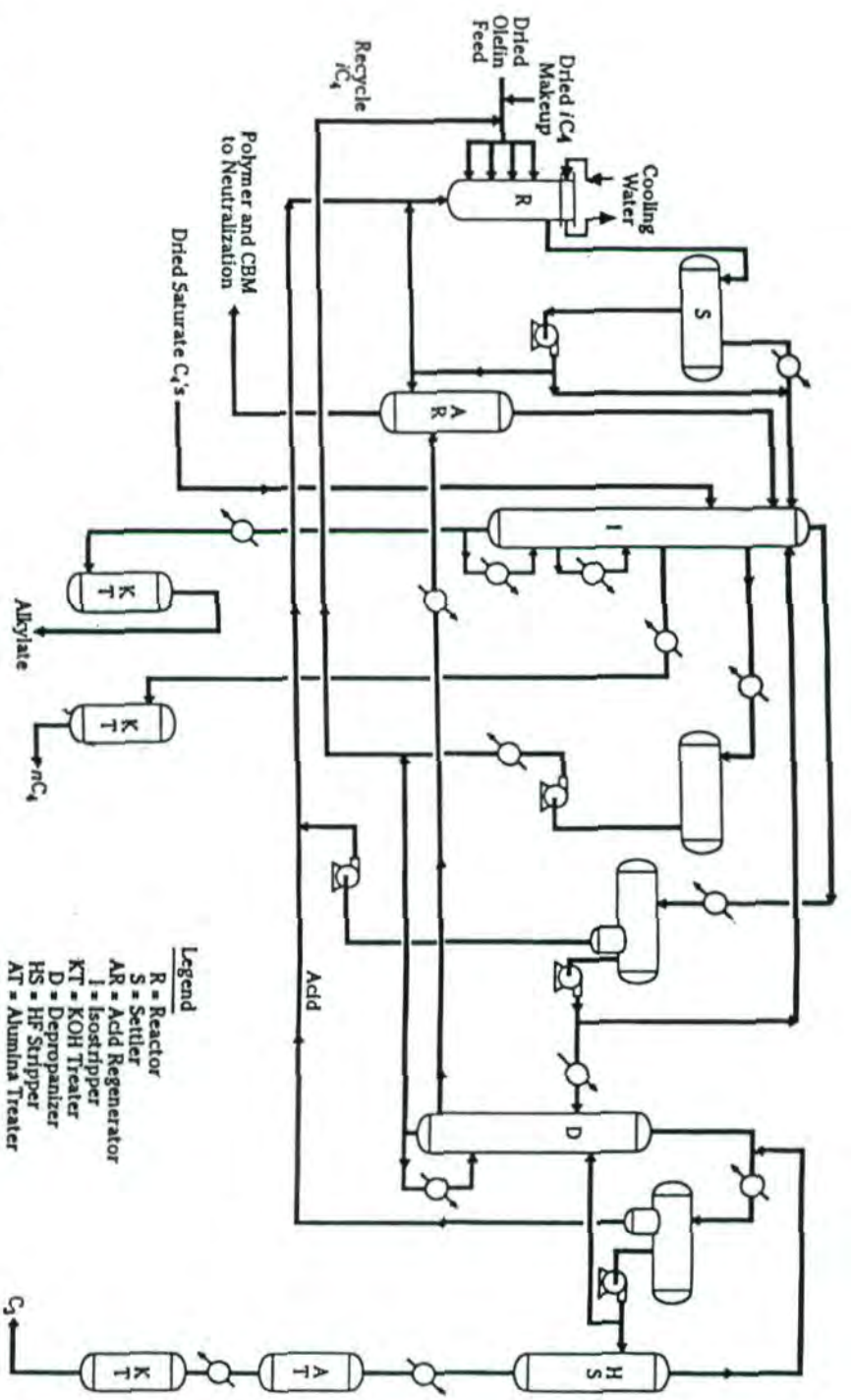


FIGURE 1.43 UOP C_3-C_4 HF alkylation process.

are processed. Simplified flow schemes for a typical C (4) HF Alkylation unit and a C (3) -C (4) HF Alkylation unit are shown in Fig. 1.4.3.

Treated and dried olefinic feed is changed along with recycle and makeup isobutane (when applicable to the reactor section of the plant). The combined feed enters the shell of a reactor-heat exchange through several nozzles positioned to maintain an even temperature throughout the reactor.

The heat of reaction is removed by heat exchange with a large volume of coolant flowing through tubes having low temperatures rise. If cooling water is used, it is then available for further use elsewhere in the unit. This effluent from the reactor enters the settler, and the settled acid is returned back to the reactor.

The isostripper overhead consist mainly of isobutane, propane, and HF acid, A drag stream of overhead material is changed to the HF stripper to strip acid. The overhead from the HF stripper is returned to the stripper overhead system to recover acid and isobutane.

A portion of the HF stripper bottoms is used as, flushing material. A net bottom stream is withdrawn, defluorinated, and charged to the gas-concentration section (C (3) - C (4)) olefins and may be required with C (4) olefin feedstocks if the quantity of propane entering the unit is too high to be recycled economically as previously described the isostripper overhead drag stream is changed to the internal depropanizer. Overhead from the internal depropanizer overhead system. High purity propane is drawn off the bottom of the HF stripper passes through a defluorination step, and is then sent to storage.

A small slop stream of circulating HF acid is generated internally to maintain acid purity at the desired level. This technique significantly reduces overall chemical consumption. An acid -regenerator column is also provided for start-up after turnarounds or in the event of a unit upset or feed contamination.

Catalytic Reforming Unit:

The Platforming process is a UOP* developed and engineered catalytic reforming process in the wide spread use today throughout the petroleum and petrochemical industries. The first UOP Platforming unit went on stream in 1945.

In the Platforming process, light petroleum distillate (naphtha) is contacted with a platinum-containing catalyst at elevated temperatures and hydrogen pressures ranging from 345 KPa to 3450 KPa (Eo to 500 lbs./in (2) gage).Platforming produces a high-

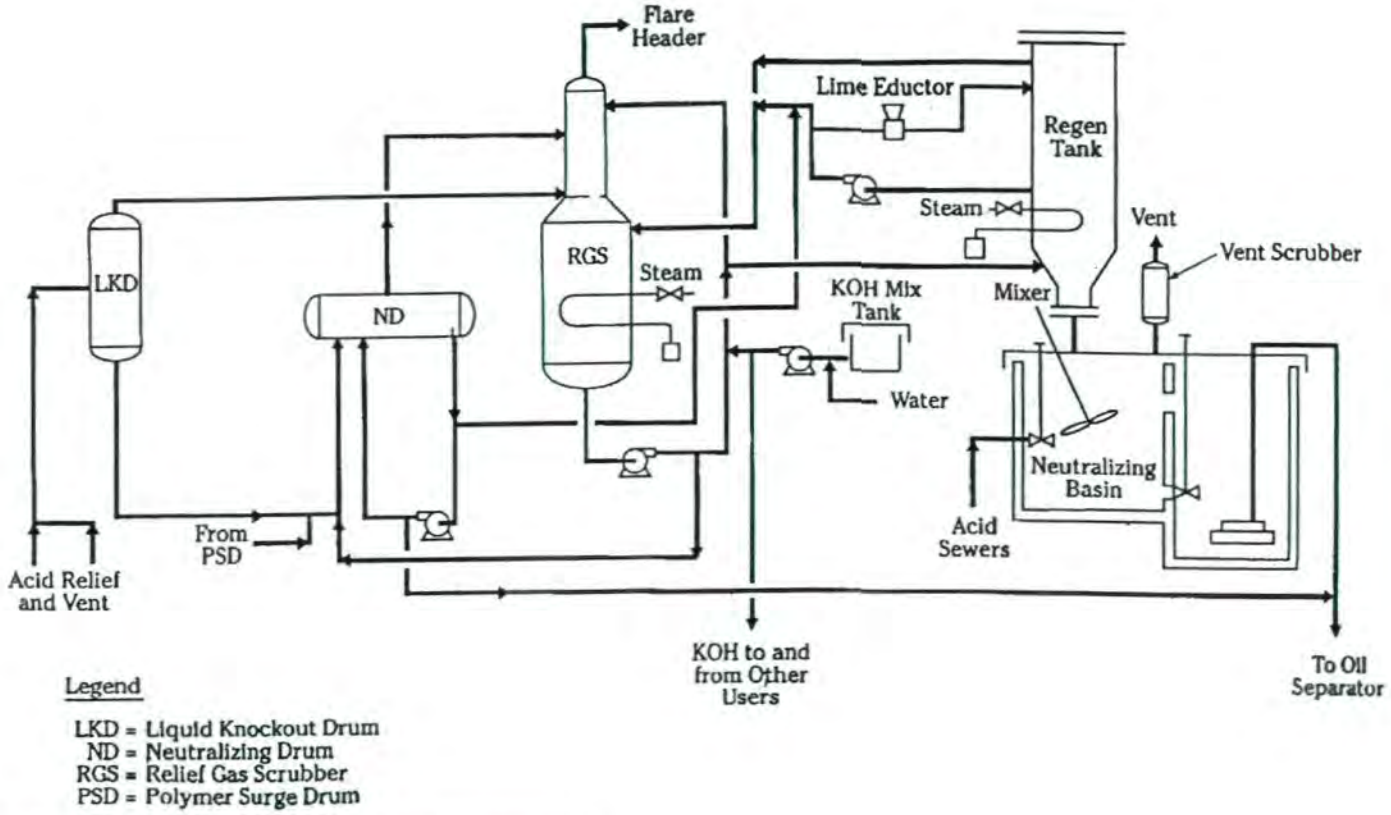


FIGURE 1.4.6 Acid neutralization and caustic regeneration section.

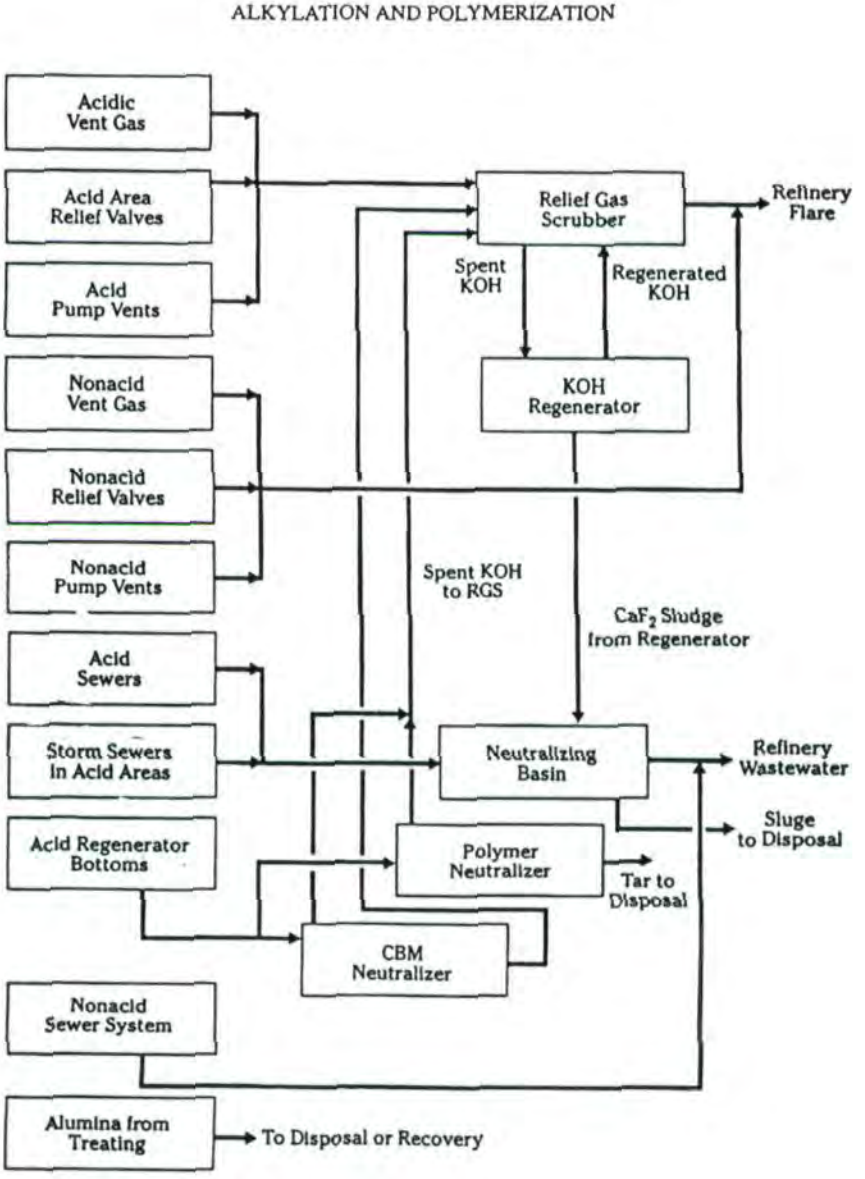


FIGURE 1.4.5 UOP HF alkylation process waste management.

octane liquid product that is rich in aromatic compounds. Chemical hydrogen, light gas,and liquified petroleum gas (LPG) are also produced as reaction by products.

Originally developed to upgrade low-octane number straight-run naphtha to high-octane motor fuels, the process has since been applied to the production of LPG and high purity aromatics.

Process Chemistry:

Feed and Product Composition

The Platforming naphtha change typically contains C (6) through C (11) paraffins, naphthalenes, and aromatics. The primary purpose of the Platforming process is to produce aromatics from the paraffins and naphthenes. The product stream is a pressure -quality gasoline blending components because of high-octane values of the aromatics.

Naphtha from different crude sources vary greatly in their hydrocarbon composition and this is their ease of reforming. The ease with which a particular naphtha feed is processed in a Platforming unit is determined by the mix of paraffin,naphthas,and aromatics in the feedstock. Aromatic hydrocarbon pass through the unit essentially unchanged.

Napthenes react relatively easily and are high selective to aromatic compounds. Paraffin compounds are the most difficult to convert, and the relative severity of the Platforming operation is determined by the level of paraffin conversion required. Low severity (low

octane) operations require little paraffin conversion,but high severity operations require a significant degree of conversion.

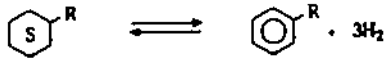
Naphthas are characterized as lean (high paraffin) or each (low paraffin content). Rich naphthas,with a higher proportion of naphthalene components, are easier to process in the reformate than does a lean charge.

Reactions:

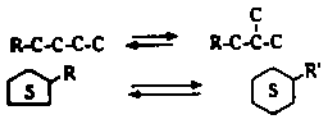
Platforming reaction can greatly be classified under four categories: dehydrogenation, isomerization, dehydrocyclization, and cracking. The extent to which each of the reactions occurs for a given Platforming operation depends on the feedstock quality,operating condition, and catalyst type.

UOP PLATFORMING PROCESS

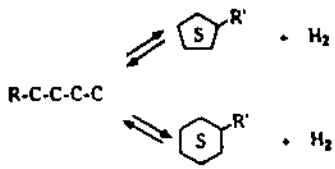
Dehydrogenation of Naphthene



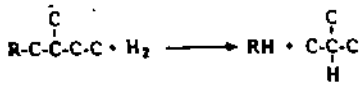
Isomerization of Paraffins and Naphthenes



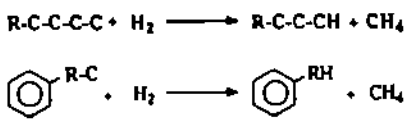
Dehydrocyclization of Paraffins



Hydrocracking



Demethylation



Dealkylation of Aromatics

Symbol Key

Where   • Saturated Rings (Naphthenes)

 • A Dehydrogenated Ring (Aromatic)

R, R,' R", • Radicals or Side Chains Attached to the Ring, for Example, – CH_2CH_3, an Ethyl Radical

FIGURE 4.1.6 Generalized Platforming reactions.

Dehydrogenation of Naphthenes:

The principal Platforming reactions in producing an aromatic from a naphthene is the dehydrogenation of an alkylocyclohexane. This reaction takes place rapidly and proceeds essentially to completions. This reaction is highly endothermic, is favored by high reaction temperature and low pressure,and is promoted by the metal catalyst function.

Because this reaction proceeds rapidly and produces hydrogen as well as aromatic naphthenes are the most desirable compounds in the Platforming feedstock.

Isomerization of Paraffin and Napthenes:

The isomerization and alkylcyclopentane to an alkylcyclohexane must take place before an alkylcyclopentane can be converted to an aromatic. The reaction involves any arrangement and thus the possibility for ring opening to form a paraffin exists. The paraffin isomerization reactions are promoted by the acid catalyst function.

Dehydrocyclization of Paraffins:

The most difficult Platforming reaction to promote is the dehdrocyclization of paraffins. This reaction consist of difficult molecular arrangements of paraffin to a naphthene. Paraffin cyclization becomes easier with increasing molecular weight of the paraffin because of the probability of ring formulation increases. Partially offsetting the effect in the greater likelihood of the heavy paraffins to hydrocrack. Dehydrocyclization is favored by low pressure and high temperature and requires both metal and acid catalyst function.

Cracking Hydrocracking and Dealkylation:

The difficulty of naphthene isomerization and paraffin cyclization combined with the acid function dictates a high probability for paraffin hydrocracking, paraffin hydrocracking is favored by high temperature and high pressure. As paraffin crack and disappear from the gasoline boiling range, the remaining aromatics become concentrated in the product, thereby increasing product octane. However, hydrogen is consumed,and the net liquid products is reduced.

The dealkylation of aromatics entails either making alkyl group (a side chain on the aromatic ring) smaller or removing the alkyl group completely. An example of the latter is converting toluene to benzene. If the alkyl side chain is large enough, the reaction is similar to paraffin cracking. Dealkylation is favored by big temperature and high pressure.

5.5.4 FW/UOP Visbreaking

Visbreaking is a well established noncatalytic thermal process that converts atmospheric or vacuum residue to gas, naphtha, distillates, and tar. Visbreaking reduces quantity of cutter stock required to meet fuel oil specifications while reducing the overall quantity of fuel oil produced.

The conversion of these residues is accomplished by heating material in high temperatures in a furance. The material is passed through a soaking zone, located either in the heater or in an external drum, under proper temperature and pressure constraints so as to produce the desired products. The heater effluent is then generated with a quenching reaction to stop the reaction.

Feedstocks:

Atmospheric and vacuum residues are normal feedstocks to a visbreaker. These residues will typically achieve a conversion to gas, gasoline, and gas oil of 10% to 15% percent, depending on the severity and feedstock characteristics. The conversion of the residue to distillate and lighter products is commonly used as a measurement of the severity of the visbreaking operation. Percent conversion is determined as the amount of 650F +(343 C +) material present in the atmosphere residue feedstock or 900 F + (482 C +) material present in the vacuum residue feedstock which is visbroken into lighter boiling.

The extent of the conversion is limited by a number of feedstock characteristics,such as asphaltene, sodium and Conradson carbon content. A feedstock with a lighter asphaltene content will result in an overall lower conversion than a normal asphaltene feedstock,while maintaining production of a stable fuel oil from the visbreaker bottom.

Process Flow Scheme:

A typical visbreaker (Fig. 12.3.4.) can be employed when viscosity reduction of residual streams is desired so that the need for high quality distillate cutter stock can be reduced in order to produce a commercial-grade residual fuel oil. This visbreaker unit is charged with atmospheric or vacuum residue. The unit charge is raised to the proper reaction temperature in the visbreaker heater. The reaction is allowed to continue to the desired degree of conversion in a soaking zone in the heater.

Stream is injected into each heated coil to maintain the required minimum velocity and residence time and to suppress the formation of coke in the heater tubes. After leaving the heater soaking zone, the effluent is generated with a quenching medium to stop the reaction and is sent to the visbreaker fractionator for separation.

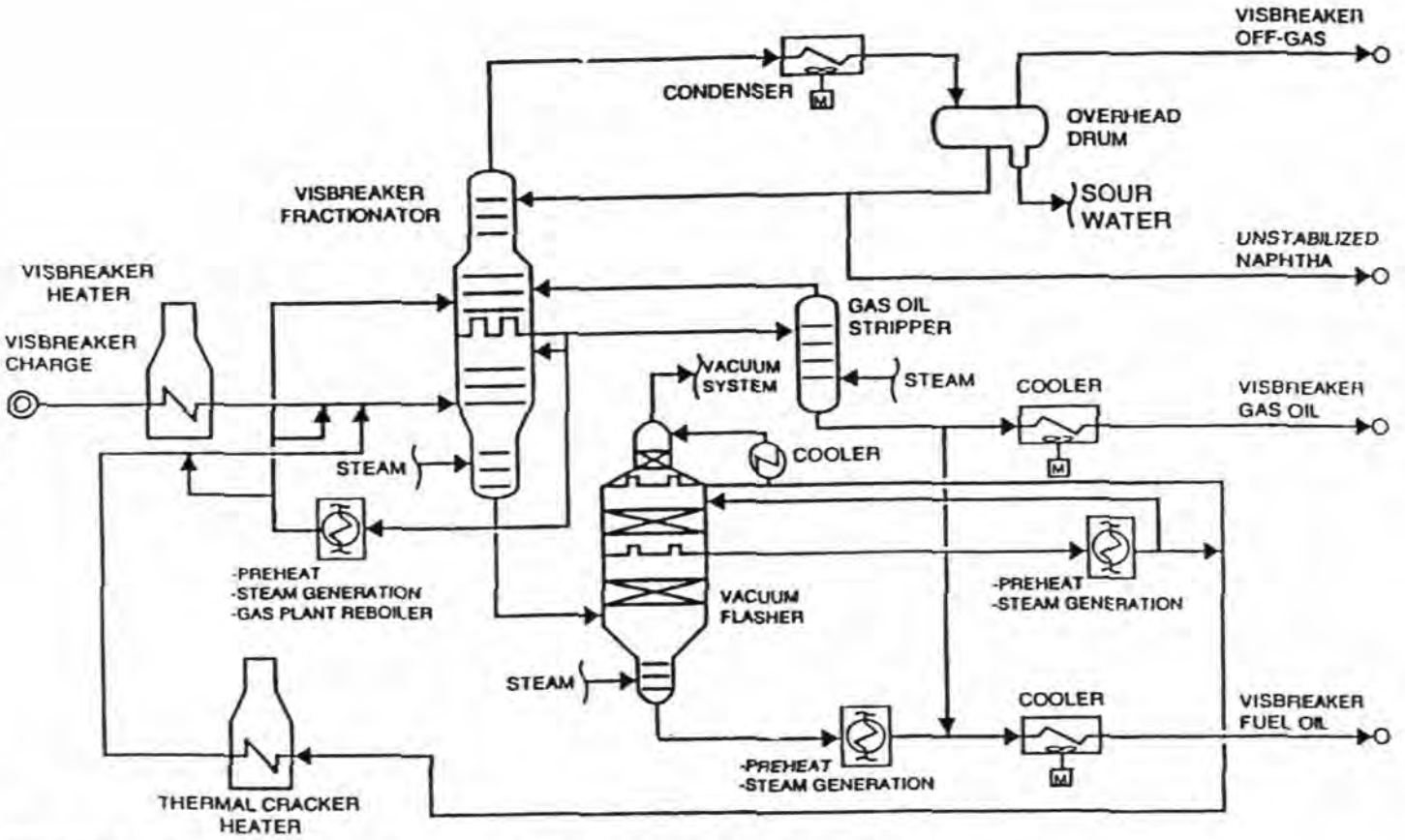


FIGURE 12.3.6. Process schematic for combination visbreaker and thermal cracker. (*Foster Wheeler and UOP.*)

The heater effluent enters the fractionator flash zone where the liquid flows to the bottom of the tower and is steam-stripped to produce the product. The vapor portion flows up to the tower to the shed and wash section where it is cleaned and cooled with a gas oil wash stream.

The washed vapors then continue up the tower, Gas oil stripper feed, as well as pumparound,wash liquid, and the oil to quench the charge are all removed on a side draw-off tray. The pumparound can be used to reboil gas plant towers, preheat boiler feedwater, and generate steam. The feed to the gas oil stripper is steam-stripped, and then a portion of it is mixed with the visbreaker bottoms to meet viscosity reduction requirements; the remainder is sent to battery limits.

The overhead vapors flow from the tower are partially condensed and sent to the overhead drum. The vapors flow under pressure control to a gas plant. A portion of the condensed hydrocarbon liquid is used as reflux in the tower and the remainder is sent to a stabilizer. Sour water is withdrawn from the drum and sent to battery limits.

5.5.5 UOP* Merox Process(Hydrodesulfurization Unit)

The UOP* Merox process accomplishes mercaptan extraction and mercaptan conversion at normal refinery rundown temperature and pressure. The process is based on the ability of an organometallic catalyst to promote the oxidation of mercaptan to disulfides in an alkaline environment by using air at the source of oxygen, for light hydrocarbons, operating pressures is controlled slightly above the bubble point to ensure liquid-phase operation: for heavier stocks, operating pressure is normally set to keep air dissolved in reaction section. Gases are normally treated at their prevailing system pressures.

Merox treatment can in, in general, be used in the following ways:

To improve lead susceptibility of light gasoline (extraction)
To improve the response of gasoline stocks to oxidation inhibitors added to prevent gum formation during storage (extraction and sweeting)
To improve odor on all stocks (extraction or sweeting or both)
To reduce the mercaptan content to meet product specifications requiring a negative doctor test or low mercaptan content (sweeting)
To reduce the sulfur content of LPG products to meet specifications (extraction)
To reduce the sulfur content of coker or fluid catalyst cracking (FCC) C (3) - C (4) olefins to save on acid consumption in alkylation operations using these materials as feedstocks or to meet the low-sulfur requirements of sensitive catalyst used in vacuum chemical synthesis processes (extraction).

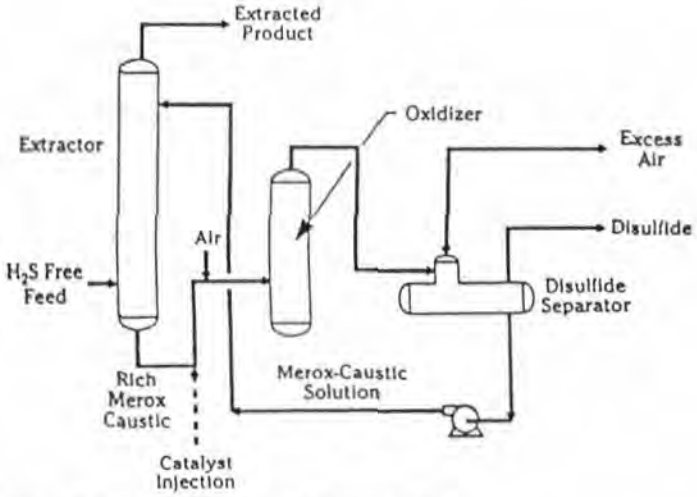


FIGURE 11.3.1 Merox mercaptan-extraction unit.

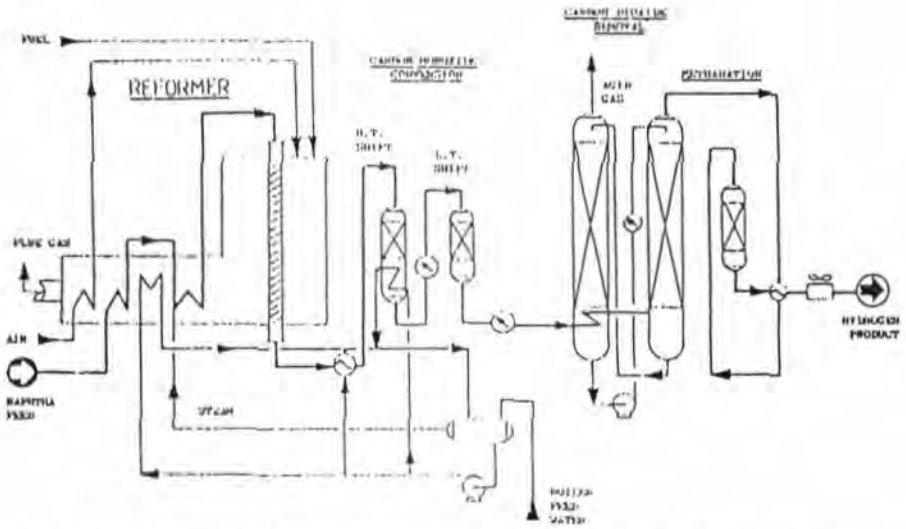


Fig. 26. Hydrogen production process using steam reforming and CO_2 absorption.

Figure 26. Figure 11.3.1 Merox Mercaptan-extraction unit

Fig. 26, Hydrogen Production Process Using Steam Reforming and CO(2) Absorption

TABLE 11.3.2 Quality Specifications for the Merox Process

Characteristics	Feed Type							
	Gases, LPG, NGL	NGL, LN	MN, HN	FBR gasoline	Jet fuels	Kerosene	Diesels	Heating oils
Feed:								
Mercaptan sulfur, wt ppm	50–10,000	50–2,000	50–5,000	50–5,000	30–1,000	30–1,000	50–800	50–800
H_2S, wt ppm*	<10	<10	<10	<10	<1	<1	<1	<1
Acid oil, wt %	....	....	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Products:								
Mercaptan sulfur, wt ppm	<5–10	<5–10	<5–10	<5–10	<10	<10	<30	<30
Mercaptan sulfur + disulfide sulfur, wt ppm	10–20	<50						

*After caustic prewash, if any, before Merox process. LPG = liquefied petroleum gas; NGL = natural gas liquid; gas = natural gas, refinery gas, or synthesis gas; LN = light naphthas; MN and HN = medium and heavy naphthas; FBR = full boiling range.

Fig. 36. Table 11.3.2. Quality Specifications for the Merox Process

Process Description:

The UOP* Merox process accomplishes mercaptan extraction and mercaptan conversion at normal refinery rundown temperature and pressure. The process is based on the ability of an organometallic catalyst to promote the oxidation of mercaptan to disulfides in an alkaline environment by using air at the source of oxygen, for light hydrocarbons, opening pressure is controlled slightly above the bubble point to ensure liquid-phase operation: for heavier stocks, operating pressure is normally set to keep air dissolved in reaction section. Gases are normally treated at their prevailing system pressures.

Merox Extraction:

Low-molecule-weight mercaptans are soluble in caustic soda solution. Therefore, when treating gases, LPG, and light-gasoline fractions, the Merox process can be used to extract mercaptans, thus reducing the sulfur content of the treated product. In the extraction unit (Fig. 11.3.1.) the sulfur reduction attainable is directly related to the extractable mercaptan content of the fresh feed.

In mercaptan-extraction units, fresh feed is charged to an extraction column, where mercaptans are extracted by a countercurrent caustic stream. The treated products passes overhead to storage or downstream processing.

The mercaptan-rich caustic solution containing Merox catalyst-flows from the bottom of the extraction column to the regeneration section through a steam heater, which is used to maintain a suitable temperature in the oxidizer, where the caustic is regenerated by converting mercaptan. Spent air is vented to a safe place, and disulfide is decanted and sent to appropriate disposal. For example, the oil can be injected into charge to a hydrotreating unit or sold as a specialty product. The regenerated-caustic stream is returned to the extraction column. A small amount of Merox catalyst is added periodically to maintain the required activity.

5.5.6 Partial Oxidation: (Methanol Production Unit)

An alternative method of hydrogen production is that of partial oxidation. In this type of process the heat required to arrive at the desired operating conditions is provided by combustion of part of the feed using oxygen. Enriched air can be used if a hydrogen nitrogen mixture is required for ammonia synthesis.

As the process is non-catalytic, it can operate with any hydrocarbon feedstock from natural gas to the heaviest residues such as asphalt and bitumen. In refinery operations the heavier feedstocks are more frequently used.

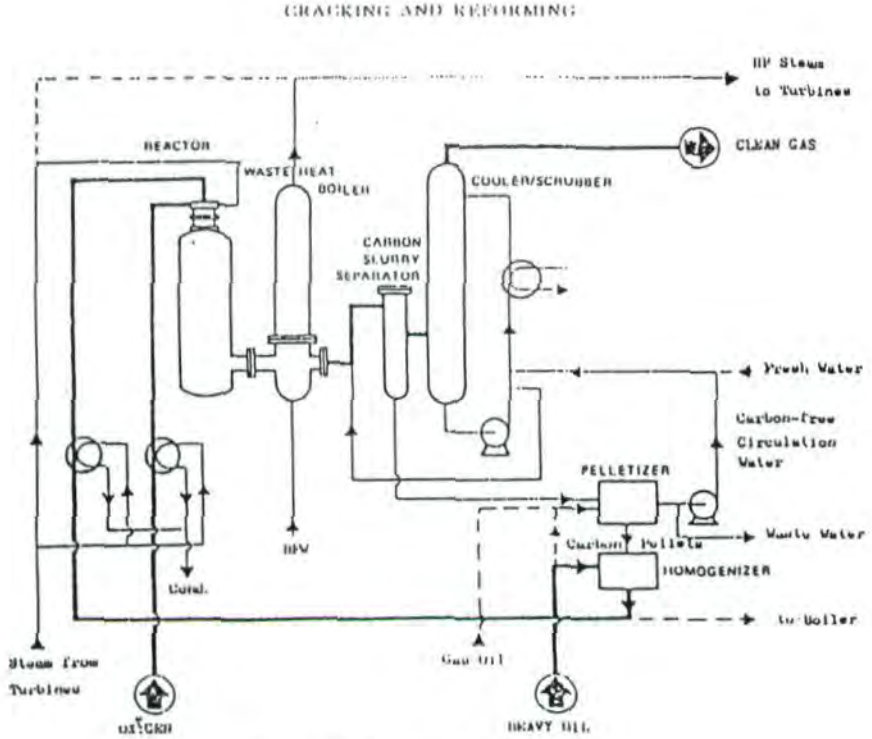


Fig. 28. Shell partial oxidation process.

TABLE XXIV
Typical Partial Oxidation Process Operating Conditions

Gasification feedstock	Dutch natural gas	Straight-run naphtha	Vacuum residue	Propane asphalt
Operating pressure, bar	60	60	60	60
Preheat temperatures, Feed/°C	40/300	25	45/245	60/245
Oxygen °C	30/245	30/245	30/245	30/245
Steam °C	313	313	313	313
Feed to reactor, kg	100	100	100	100
Oxygen to reactor, Nm^3	79.2	87.9	70.6	66.6
Steam to reactor, kg	20	40	45	50
Crude gas produced, Nm^3	298	321	294	284
$(CO + H_2)$ produced, Nm^3	262	298	274	262
Composition of gas (dry), % vol				
CO_2	4.30	5.21	4.20	4.51
CO	41.71	41.29	47.23	47.74
H_2	50.28	51.45	45.81	44.22
CH_4	0.60	0.60	0.60	0.60
N_2	1.27	0.38	0.64	0.58
Ar	0.84	0.80	0.76	0.74
H_2S		0.01	0.75	1.55
COS			0.03	0.06

Fig. 37. Fig. 28 Shell Partial Oxidation Process
Table XXIV Typical Partial Oxidation Process

Shell and Texaco have both developed successful processes, which operates in the 30-80 bars pressure range and at temperatures between 1000 and 1600 C. A flow diagram of the Shell Process is shown in Fig. 28. The hydrocarbon feed and oxidant (oxygen and air) are heated separately and fed to the reactor.

Before entering the reaction zone, these components are initially mixed to avoid local high concentrations of oxygen, which would otherwise give excessive temperatures rises, and low concentrations which would give increased carbon formation. in simplified terms, parts of the hydrocarbons is burnt, the heat produced assisting, to break up the residual oil into gasifiable fractions.

The combustion and cracked products react to give the desired gas mixture. To acheive the simultaneous combustion and cracking of the feedstock in desirable ratio, it is often necessary to include a "moderator" in the reaction mixture to control the temperature. In the case where oxygen is used, steam or carbon dioxide may be used as the moderator, and where air is used the nitrogen acts as the moderator.

Carbon is produced in the process and the tendency to form carbon increases with feedstock boiling range, rising from 0.1% wt. with gaseous feeds and up to 3% wt. with heavy fuel oil.

The product gas leaves the reactor carrying with it an applicable amount of sensible heat which is recoverable in a downstream waste boiler. Despite the pressure of carbon in the effluent gas high heat transfer rates are acheived and the gas leaves the boiler at a temperature closely approaching that of steam produced in the boiler. If oxygen is used for gasification, about 2.8 tonnes are produced/tonne of oil gasified. About 0.4-0.5 tonnes of feed often is used as the moderator

The carbon is removed from the product gas, which is then purified by removal of hydrogen sulfide,before passing to shift reactors for CO conversion. Amine or carbonate absorbers are used to remove CO, and finally the gases are sent to a methanation reactor, as in the steam reforming process.

Typical operating conditions and reaction effluent gas composition for different feedstock are shown below. Partial oxidation has the advantage of being able to operate on low priced fuel with no restrictions on sulfur content and at high pressures to reduce compression cost for high pressure processes such as hydrocracking ammonia production. The advantage is the necessity for pure oxygen and therefore an air liquefaction plant is normally required.

Approximately three quarters of all methanol is used in the production of formaldehyde, acetic acid and a variety of other chemical intermediates which form the foundation of a large number of secondary derivatives. These secondary derivatives are used in the manufacture of a wide range of products including plywood, particleboard, foams,resins, and plastic.

The remainder of the methanol demand is in the fuel sector, principally as MTBE, which is blended with gasoline as a source of octane and as an oxygenate to reduce the amount of harmful exhaust emissions from motor vehicles.

Storage Facilities

Product	Tank (s)	Capacity (bbls.)
Crude Oil	4	1.0 million*
Gasoline (unleaded)	2	1.0 million*
Naphtha	2	1.0 million*
LPG	2	250,000*
Methanol	1	1.0 million*
Bitumens*	1	250,000*
Fuel Oil	1	250,000*
Jet Fuel	2	1.0 million*
Kerosine	1	100,000*
Sulfuric acid	1	500,000
Wastewater	1	500,000
Stormwater	1	500,000

* each

The entire tank farm will be bermed for soils, drainage systems for liquid spills,to include the stormwater system. Crude oil tanks, will be located to provide direct feed to the atmospheric tower(s). Tank farm foundation will be a solid slab of concrete to support the weight of the tankage for crude oil and products.

Bitumen products tank will have a heated core to keep the product liquid. Instrumentation in the control room will assist in the inventories of both crude oil and petroleum products tanks.

Permanent fire hoses are mounted in the tank farm area to assist during any fires in the area. Automatic heat sensors to signal the presence of fire in the tank farm and sound the sound the alarm to control and extinguish the fire.

Petrochemical - Refinery Yields

Product	Distillation Tower (s)	Catalytic Reformer	Vacuum Unit	Partial Oxidation	Hydrotreater (naphtha)
Light & Heavy	x				
Naphtha	x				
Kerosine	x				
Aviation Fuel	x				
Diesel Fuel	x				
Heating Oils	x				
Gas Oils	x				
Fuel Oils	x				
Naphtha		x			
Gasoline straight run		x			
High Octane Gasoline (Low Sulfur)					x
Pitch Asphalt			x		
Methanol				x	

Petroleum Products

Product	Domestic	Europe	Quantity (tons/yr)
Gasoline (unleaded)	x	x	2,200,000
Naphtha	x	x	700,000
LPG	x		250,000
Methanol		x	540,000
Bitumen	x		400,000
Jet Fuel	x	x	2,000,000
Diesel	x	x	2,000,000

Catalyst

Type	Source	Quantity
Zeolite Catalyst	UOP, Inc.	2.35 million mt./yr

Chemicals

Type	Source	Quantity
Sulfuric Acid	Stratco Inc.	290,000 mt./yr

5.5.7 Waste

Ankobra Resources Ltd. project waste generated at an estimated 1,510,000 tons/yr. on an annual basis. Approximately eighty-five (85%) percent of the waste being generated will be liquid in the form of waste water.

Waste Streams

Waste	Gas	Liquid	Solid	Quantity
Waste water		x		1,359,00 tons/yr
Zeolite Catalyst			x	151,00 tons/yr
Sulfuric Acid		x		290,000 tons/yr
Calcium Fluoride			x	100,000 tons/yr

5.5.8 Solid Waste Disposal Practices

The most significant solid waste, Zeolite Catalyst, which will be, (1) recycled and (2) shipped to manufacture to re-activate the catalyst. Internal boilers will burn both liquid and solids as intermediates in both the petrochemical and refinery units.

Contaminated solids such as crude oil solids, solids contaminated with petroleum products are primarily disposed of by high temperature incineration (Fig. 19) . Ankobra Resources Ltd. will have an onsite incineration unit and storage capacity to burn all waste at a scheduled time.

Bottom sludges from the petrochemical-refinery complex is incinerated on site in the high temperature incineration unit. The rotary kiln section is normally used for such disposal.

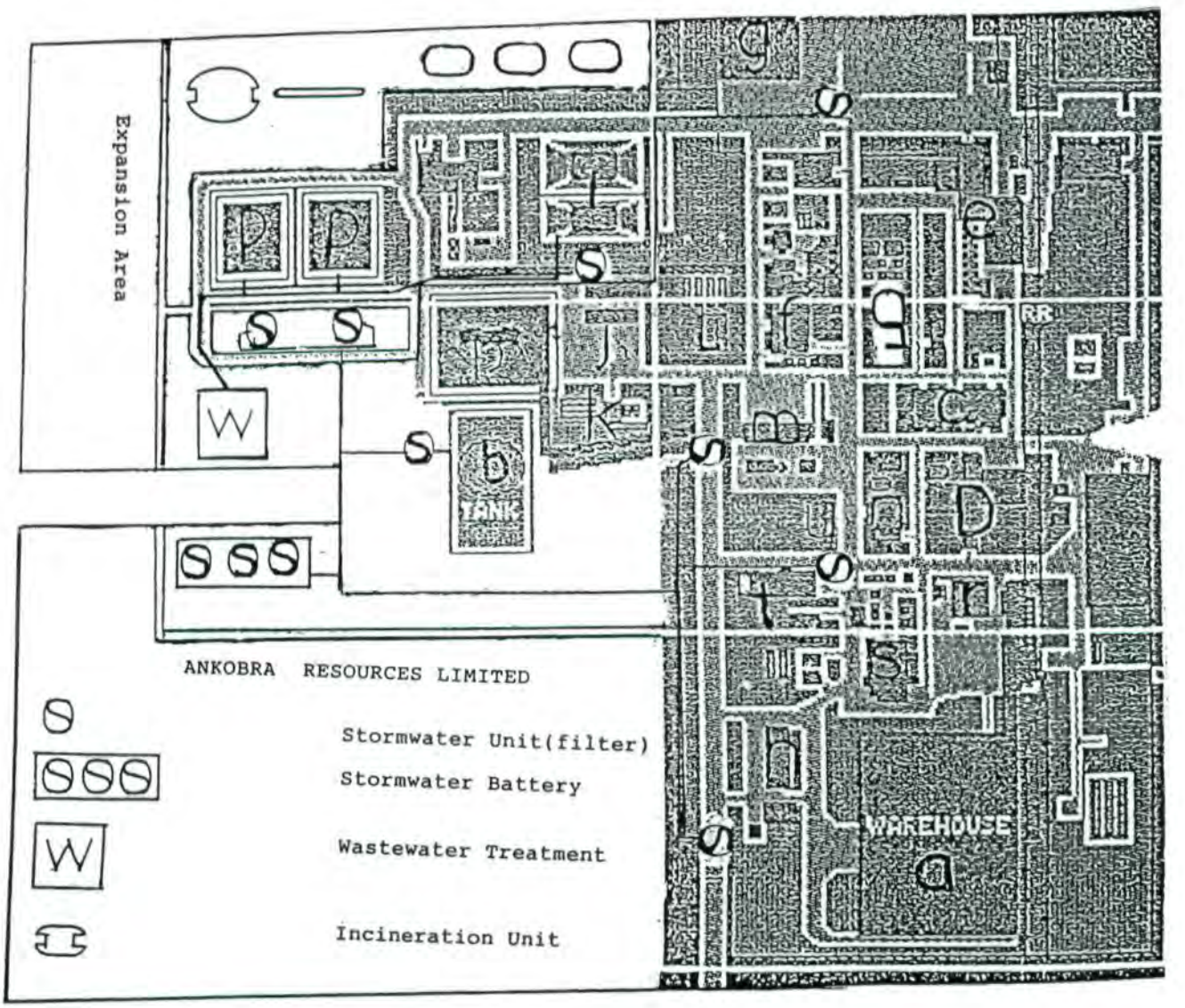


Figure 17. Stormwater and Wastewater Diagram

ANKOBRA RESOURCES LTD.

A.	WAREHOUSE(S)	
B.	TANK FARM	
	1. Crude Oil	600,000 tons
	2. Intermediate Products	900,000 tons
	3. End Products	500,000 tons
	4. Wastewater/Sludge	500,000 tons
C.	ADMINISTRATIVE BUILDING	
D.	LABORATORIES	
	1. Environmental	
	2. Quality Control	
	3. Petroleum	
	4. Chemistry	
E.	TRAINING BUILDING (S)	
F.	PERSONNEL CHANGING ROOM COMPLEX	
G.	MEDICAL DENTAL CENTER	
H.	AUTOMOTIVE/TRUCK REPAIR CENTER	
I.	TURBINE GENERATORS (ELECTRICAL)	
J.	CONTROL ROOM (S)	
K.	CONTROL ROOM - TANK FARM	
L.	GENERATORS (EMERGENCY)	
M.	TRANSPORT CENTER	
N.	MAINTENANCE BUILDINGS	
O.	PIPELINE(Pipeline under road throughout Free Zone)	
P.	PROCESSING EQUIPMENT	
	1. Distillation Tower	
	2. Catalytic Reforming Unit	
	3. Alkylation Unit	
	4. Visbreaking Unit	
	5. Fluid Catalytic Cracking (FCCU)	
	6. Hydrodesulfurization Unit (HDS)	
	7. Unibon Unit	
	8. Partial Oxidation/Methanol	
Q.	TRAINING FIELD AREA (Fire Fighting Techniques)	
R.	SHIPPING AND RECEIVING BUILDING	
S.	FIRE STATION	
T.	LPG FILLING STATION	
U.	SCALES (TRUCKS)	

Contaminated items candidates for high temperature incineration:

1. contaminated paper, wood, metal objects, and debris
2. contaminated sulfuric acid (not recycable),waste water (high metal content)
3. tank cleaning solids, and liquids

5.5.9 Waste water Treatment Facility

A significant amount of wastewater will be generated on an annual basis. The wastewater treatment facility can treat up to 1.5 to 2.0 million gallons of wastewater per day (Fig.17). About seventy to ninety percent of the wastewater treated can be re-used in the petrochemical-refinery complex. The ten (10%) percent to thirty (30%) percent incinerated on-site by the thermal oxidation method, incineration that produces steam. This steam can be piped into electric power generating area to produce electricity.

Sulfuric Acid:

The sulfuric acid will be recycled and fresh sulfuric acid added to the amount in process. The residual solids will be incinerated in the on-site incinerator.

5.5.10 Management of Process Effluents:

The management of process effluents can be determine by the simplified refinery flow diagram (Fig.2C). Effluents from the atmospheric distillation column are normally processed in the alkylation unit. In the alkylation unit's effluent-treating systems, any neutralized HF acid must eventually leave the system as a metal fluoride.

Effluent Neutralization:

The effluent containing HF acid can be treated with lime [CaCO-Ca(OH) (2)] solution or slurry, or it can be neutralized indirectly in a KOH system to produce the desired CaF(2) product. The KOH neutralization system currently used in a UOP-designed unit involves a two-stage process. As HF acid is neutralized by aqueous KOH,soluble potassium fluoride

(KF) is produced, and the KOH is gradually depleted. Periodically,some of the K-F containing neutralizing solution is withdrawn to the KOH generator. In this vessel,KF reacts with a lime slurry to produce insoluble CaF (2) and thereby regenerates KF to KOH. The generated KOH is then returned to the system,and the solid CaF (2), is routed to the neutralizing basin.

REVERSE OSMOSIS FOR WASTEWATER TREATMENT
AND WATER RECYCLE

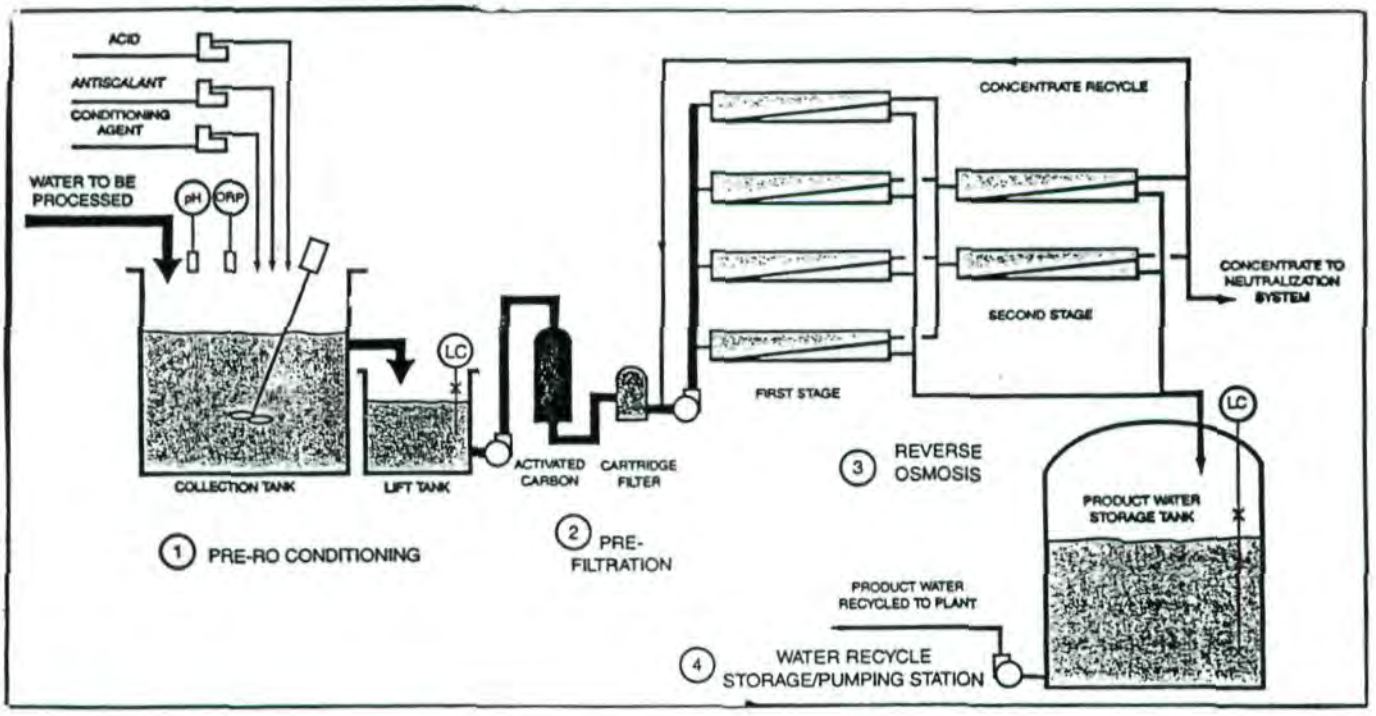


Figure 30. Reverse Osmosis for Wastewater Treatment and Water Recycle

5.5.11 Waste Disposal

Effluent Gases- The HF Alkylation unit uses two separate gas vent lines to maintain the separation of acidic gases from nonacidic gases until the acidic gases can be scrubbed free of acid.

Acidic Hydrocarbon Gases. Acidic hydrocarbon gases originate from section of the unit where HF acid is present. These gases may evolve during a unit upset, during a shutdown or during a maintenance period in which these acidic gases are partially or totally removed from the process vessels or equipment. The gases from the acid vents and from the acid pressure-relief valves are piped to a separate closed relief system for the neutralization of the acid-scrubbing section to the refinery nonacid flare system,where they are disposed of properly by burning.

The acidic gases are scrubbed in the acid neutralization and caustic regeneration system as shown Fig. 1.4.6. This system consists of the relief -gas scrubber, KOH-mix tank, liquid knock-out drum, neutralization drum, circulating pumps, and a KOH-regeneration tank.

Acidic gases, which were either vented or released, first flow to a liquid-knockout drum to remove any entrained liquid. The liquid from this drum is pumped to the neutralization drum. The acidic gases from the liquid-knockout drum then pass from the drum to the scrubbing section of the relief-gas scrubber, where countercurrent contact with KOH solution removes the HF acid. After neutralization of the HF acid, the nonacidic gases are released into a refinery flare system or the onsite incineration system(Fig.19).

Nonacidic Hydrocarbon Gases. Nonacidic gases originate from section of the unit in which HF acid is not present. These nonacidic gases from process vents and relief valves are discharged into the refinery nonacid flare system or the onsite incineration system, which they are disposed of by burning.

Obnoxious Fumes and Odors. The only area from which these potentially objectionable fumes could originate is the unit's neutralizing basin. To prevent the discharge of these odorous gases to the surroundings, the neutralizing basins are tightly covered and equipped with a scrubber to remove any offensive odors. The gas scrubber uses either water or
activated charcoal as the scrubbing agent. However, in the aftermentioned neutralizing system, odors from the basin are essentially nonexistence because the main source of these odors (acid-regenerator bottoms) is handled in separate closed vessels.

Liquid Waste. The HF Alkylation unit is equipped with two separate sewer systems to ensure the segregation of the nonacid from the possibly acid-containing water streams.

Acidic Waters. Any potential HF-containing water streams (rainwater runoff is the acid area and wash water), heavy hydrocarbons, and possibly spent neutralizing media are directed through the acid sewer system, to the neutralizing basins for the neutralization of any acidic material. In the basins, lime is used to convert the incoming soluble fluorides to CaF (2). The CaF (2) residue can be used in the Steel Mills as a flux agent.

Nonacidic Waters. The nonacid sewers are directed to the refinery waste water disposal system or the API Separators.

Liquid Process Wastes (Hydrocarbon and Acid). Hydrocarbon and acid wastes originates from some minor undesirable process side reactions and from any feed contaminants that are introduced to the unit. Undesirable by-products formed in this manner are ultimately rejected from alkylation unit in the acid-regeneration columns as a bottoms streams.

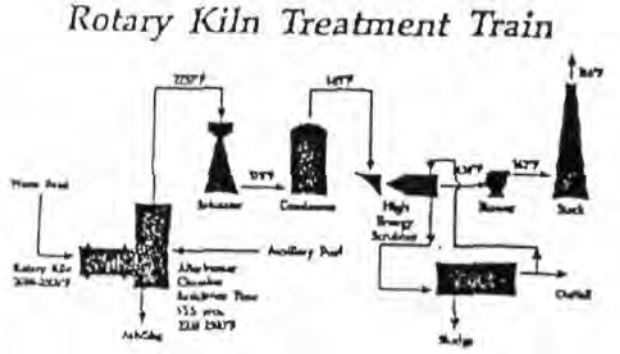
The first step is the disposal of these materials is to direct the regenerator bottoms to the polymer surge drum, where the two mixtures separate. The acid and water mixture form an azeotrope, or constant boiling mixture (CBM), which is directed to the neutralizing drum (Fig. 1.4.8.) for neutralization of the HF acid. The acid is this CBM ultimately ends up as insoluble CaF (2) (as described previously). The polymer that remains in the polymer surge drum is then transferred to the tar neutralizer, where the free HF acid is removed. The polymer can then be disposed of by burning (Fig.19). However by mid 1980's technology and special operating techniques such as internal acid regeneration had virtually eliminated this liquid-waste stream.

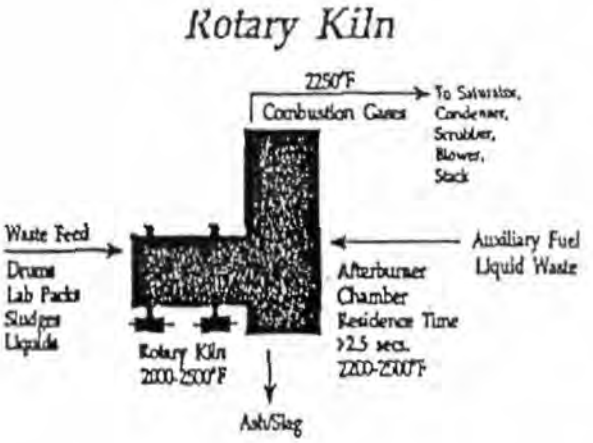
5.5.12 Solid Waste Disposal Practices:

Neutralization-Basins Solids. The neutralization-basin solids consist largely of CaF (2) and unreacted lime. As indicated previously, all HF-containing liquids that are directed to the neutralizing basins ultimately have any contained soluble fluorides converted to insoluble CaF (2). The disposal of this solid material is done on a batch basis. A vacuum truck is normally used to remove the fluoride-lime sludge from the pit. This sludge has traditionally been disposed of in a landfill, Ankobra Resources Ltd. will incinerate the sludge.

The disposal of waste generated by the Ankobra Resources Ltd. petrochemical-refinery complex is mainly wastewater. Solids potentially will range around two percent of the total number of tons generated on an annual basis.

The wastewater treatment facility will eliminate the need for a significant amount of incineration of waste on the proposed site. Catalyst will rejuvenated by shipping back to Europe to the manufacturer.





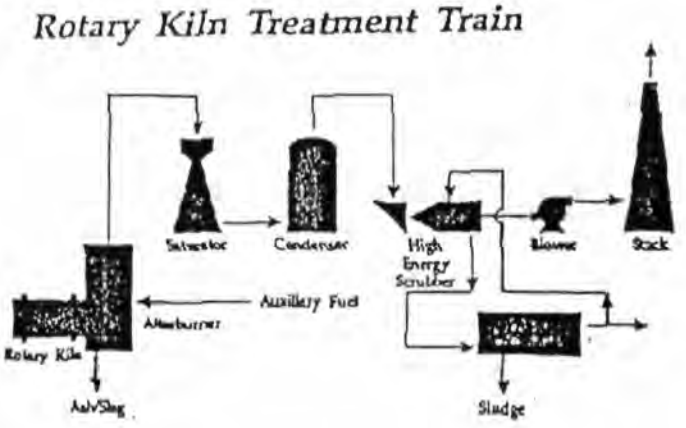


Fig. 19. Rotary Kiln Treatment Train

General Waste Management Scheme

Process	Gas	Liquid	Solid	Wastewater Treatment	Flare*	Incineration
HF Alkylation						
Relief Gas	x				x	x
Refinery Wastewater		x		x		
Process Sludge			x			x
Process Tar			x			x
Alumina			x			x
Calcium Fluoride			x			x
Partial Oxidation						
Wastewater		x		x		x

* optional for incineration

Figure 29. General Waste Management Scheme

Disposal of bottom sludge with No.6 fuel oil consistency is normally formed into a slurry for high temperature incineration into the rotary kiln train (Fig.19). Small amounts of bottom sludge is drummed in 55 gallon steel drum, if kiln can burn metal drums or fibre paks (pressed paper) are burned in these containers.

Product-Treatment Waste Solids. The product-treating waste solids originate where LPG products are defluorinated over activated alumina. Over time, the alumina loses the ability to defluorinate the LPG product streams. At this time, the alumina is considered spent, and it is then replaced with fresh alumina. Ankobra Resources Ltd. will send the alumina to the alumina vendor for recovery.

Miscellaneous Waste Solids. Porous material such as wiping cloths,wood,pipe covering and packings that are suspected of coming into contact with HF acid are placed in specially provided disposal cans for removal and periodically burned (Fig.19)

5.5.13 Drainage Systems and Stormwater Management:

Drainage of the entire petrochemical-refinery complex will be a "closed system". The "closed system" includes polypropylene piping for both the waste water and stormwater drainage (Fig.17).

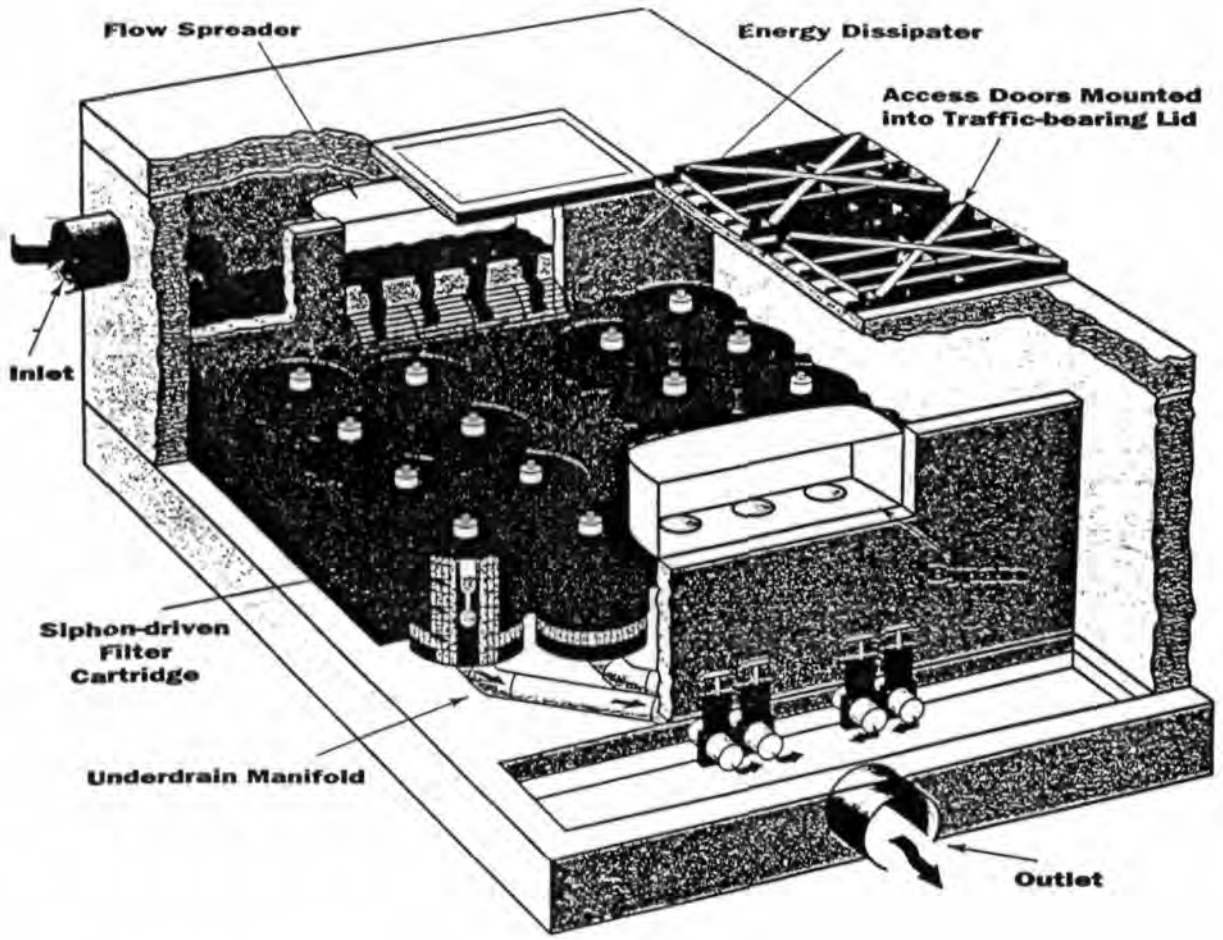


Figure 18. Stormwater Unit-Filter

Drainage-Operational Phase

Area of Contamination	Effects on Drainage
Petrochemical-Refinery Complex	The Petrochemical-refinery complex will consist of a stormwater collection system (Fig.17). All rain water collected from its streets and bermed tank area is then collected, filtered, tested, and finally discharge for "cooling" water or incinerated The wastewater from the petrochemical-refinery unit is collected via a "closed system", treated by a wastewater treatment center. Seventy (70%) to ninety (90%) percent of the treated wastewater will be used as "cooling" water. The ten (10%) to thirty (30%) percent will be incinerated on site. All streets located within the petrochemical -refinery complex will have a "closed system" for the collection of stormwater.

An example as related to socioeconomic impacts associated with wastewater treatment plants and related area wide water-quality planning efforts. A conceptual example of direct and indirect socioeconomic impacts of a small wastewater treatment plant, and their inter-relationship.

The drainage of rain water through the stormwater "closed system" will not impact the petrochemical-refinery complex during the operational phase. There is no contamination to the soil surface or ground with a "closed system" with polypropylene piping for discharge into the stormwater units and subsequent stormwater batteries for final filteration (Fig.17)

5.5.14 Monitoring of all Air Emissions:

Several operations have been mentioned in the treatment of wastewater, incineration, and perimeters around the Ankobra Resources Ltd. site. It has been noted that internal boilers

will burn most of the intermediate by products produced by the petrochemical-refinery complex.

The incineration system shown in Figure 19 are the typical components found in most incinerators that handles large volumes of waste (liquid/solid/sludge). These units on a worldwide basis are monitored by electronic devices,which monitor mainly gases, i.e. NO,NO(2), SO(2),NH(3),Hg,H(2)O and CO (Fig. 20). We have choosen the Opsis System, primarily its made in Europe and has such components as an emitter, receiver, power supply fibre optic cable, and analyzer (Fig.22).

The Desonex Process can be used in the electricity power generating station using fuel oil as a raw material, while steam is converted into electricity (Fig. 20). The atmospheric modelling area will include a computerized air quality monitoring system, Fig 23, to monitor all gases being emitted from the plant area. Daily logs are kept on all readings by the electronic equipment and analytical data processed by the operator.

Components of the Desonex Process:

1. Steam generator
2. Air pre-heater
3. Electric precipitator
4. Fan
5. Gas pre-heater
6. Channel Combustion
7. NH (3) Injection
8. Catalyst Tower
9. Heat Exchanger and H (2) SO (4) prod.
10. Sulphuric acid scrubber
11. Wet electric reheater
12. Flue gas reheater
13. Stack

The Opsis Computerized Air Quality Monitoring System has a range between 300 to 800 meters in length. Data collected by this monitoring system will enable the Environmental Engineer to compare the baseline with the operational phase of gases being emitted.

5.5.15 Air Quality Modelling and Predictions of Ambient Air Quality Conditions

Ankobra Resources Ltd. has presented a case study of a refinery complex with the basic processing equipment and petrochemical production of methanol. This case study used various atmospheric diffusion modeling to determine air quality impacts.

Comparison by Processes

Kingsport, Tennessee	Sekondi Export Processing Zone
Crude oil distillation to produce the major fractions	Same
Vacuum distillation of the crude oil still bottoms	Visbreaker

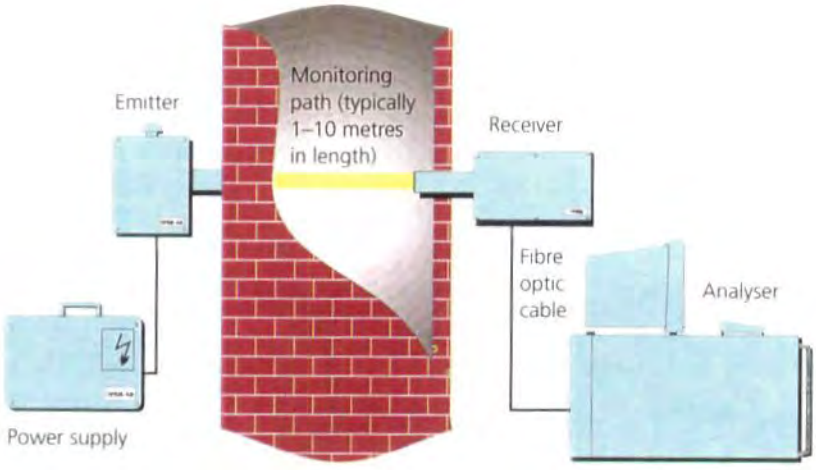


Figure 22. Typical Components of the Opsis System

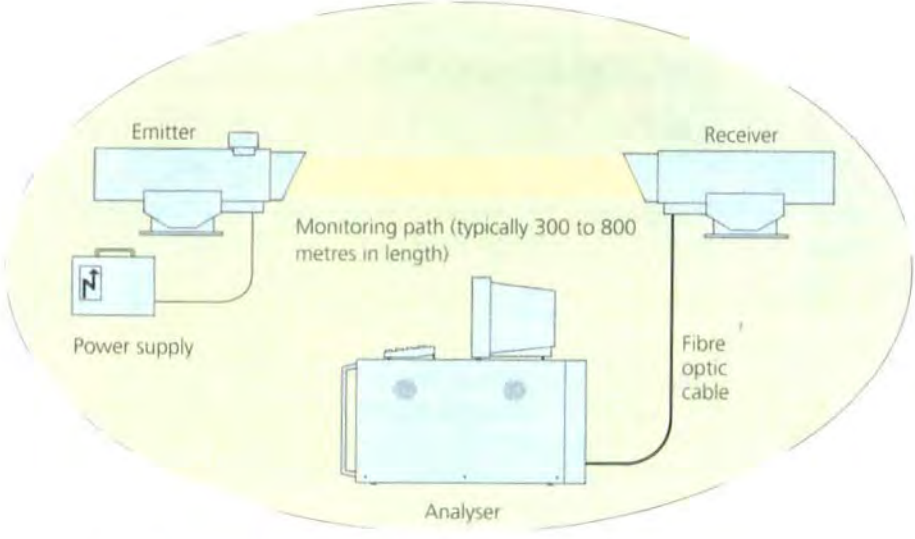


Figure 23. Opsis- Computerized Air Quality Monitoring System

Catalytic coking of the heavy bottoms of the vacuum still to produce coke, gas, and gasoline	FCC unit
Catalytic cracking of the heavy gas oils from the crude oil still and the vacuum still overhead to produce Light oil and gasoline	FCC unit
Hydrogen treating to saturate the middle distillate from the crude oil still to produce light fuel oil,diesel fuel,and kerosene	Hydrodesulfurization Unit
Catalytic Reforming of the heavy naphtha to produce gasoline	Catalytic Reforming Unit
A gas plant to purify liquid petroleum gas (LPG) and fuel gas from the light naphtha off the crude still and the tops off other units	Syngas conversion
Gasoline blending operations	Gas-Concentration Unit
Elemental sulfur production from the hydrogen sulfide off gas streams	UOP*Merox Process
Sulfuric acid production in a contact acid plant	Acid neutralization and caustic regeneration section
Coal fired boiler	Fuel oil (No. 2)

Major Pollution Units

Kingsport, Tennessee		Sekondi Export Processing Zone	
1.	sulfur plant	1.	None
2.	sulfuric acid plant	2.	None
3.	Catalytic Coker	3.	Yes
4.	Catalytic Cracker	4.	Yes
5.	# 1 Boiler (coal fired)	5.	#1 Boiler (fuel fired)
6.	#2 Boiler (coal fired)	6.	# 2 Boiler(fuel fired)

The following simplified case study illustrates the results of the diffusion modeling required for the air quality impacts analysis for a prevention of significant deterioration process.

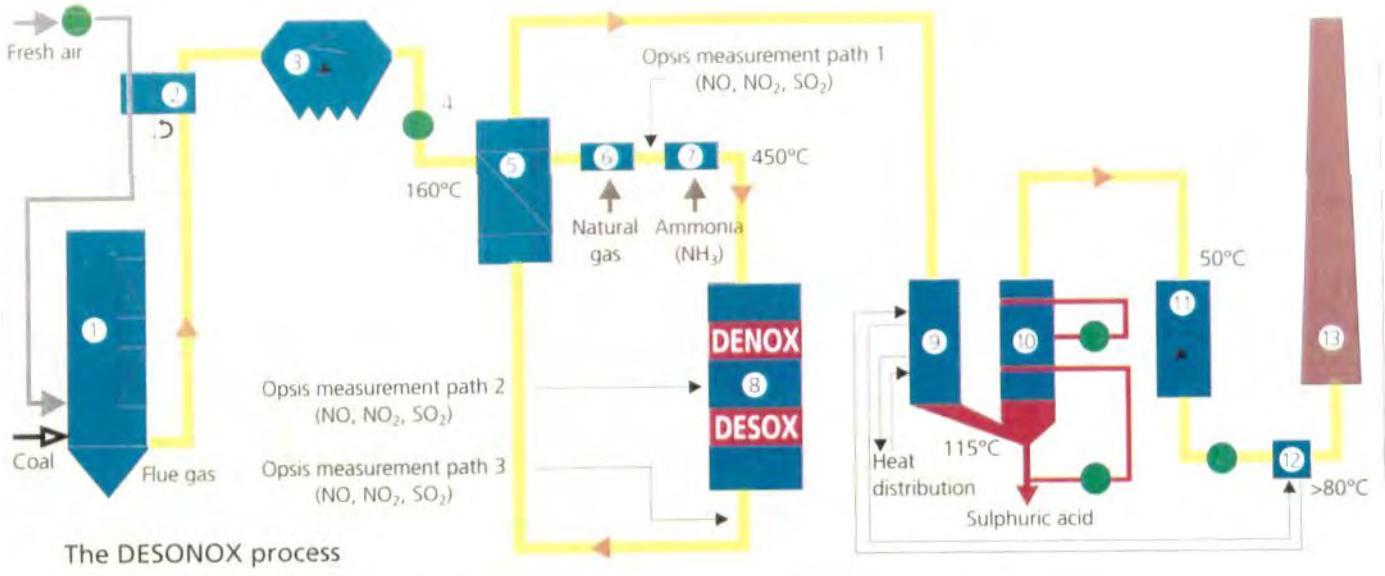


Figure 20. Desonox Process- Monitoring Electricity Power Generation Station

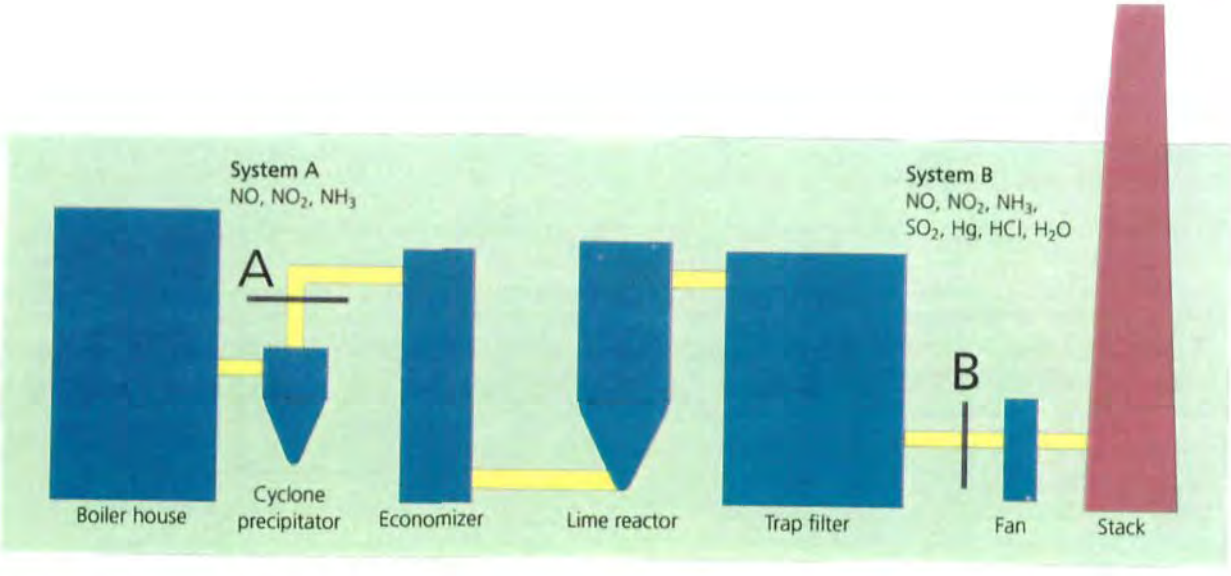


Figure 21. Opsis Syatem A & B - Incineration

Kingsport, Tennessee	Sekondi Export Processing Zone
1. refinery-complex located near a large chemical facility on the central section of an island	refinery-complex has a petrochemical unit on roughly elevated level soil
2. island surrounded by a large river on one side and a channel on the other	No creeks, lakes, or rivers located on the proposed site
3. is served by a rail and highway facilities	is served by a rail and highway facilities
4. hilly terrain surrounds the area with prominent ridges running in the northeasterly-southwesterly direction	terrain basically level,but elevated as as compared to the nearest village
5. small city lies mostly northeast of the island	Anoe Village approximately 300m south

The Kingsport,Tennessee area is a Class II Air Quality Region for PSD analysis. Increments listed in Table 2.7 are, therefore,in effect. There are several monitors in the area which maybe used for establishing the baseline. It maybe assumed that the highest concentration measured at available PSD monitors in the are will set the baseline concentration.

Table 2.8 lists both growth and credit sources. Sulfur dioxide monitor # 47-163-0009 is closest to the refinery-chemical complex and data from this monitor is used in Table 2.10. Latest available data taken from two sulfur dioxide plants monitors,including the one just mentioned, follows in Table 2.9.

5.5.16 Meteorological Data:

Surface meteorological data is available for the area from the station location at the Bristol Tri-Cities, Airport in Tennessee. This station is about 12 km east by northeast of the plant site.

5.5.17 Modeling Results:

The goal of the modelling exercise is to determine the increase in ground level SO(2) concentration for 3-hs,24-h, and annual averaging periods and also it determine the total ambient air impact after the new plant begins operating. The desired results is that the increase in ground-level SO(2) concentrations for each averaging period should be less than PSD increments shown in Table 2.7, and the total ground-level SO(2) should be less than the National Ambient Air Quality Standards (NAAQS) for SO(2).

The goal is accomplished by setting up two source groups,one group being the existing PSD sources listed in Table 2.8 alone (hereafter referred to as the "OLD group") and the second group being all the PSD sources, including the new sources listed in Table 2.6 (hereafter referred to as the "ALL group). The maximum SO(2) concentration for each averaging period at each receptor location at each receptor group in the OLD group is the "PSD increment" that is being referrred to.

Also, the appropriate monitored ambient air concentration at Sulfuric Dioxide monitor # 47-163-0009 at Kingsport (which is the" background" SO(2) concentration) has to be added to the maximum total of SO(2) concentration in the ALL group and the result has to be compared to the NAASQ standards to make certain that there is no violation of those standards.

A rectangular coordinate system was used. The grid set up by using the plant center and extending a grid 10km in each direction from this point. A grid spacing of 200m was used.

Results are presented in Table 2.10. In the last column of the table,the measured impact of SO(2) at the monitor (1), is added to the highest impact from the "old" and "new",i.e ALL group,sources. This sum is then compared to the NAAQS. In no case is the ambient air quality standard (NAAQS) exceeded.

Also, when the maximum calculations done by the ISCST model indicate no violations. Thus, it could be concluded that the air pollution control provided by this plant is adequate to prevent significant deterioration of ambient air quality.

5.5.18 Ankobra Resources Ltd. Project:

The Kingsport,Tennessee case study was presented, (1) similar processing equipment,(2) similar product line, and (3) both projects have methanol production as a petrochemical. Kingsport,Tennessee project is using coal fired vs fuel oil as the primary energy source in the Ankobra Resources Ltd. project.

Takoradi Air Force Base Air Quality Parameters

Atmospheric Gases	Predictive	WB / USA / Can	Ghana EPC
NOx Emissions			
hourly - ng/L	< 100		
daily - t/d	6.3		
Ambient			
annual/average - ug/m(3)	31.3		
24-hr.average- ug/m(3)	36.5		320

SOx Emissions			
hourly - ng/L	92.7		
daily - t/d	5.5		
Ambient			
annual/average- ug/m(3)	20.5		
24-hr. average- ug/m(3)	23.9		200
Suspended Particulates			
Emissions			
hourly - ng/L	4.9	43	
Ambient			
annual average- ug/m(3)	0.7	50-100	
24-hr.average- ug/m(3)	0.8	150-500	260
Carbon Monoxide			
Ambient			
annual average- ug/m(3)	0.004		10

The Takoradi Air Force Base Air Quality Parameters shows the predictive for air quality in the area near the Takoradi Air Force, Ankobra Resources Ltd. proposed site within the Sekondi Export Processing Zone should be within 15 km of the base. The Ghana EPC limited have been shown for NOx, SOx, Suspended Particulates, and Carbon Monoxide.

Steam emissions are used by the electrical power generating unit and condensation (water) recycled during the process in the Ankobra Resources Ltd. project. The Rectangular Coordinate System will be used by Ankobra Resources Ltd.

Ankobra Resources Ltd. with similar processing equipment and methanol production should be close to the NAAQS results of the Kingsport,Tennessee project. Therefore, the Ghana EPC limits will be obtainable by the Ankobra Resources Ltd, petrochemical-refinery complex, proposed for the Sekondi Export Processing Zone.

5.5.19 Marine Investigation:

Marine investigations revealed that the Sadinella species and shrimping industries are very important to the local economy. The fragile marine and coastal ecosystems are identified as sensitive areas that are subject to coastal erosion and the effects of marine-based pollution, as well as the effects of land-based activities.

Coastal waters are those waters less than 5.5 m in depth and which have a salinity >1500mg/L. There is a known aquatic spawning area in the Gulf of Guinea, located south of the coastline of the proposed site for Ankobra Resources Ltd. within the Sekondi

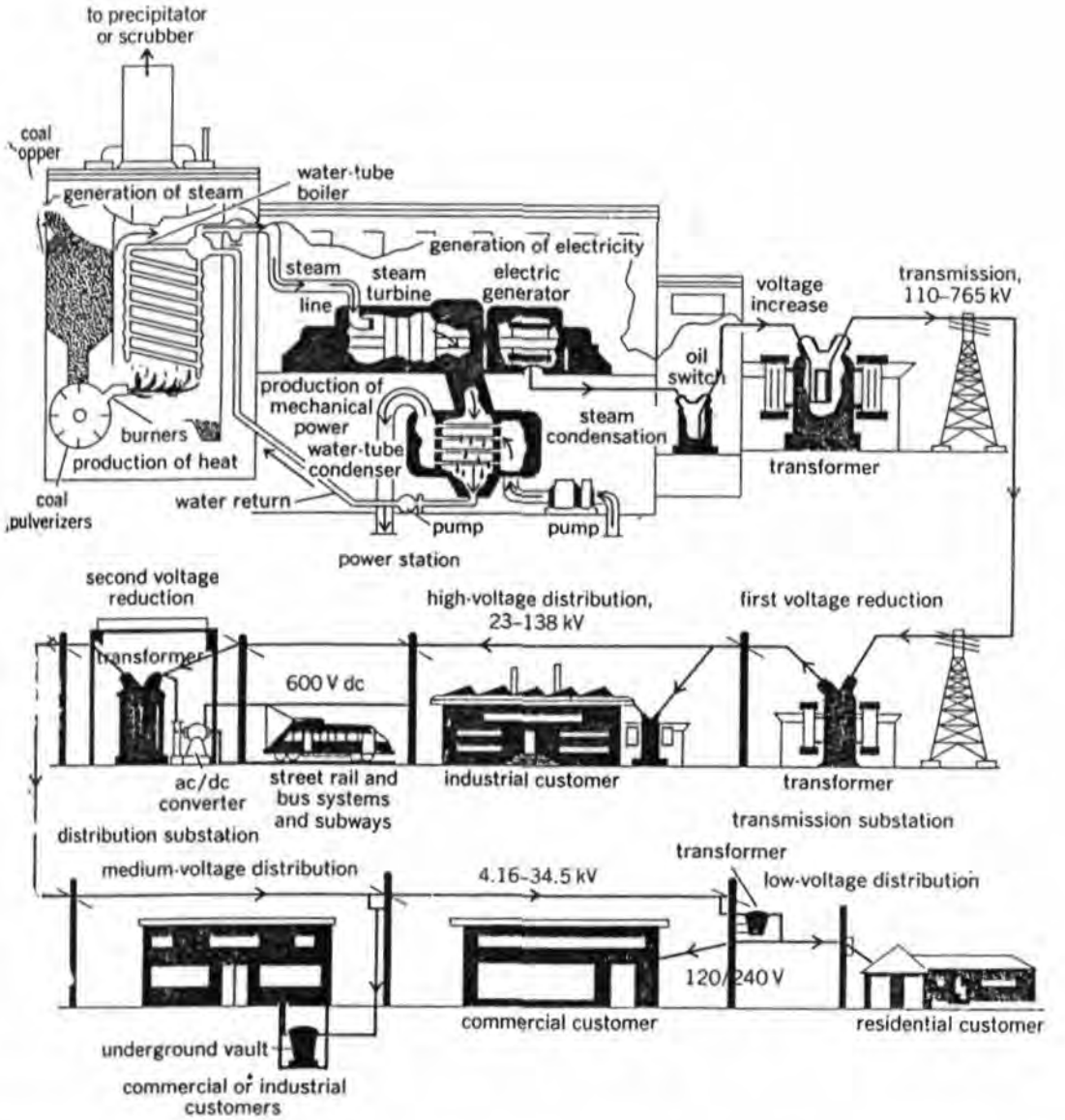


Figure 15. Major Steps in the Generation, Transmission,and Distribution of Electricity

Notes

Export Processing Zone. The aquatic spawning area roughly begins at the 100 fathom level in the gulf of Guinea, Figure 32, Aquatic Spawning Area.

5.5.20 Single Point Mooring System(SPM):

The single-point mooring system will be located downcurrent of the important fishing grounds and aquatic spawning area. Location, north,latitude 5",south, latitude 4" 55' and west, longitude 1" 45' and east, longitude 1" 40' within the Gulf of Guinea.

A double-walled hose will be fitted to the single-point mooring system (SPM). These double walls contain an alarm system to reduce the risk of total hose failure connected to the single point mooring system.

6.0 Mitigation Plan:

Mitigation plans are primarily for the air emissions and for the protection of the aquatic life in the Gulf of Guinea. The Anoe Village, 300m south of the petrochemical-refinery complex, air emissions are a concern of the project and it effects on the population.

6.1 Air Emissions:

Most of the air emissions are noted during the alkylation and polymerization process. The relief gas scrubber piped to a refinery flare system or on-site incineration process. Acid neutralization and caustic regeneration section, relief gas scrubber is vented to flare header or on-site incineration system.

Neutralizing Basin, gas emission to vent scrubber. The vented gases can be piped to an incineration unit to be burned. Excess air vented from the disulfide separator drum can be piped to an incineration unit to be burned. Hydrogen production unit, vented acid gas piped to an incineration unit to be burned.

Shell partial oxidation process, clean gas vented from the cooler/scrubber column can be piped to an incineration unit to be burned. The incineration of off-gas will greatly reduce the potential of air pollutants at the petrochemical-refinery complex.

Gas Emissions

Unit	Gas Emissions	Flare	Scrubber	Incineration
Alkylation	relief gas	x		x
Acid neutralization	relief gas	x		x
Neutralizing Basin	gas-vent scrubber		x	x
Disulfide Separator	excess air			x
Hydrogen Production	acid gas			x

6.2 Aquatic Conditions:

The mitigation plan for aquatic conditions include, (1) understanding the basic Benthos community, (2) placing single-point mooring system(SPM) downcurrent of the aquatic spawning area, and (3) place intake pipe of desalination of seawater in distance less than the output pipe of wastewater discharge.

The single-point mooring system (SPM) will be downcurrent of the fish spawning area Figure 32, shows the activity of currents in the Gulf of Guinea.

The seawater intake for the desalination process at a minimum bottom depth of 6m. Approximately 1200m long intake pipe for the desalination process will be used for the petrochemical-refinery complex.

Wastewater discharge piped approximately 600m long from the land based petrochemical-refinery complex. Approximately minimum velocity discharge rate of 2 m/s (Fig.31).

Discharged Water-Gulf of Guinea

Point of Discharge	Predictive	WB/USA/Can	Ghana EPC
Gulf of Guinea			
salinity (ppt)	55	-	5 above ambient
Tmax (deg.C)	40		at beach

6.3 Social Mitigation:

Anoe Village, located 300m south of the proposed petrochemical-refinery site and is not in the 100m range to be considered a significant factor. Social mitigation includes a Joint Venture Partnership to start an agro-business, initially with egg layers and boilers. Education for school age children of Anoe Village is a part of the social mitigation plan. A progressive educational scheme, development of students in vocational trades,to serve in support industries for commercial and industrial operations.

6.4 Residual Impacts After Mitigation:

The residual impacts after mitigation include (1) air emission, (2) aquatic conditions,and (3) social mitigation. Residual impacts for air emissions include reduce gas emissions in terms of NOx and SOx emissions.

The residual impacts of aquatic conditions involves the discharged wastewater from the land based petrochemical-refinery complex. Samples of seawater and Benthos community as an ongoing aquatic study with the assistance of University personnel to determine the extent of the residual impact.

Residual impacts after social mitigation,will have to be monitored by, Vice-President, Human Resources-Community Development,Ankobra Resources Ltd. to determine, (1) social welfare, (2) health of the community, (3) occupational levels, and (4) agro-business activities. Social welfare of the Anoe Village people includes overseeing housing (if applicable) and educational development.

Through the Human Resources-Community Development Officer,health of the community is a priority and all health issues are presented to the Director of the Medical Center. The health conditions of the Anoe Village people will be a part of the general baseline data gathered initially during the PreConstruction phase.

It is the objective of the petrochemical-refinery complex, to employ 80% to 85% of the indigenous qualified individuals with good health conditions to permit such employment. The Joint Venture Partnership should be able to employ about 90% of the residual members of Anoe Village.

Agro-business activities can employ both males and females, even with some medical conditions not acceptable at the petrochemical-refinery complex. The egg laying and boiler business can be expanded to several regions in the Republic of Ghana in a 3 to 4 year period of time.

6.5 Cost of Mitigation Measures

Estimated Cost of Mitigation Measures

Mitigation Measures	Impact Area(s)	Estimated Cost
Incineration Unit	air emission	$ 19,000,000
Opsis System	air emission (incineration unit)	$ 1,000,000
Opsis System	gaseous emission (power generation)	$ 1,000,000
Desalination System	aquatic environment	$ 4,000,000
Wastewater Discharge	aquatic environment	$ 1,500,000
Dock and SPM	aquatic environment	$ 100,000,000
Agro-business	Anoe Village	$ 500,000
a. buildings	Anoe Village	$ 200,000
b. egg-layer stock	Anoe Village	$ 30,000

c.	boiler stock	Anoe Village	$ 40,000
d.	vehicles	Anoe Village	$ 100,000
e.	feed	Anoe Village	$ 10,000
f.	equipment	Anoe Village	$ 100,000

7.0 Environmental Management and Training:

Environmental management at the proposed site involves the full scope of the land based petrochemical-refinery project. It involves the aquatic conditions of the Gulf of Guinea in relations to the desalination process , discharge of wastewater, and loading and unloading of crude oil and petroleum products at the SPM location.

7.1 Personnel Requirements:

Ankobra Resources Ltd. petrochemical-refinery complex has planned an estimated 350 to 400 workers for the entire operation. The petrochemical-refinery complex will have an Environmental Engineer in charge of environmental activities.

An Environmental Engineer, assumes the responsibilities of the impacts related to the air,land, and water. Supervise all monitoring stations involved in air emissions, land contamination-hazardous waste, and water quality/wastewater discharge activities.

Monitoring and sampling of air, as an air quality requirement within the primary processing zone. Also, monitoring areas to determine the noise level greater than 55dBA to 85dBA. Vibrations are to be monitored on a station to station basis.

The Environmental Engineer, has the responsibility to identify areas within the biomes premises of the petrochemical-refinery site that are considered as causative agents for diseases. Those diseases that are potentially threatening the Public Health of the area. Many diseases are debilitating and caused negative economic trends in the area or region.

7.1.1 PreConstruction

Duties of the Corporate Environmental Scientist during the PreConstruction Phase is to design an Environmental Study, i.e. air monitoring /sampling,noise monitoring, vibration analysis/monitoring, land -soil samples and gridding of area, and Botany-Zoology study in terms of breeding areas,and alternate sites of habitats.

The Corporate Environmental Scientist, designs the information and data base to provide its required environmental report to the Ghana EPA. An understanding of the Environmental Report is the responsibility of the Corporate Environmental Scientist to be submitted to the Ghana Environmental Protection Agency.

The Corporate Environmental Scientist, will develop the environmental study on the Benthos community of the Gulf of Guinea. Specifically, the areas of aquatic spawning for the PreConstruction (baseline), Construction, Operating, Decommission, and Post-Decommission phases. Parameters from the Ghana Environmental Protection Agency will be used to meet the criteria for the environmental study.

7.1.2 Construction Phase

Both the Corporate Environmental Scientist and Environmental Engineer will work to generate models for (1) air quality, (2) noise, (3) vibrations, (4) dust, (5) aquatic spawning area(s), and (6) Anoe Village. During the construction phase, the Corporate Environmental Scientist will work with the V.P. Human Resources and Community Development to provide a model for its environmental issues, (1) air quality, (2) noise, (3) vibrations, and (4) dust in the Anoe Village area.

The community development scheme, includes better health conditions for the Anoe Village people. Monitoring of the environmental impacts is one method of reaching this goal throughout the life span of the petrochemical-refinery project.

7.1.3 Operation Phase

During the operational phase, environmental management includes the following.

1.	monitoring	air, noise, vibrations, hazardous waste disposal practices,flora & fauna,Benthos community (specifically spawning area) water quality and water discharge.
2.	sampling	air, hazardous waste or materials (analysis),water quality samples,waste water samples, and offshore activities i.e. discharged wastewater around aquatic spawning area, and water in the SPM area. residual or ash from the high temperature incinerator, benzene as an intermediate chemical,stormwater before and after final discharge or incineration.
3.	recordkeeping	recordkeeping is a vital part of any enviromental management program. Correlation of data in each phase of the project is essential in the development of a program that will meet the environmental factors, i.e air and water quality, marine environment, wastewater,and hazardous disposal.

7.2 Training Needs

All personnel directly involved in the monitoring and sampling of various environmental areas will have training needs specific to the responsibilities and duties of the individual. Those major areas of training and associated duties have been listed below.

Corporate Environmental Scientist	areas of training inclusive of procedure and methodology of air, water quality, waste water discharge sampling. Gridding and sampling of soil on an internationally accepted basis. Offshore sampling of water and modeling for aquatic spawning areas.
Environmental Engineer	major areas of training includes knowledge of all processes with air emissions,water discharges, and chemicals or materials as residual discharge. Engineer must receive training on hazardous waste disposal, specifically high temperature incineration
Environmental technician	major areas of training includes knowledge of all processes for air emissions,water discharges, and chemical or material as residual discharges. Technician must receive training on hazardous waste disposal, specifically high temperature incineration. The Environmental Technician will have the responsibility of physically taking samples and gather data from various monitoring stations.

7.2.1. Environmental Management

Environmental Management consist of managing sections of the petrochemical-refinery complex that involves air emissions, chemical residuals or materials, water quality, waste water discharge, noise, vibrations, offshore-Gulf of Guinea, i. e. Benthos community and potential areas of contamination, and hazardous waste disposal. This type of management is accomplished by daily monitoring of air emissions (electronic equipment), chemicals or

materials (sampling on a scheduled basis), water quality (monitoring and sampling), waste water discharge(monitoring/sampling), noise (monitoring/recording data), vibrations (monitoring/recording data), offshore-Gulf of Guinea (monitoring/sampling and recording data), and hazardous waste disposal(monitoring/sampling and recording data). All monitoring, sampling, and recording data shall be established either on a daily,weekly, monthly, quarterly, semi-annually or annual basis.

Noise:

Direct and Indirect Impact for the Undertaking

PreConstruction	noise levels are ambient during the pre construction phase of the project. Boundaries established at the perimeter of the petrochemical -refinery complex to locate noise receptors. Dosimeters used to record the ambient noise level on the proposed project site
Construction	all noises receptors sites monitored on a daily basis. The dosimeters used on a daily basis per the planned sites and specific times during the construction phase. Daily logs are a part of the activity to include weekly summarizations to determine times and areas to reduce noise.
Operation	a noise abatement program includes office noise,processing equipment noise, control room noise, and perimeter noise.The community noise receptors will be placed to detect noise Perimeter noises between 55dBA to 85dBA. Daily logs are kept on noises in the community as part of the abatement program.
Decommission	removal of plant processing equipment (i.e. distillation tower(s), FCCunit, Visbreaker,and Unibon) will eliminate the potential of generating any noise,except ambient noise levels. All modular units are removed by heavy equipment or helicopter (s), no high explosives will be used.
Post-decommission	noise receptors will remain in place. Personnel will be used to monitor the area for about a six month period of time. Survey of all logs from the monitoring activities during this period of time will be analyzed for abnormal noise patterns or peaks of noise. Community monitors will remain in place and personnel will survey all logs on a scheduled basis.

Ankobra Resources Ltd. has presented a case study,"Installation Compatible Use Zone (ICUZ) Program for Military Installations, in relations to land use and defining of the three primary zones. Noise incompatibility (in relation to land use) at a military installation is addressed by means of a land-use planning effort known as the "Installation Compatible Use Zone (ICUZ) Program.

The ICUZ zones are delineated in Table 9.7. An ICUZ study involves the identification and control of noise impacts through the preparation of noise-zone maps of the installation existing and future noise environment; analysis of land -use compatibility problems and solutions,including (1) identification of existing incompatible land uses within zones II and III; (2) identification of possibly incompatible land use within zones II and III;and (3) identification of desirable land uses within zones II and III; review of installation master plans to ensure that existing and future facility sitting is consistent with the noise environment, and the identification of noise sources that create impact,along and the programming of resources for noise-impact reduction (U.S. Department of the Army, 1990; Fittipaldi et al.,1988).

Housing, schools, medical facilities, and other noise-sensitive land uses should be sited according to the following principle:

1. ICUZ zone 1, acceptable
2. ICUZ, zone II, normally unacceptable
3. ICUZ,zone III,unacceptable

Table 9.7

ICUZ Noise Zones

ICUZ zone	Percentage population highly approved	A-weighted day-night sound level ADNL (dBA)	C-weighted day-night sound level CDNL(dBC)
I	< 15	< 65	< 62
II	15-39	65-75	62-70
III	>39	>75	>70

Source: U S Department of the Army, 1990. p.44

The primary means of noise assessment at a military installation should be by mathematical modeling and computer simulation. Simulations will normally be summarized using the

annual average DNL. Separate,overall A-weighted noise-zone maps expressed in A-weighted DNL (ADNL) and C-weighted maps expressed in CDNL should normally be prepared for each major noise source.

All maps should be labeled using the zone designations I, II, and III. In locations where the DNL is determined by a few infrequent, very high-level noise sources (for example,blasts with C-weighted sound exposure levels in excess of 110 to 115 dBA), the contour map should be supplemented with descriptions of these single events and potential community reaction (US Department of the Army,1990).

Table 9.8 shows typical energy-equivalent noise levels at construction sites. Table 9.9 contains information on noise levels observed 50ft from various types of construction equipment.

These levels range from 72 to 96 dBA for earth-moving equipment, from 75 to 88 dBA for materials-handling equipment, and from 68 to 87 dBA for stationary equipment; impact equipment may generate noise levels up to 115 dBA (U.S. EPA,1972).

Both Table 9.8 and Table 9.9 indicate increased noise levels during the construction phase of the project. Table 9.9 indicate noise levels at fifty (50) feet distance and Anoe Village is approximately 300m south of the proposed construction site. Therefore, the local population will be not be affected by noises other than during the construction phase. All processing equipment to include the wastewater facility not greater than 65dBA(zone I).

Vibration: ✓

Direct and Indirect Impacts to the Undertaking

Pre Construction	seismic activities will enable the structural engineers to evaluate the subsurface morphology. During this time, active vibration areas will be detected and logged.
Construction	pre-construction activities such as seismic activities will detect areas with lithology that reduce the potential for vibrations. Concrete anchors on solid base rock such as volcanic rock will further reduce the potential of vibrations. Foundations of portland cement placed on concrete anchors contribute to a solid surface area.
Operation	vibration analysis are routine in terms of fatigue of process equipment and the safety of the employees. Safety engineers logs are vital to the knowledge of fatigue problems with processing equipment
Decommission	removal of processing equipment will eliminate the potential of vibrations at the petrochemical-refinery site. Vibrations monitors provide data or patterns of vibrations to determine the ambient level.

Post-decommission	all vibrations monitors are checked on a scheduled basis. The data recorded serve as a future reference in terms of building during construction activities. Personnel will be used to monitor for vibrations up to a six month period of time.

7.3 Odor

The Ankobra Resources Ltd. project is primarily a crude oil refining and methanol production unit. Refinery gases are a source of raw material for petrochemicals, high octane gasoline, and organic synthesis of alcohols.

Refinery gas, a mixture of hydrocarbon gases (and often some sulfur compounds) produced in large scale cracking and refining of petroleum. The usual components are hydrogen, methane, ethane, propane, butanes, pentanes, and small amounts of other components such as butadiene.

Methanol (methyl alcohol):

Properties:

Clear, colorless, mobile highly polar liquid; miscible with water, alcohols, and ether. D 0.7924, fp -97, bp 64.5 C, bulk d 6.59 lb/gal (20C),refr index 1.329 (20C), surface tension 22.6 dynes/dm (20C),viscosity 0.00593 poise (20C),vap. press 92 mm (20C), flash p 54F (12.2C), autoign temperature 867F (464C).

The properties of methanol does not indicate an odour in its properties. The petrochemical-refinery complex will refine sweet crude with low sulfur content,which means a significant reduction in odour.

Benzene:

There are several methods to produce Benzene an intermediate chemical (1) Hydroalkylation of toluene or pyrolysis of gasoline, (2) transalkylation of toluene by disproportionation reaction, (3) catalytic reforming of petroleum and (4) fractional distillation of coal tar.

Properties:

Colorless to light-yellow. mobile, non-polar liquid of high refractive nature;aromatic odor; vapors burn with smoky flame, bp. 80.1 C;fp. 5.5C,d. 0.8790 (20/4C); wt/gal 7.32 lb; refr index 1.50110 at 20C, flash p 12F (-11C), surface tension 29 dynes/cm. Autoign temperature 1044F (562C). Miscible with alcohol,ether,acetone,carbon tetrachloride,

Table 14.8 Odor Thresholds in Air[22]

Compound	ppm	Compound	ppm
Acetaldehyde	0.21	Ethyl acrylate	0.00047
Acetic acid	1.0	Ethyl mercaptan	0.001
Acetone	100.0	Formaldehyde	1.0
Acrolein	0.21	Hydrochloric acid gas	10.0
Acrylonitrile	21.4	Methanol	100.0
Allyl chloride	0.47	Methyl chloride	(above 10 ppm)
Amine, dimethyl	0.047	Methylene chloride	214.0
Amine, monomethyl	0.021	Methyl ethyl ketone	10.0
Amine, trimethyl	0.00021	Methyl isobutyl ketone	0.47
Ammonia	46.8	Methyl mercaptan	0.0021
Aniline	1.0	Methyl methacrylate	0.21
Benzene	4.68	Monochlorobenzene	0.21
Benzyl chloride	0.047	Nitrobenzene	0.0047
Benzyl sulfide	0.0021	Paracresol	0.001
Bromine	0.047	Paraxylene	0.47
Butyric acid	0.001	Perchloroethylene	4.68
Carbon disulfide	0.21	Phenol	0.047
Carbon tetrachloride (chlorination of CS_2)	21.4	Phosgene	1.0
		Phosphine	0.021
Carbon tetrachloride (chlorination of CH_4)	100.0	Pyridine	0.021
		Styrene (inhibited)	0.1
Chloral	0.047	Styrene (uninhibited)	0.047
Chlorine	0.314	Sulfur dichloride	0.001
Dimethylacetamide	46.8	Sulfur dioxide	0.47
Dimethylformamide	100.0	Toluene (from coke)	4.68
Dimethyl sulfide	0.001	Toluene (from petroleum)	2.14
Diphenyl ether (Perfume Grade)	0.1	Tolylene diisocyanate	2.14
Diphenyl sulfide	0.0047	Trichloroethylene	21.4
Ethanol (synthetic)	10.0		

Composition of tropospheric air

Gas	Volume mixing ratio
Nitrogen, N_2	0.781 (in dry air)
Oxygen, O_2	0.209 (in dry air)
Argon, ^{40}Ar	9.34×10^{-3} (in dry air)
Water vapor, H_2O	Up to 4×10^{-2}
Carbon dioxide, CO_2	2 to 4×10^{-4}
Neon, Ne	1.82×10^{-5}
Helium, ^4He	5.24×10^{-6}
Methane, CH_4	1 to 2×10^{-6}
Krypton, Kr	1.14×10^{-6}
Hydrogen, H_2	4 to 10×10^{-7}
Nitrous oxide, N_2O	3.3×10^{-7}
Carbon monoxide, CO	1 to 20×10^{-8}
Xenon, Xe	8.7×10^{-8}
Ozone, O_3	Up to 5×10^{-8}
Nitrogen dioxide, NO_2	Up to 3×10^{-9}
Nitric oxide, NO	Up to 3×10^{-9}
Sulfur dioxide, SO_2	Up to 2×10^{-9}
Hydrogen sulfide, H_2S	2 to 20×10^{-9}
Ammonia, NH_3	Up to 2×10^{-9}
Formaldehyde, CH_2O	Up to 1×10^{-9}
Nitric acid, HNO_3	Up to 1×10^{-9}
Methyl chloride, CH_3Cl	6×10^{-10}
Hydrochloric acid, HCl	Up to 1.5×10^{-9}
Carbonyl sulfide, COS	3×10^{-10}
Freon-11, $CFCl_3$	2.7×10^{-10}
Freon-12, CF_2Cl_2	5.8×10^{-10}
Carbon tetrachloride, CCl_4	1.4×10^{-10}

Figure 10. Table 14.8 Odor Threshold Air

carbon sulfide, acetic acid,slightly soluble in water.

The term aromatic, a major group of unsaturated cyclic hydrocarbon containing one or more rings, these are typified by benzene which has a 6-carbon ring containing three double bonds. The vast number of these compounds of this group derived chiefly from petroleum and coal tar rather than highly reactive and chemically versatile.

The name is due to the strong and unpleasant odor characteristics of most substances of this nature. Certain 5-membered cyclic compounds such as the furan group (heterocyclic) are analogous to aromatic compounds.

Direct and Indirect Impacts to the Undertaking

PreConstruction	survey of the acreage in terms of odor is performed during the pre-construction phase. Odors can be persistent and nasal sensory discomfort on nausea to the worker and the communities.
Discoloration	of areas within the survey will enable the surveying team to possibly locate any potential site of odors.
Construction	construction activities will not involve any chemicals,open burning of materials or waste with the ability to generate an odor. Use of chemicals in the construction phase will be very limited.
Operation	any use of chemicals will be in a closed system. Loading and unloading of chemicals from a railway tanker and tank trailers will be properly vented.
	railways and tank trailers loading include docking areas with "spill pans" leading to a concrete sump lined with polypropylene (plastic) to control odors and safety of workers.
Decommission	removal of storage facilities of both crude oil and petroleum products will eliminate the potential of odors. Removal of in-plant pipelines for crude oil and petroleum products will further reduce the risks of odors. Back fill areas with new soil and clay to background level
Post-decommission	all meteorological factors, specifically wind directions are monitored in case of odors being emitted after decommissioning of the storage facility. Visible discolorations of the soil will be monitored on a scheduled basis.

7.4 Water Quality

Water quality has to be maintained from the PreConstruction phase to the Decommission phase of the project. The quality is for drinking and industrial uses in the project.

Direct and Indirect Impacts of the Undertaking

PreConstruction	no on-site wells drilled for drinking water, process or waste water treatment facility. Project will use the desalination process to purify water drawn from the Gulf of Guinea.
Construction	project will use a 25,000 gallons per day mobile water purification system.
Operation	project will use the desalination process with a capacity of 1.0 to 1.2 million gallons per day. All waste water will be treated by a waste water treatment facility before being discharged into the Gulf of Guinea
Decommission	dismantling of the desalination process may not be needed,since the prices will benefit the local population in terms of purified water for human consumption. The unit will be dismantled only if the unit is not repairable or political complications are present.
Post-decommission	design of the desalination system using a reverse osmosis process will allow ultra-pure water to be generated. The recycled water can be used for agriculture purposes.

7.5 Wastewater

Direct and Indirect Impacts of the Undertaking

PreConstruction	wastewater generated during the actual preconstruction phase Small incineration units used to incinerate wastewater as generated. Also, electric toilets used for human waste.
Construction	portable housing units available to include offices,sleeping quarters,mess hall, portable water purification system,and incineration units for waste to include water.
Operation	a waste water treatment facility to handle all waters to include process water,drinking water,and sanitary sewer liquids. Off-specification waste water that cannot be recycled will be incinerated.

TABLE 7.3.3 RAW WASTEWATER[a] LOADINGS IN NET KILOGRAMS/1000 M^3 OF FEEDSTOCK THROUGHPUT BY SUBCATEGORY IN PETROLEUM REFINING

	Topping Subcategory		*Cracking Subcategory*		*Petrochemical Subcategory*		*Lube Subcategory*		*Integrated Subcategory*	
Characteristics	*Range*[b]	*Median*	*Range*[b]	*Median*	*Range*[b]	*Median*	*Range*[b]	*Median*	*Range*[b]	*Median*
Flow[c]	8.00–558	66.6	3.29–2,750	93.0	26.6–443	109	68.6–772	117	40.0–1,370	235
BOD_5	1.29–217	3.43	14.3–466	72.9	40.9–715	172	62.9–758	217	63.5–615	197
COD	3.43–486	37.2	27.7–2,520	217	200–1,090	463	166–2,290	543	72.9–1,490	329
TOC	1.09–65.8	8.01	5.43–320	41.5	48.6–458	149	31.5–306	109	28.6–678	139
TSS	0.74–286	11.7	0.94–360	18.2	6.29–372	48.6	17.2–312	71.5	15.2–226	59.1
Sulfides	0.002–1.52	0.054	0.01–39.5[d]	0.94[d]	0.009–91.5	0.86	0.00001–20.0	0.014	0.52–7.87[d]	2.00[d]
Oil and grease	1.03–88.7	8.29	2.86–365	31.2	12.0–235	52.9	23.7–601	120	20.9–269	74.9
Phenols	0.001–1.06	0.034	0.19–80.1	4.00	2.55–23.7	7.72	4.58–52.9	8.29	0.61–22.6	3.78
Ammonia	0.077–19.5	1.20	2.35–174	28.3	5.43–206	34.3	6.5–96.2	24.1		
Chromium	0.0002–0.29	0.007	0.0008–4.15	0.25	0.014–3.86	0.234	0.002–1.23	0.046	0.12–1.92	0.49

Source: U.S. EPA, 1980.

Notes: [a]After refinery oil separator.

[b]Probability of occurrence less than or equal to 10 or 90% respectively.

[c]1000 m^3/1000 m^3 of feedstock throughput.

[d]Sulfur.

Figure 9. Raw Wastewater Loadings in Net Kilograms 1000 M(3) of Feedstock Throughput By Subcategory in Petroleum Refining

Decommission	the wastewater treatment facility to due age of unit or cease to function as designed. The main housing units for workers will be in existence and a use for such system. Proper disposal of metal contents either for recycling or proper disposal in approved landfill.
Post-decommission	any decommissioned wastewater treatment facility will be replaced since a housing community will be in existence.

7.6 Land Assessment

Direct and Indirect Impacts to the Undertaking

PreConstruction	land use in the pre-construction phase includes the study of the subsurface morphology. These activities are accomplished by non-intrusive process such as Landsat and seismic exercises. Demarcation of the surface is a normal procedure for intended construction activities. This process does not alter the surface morphology or terrain.
Construction	include the removal of various surface elevations for the ground work such as the foundation of Portland cement Foundation work does not provide any significant negative impact to the demarcated soil area. Various trenches will be dug to have cement anchors to support the project's foundation. modular units will eliminate the need of on-site fabrication and further reduce the risk of soil contamination with chemicals,metal chips, oil, and degreasers. These units will eliminate the need to erect other industries on-site. Thus reducing greatly the cumulative effect of soil contamination.
Operation	during the operation phase,all modular units will be placed on portland cement foundations,concrete catch basins,and concrete berms for over flow of spills in the immediate area. Stormwater system, drains and catch basins for raw water to be treated for re-use within the petrochemical-refinery complex
Decommission	removal of modular units by heavy cranes or helicopter to include portland cement slabs. All modular units residuals removed,flushed with the appropriate solvent(s) and the incineration of all solids,flushates and liquids on-site.

	The removal of concrete anchors and decontamination with the proper solvent (s) and incinerated. All trenches and excavated space,back filled with clean soil and clay after soil sampling completed and approved.
Post-decommission	sampling of surrounding soil surface to determine; if the background soil surface is within limits of the newly laid area of soil and clay. Landscaping near the natural surrounding to include planting trees for wind barriers and potential soil erosion.

7.7 Flora

Direct and Indirect Impacts to the Undertaking

PreConstruction	the proposed site undergoes demarcation. Presently, no land is under cultivation. At least 100 to 120 acres as the primary site for the petrochemical-refinery site.
Construction	removal of flora over a 100 to 120 acre site will take place in the construction phase. Standing trees spared to remain intact in the construction phase.
Operation	all vegetation, trees, and grasses will have undergone landscaping activities prior to the operation phase. Active cultivation of the natural vegetation,trees, shrubs, and grasses serve both the visual and functional aspects.
Decommission	all vegetation,trees,shrubs,climbers, and grasses will be used as background for newly planted vegetation, trees, and grasses should be very similar to the natural setting of the area.
Post-decommission	the post-decommission phase is used to identify the growth of the newly planted vegetation,trees,shrubs,and grasses.The detection of possible diseases specifically vegetation,trees, shrubs,and grasses are made in this phase. The final activities to bring the floral (vegetation, trees, shrubs, and grasses) to a natural condition.

The Botany-Zoology Survey, University of Ghana, Botany Department has indicated such mammals as the antelopes, durikes, pigs, red river hogs, monogooses, civet, bush babies, and Senegal Bush Baby. Other mammals noted are rats, mice, giant rats, grass cutters, and tree hyrax.

7.8 Fauna

Direct and Indirect Impacts to the Undertaking

PreConstruction	the proposed site will undergo demarcation. Activities to locate any breeding areas for mammals to identify, map and re-settle to a different habitat.
Construction	priority to fence area with continuous construction activities to reduce risk of accidents with mammals. Conclude any re-settlement of mammals to another suitable habitat if necessary during the construction phase.
Operation	perimeter area of the primary petrochemical-refinery complex fenced to stop wandering mammals into the work areas. Also, the fenced perimeter will stop nocturnal activity of some species of mammals.
Decommission	data recorded on activity of local mammals will assist in the landscaping to ensure breeding areas for mammals are protected . Natural vegetation, trees,and grasses should be consistent with the needs of the local mammals for both feeding and breeding.
Post-decommission	the post-decommission phase is used to identify the mammalian population breeding areas, feeding areas, and migratory activities. Correlation between flora and fauna is needed to plan the future will bring of expected mammals in the area.

7.9 Communities

Direct and Indirect Impacts to the Undertaking

PreConstruction	identify the baseline conditions of the nearest communities around the proposed petrochemical-refinery complex. Anoe Village has been identified south of the proposed site for the petrochemical-refinery site.	
	Population	387 indigenous people
	Children	Approximately 80%
	Occupation	Farmers
	Housing	Cinder Block
	School	Elementary
	Health Care	Visiting Medical Personnel
	Major diseases	Malaria
	Basic Utilities	Water yes

Notes

	Electricity no Sewage no
Construction	Basic electricity provided to the site by large generators. Removal of housing and road building on the south end leading to main Accra highway. Activities to build housing,both indigenous and expatriate workers.
Operation	company housing both indigenous and expatriate personnel includes a wastewater treatment facility. Basic utilities such as water, electricity, and sewage as part of the operation phase.
Decommission	removal of company housing with heavy construction equipment. Decontamination of cinder blocks, if needed. Basic utilities are decommissioned to include water, electricity, and sewage services. Removal of Portland cement type foundation and remediation of the soil.
Post-decommission	survey of community site for re-settlement of soil and clay. Inspect planted vegetation,trees,and grasses for signs of growth to determine the health status. Review landscape activities,determine if contours are satisfactory for erosion.

8.0 Pollutants in Environmental Media,Air, Water,and Land

8.1 Pollutants in Environmental Media-Air

Concentrations of Pollutants

PreConstruction	in ambient air conditions, the trophosphere air contain the various gases,water vapor,and chemicals.
Construction	during the construction period meterological equipment to determine wind directions and velocity,precipitation (i.e rain, or hail), on a daily basis. Logged data will assist in mapping a pattern of the area. Emissions are reviewed from the planned operational process and then correlated with the expected emissions from the petrochemical process. No pollutants of air are active during the construction phase.
Operation	during the operational phase,daily checks of valves and the emissions system to include both gases and steam will be recorded. Monitoring equipment placed at boundaries of the petrochemical-refinery complex will detect any gases or steam that migrates beyond the perimeter of the site. This equipment will monitor all VOC and halogens.

Control of air pollution will be accomplished , (1) through the design of all units as related to air or gas emissions, (2) benzene surveillance (3) stack monitoring (plumes), and (4) design of gas emitted from any high temperature incineration unit.

Monitoring of such contaminants as sulfur dioxide,oxides of nitrogen, hydrocarbon (emission as gases), ozone disturbances,oxidants, hydrogen sulfide,smoke, and haze will assist in the reduction of such contamination or gases.

Electronic instrumentation, on a daily basis, providing graphs and charts,are typical methods in maintaining an acceptable level of emissions with either contaminants or gases. Air pollution control equipment (electroprecipitator, vortex, cyclones and air monitoring system on stacks (electronics), is part of the design for the entire plant.

Monitoring of stacks or valves (i.e. release valves) of piping within the plant, and recorded data further analyze emissions,to make the the corrections ,and all emissions to acceptable levels to the local EPA.

Decommission

removal of processing equipment and pipeline will greatly reduce the emissions of organics (i.e VOC's) from the petrochemical-refinery complex site. Removal of the site's incineration units will be last to

further destroy any gases or chemicals that have the ability to contaminate the site or may cause medical problems to the surrounding population.

Post-decommission

all monitoring equipment to include receptors will remain in place for a six month period of time after complete removal of all processing equipment and piping. This activity will allow the assessment of any residual chemicals or gases.

8.2 Pollutants in Environmental Media-Water

Concentrations of Pollutants

PreConstruction

activities to include both seismic and landsat during the *pre-construction phase will assist in subsurface morphology and basic* lithology present. The present site has not shown any indication of any tributaries on the proposed site.

both seismic and Landsat activities will assist in the determination of under ground tributaries. All of the subsequent activities will be geared to the remediation of such tributary or re-directing of such free flowing water.

	the environmental study during the preconstruction will include the detection of the following: Chemical constituents: Carbohydrates,Fats, Oils, and grease,Pesticides Phenols,Proteins, Volatile organic compounds Inorganics: Alkalinity, Chlorides,Heavy metals, Nitrogen,pH Phosphorous and Sulfur Biological constituents: Animals,Plants and Protist (Eubacteria,Archaebacteria,and Viruses)
Construction	the construction phase will not encounter any free flow of water.Any construction will be to avoid the free flowing of water. All major pollutants will be determined in the pre-construction phase of the project.
Operation	during the operating phase pollutants are monitored on a regular basis if present in free flowing or any stagnant waters. the main source of water, whether drinking or industrial uses are from the Gulf of Guinea. A desalination unit will be used to generate around 1.2 million gallons per day of fresh water up to the ultrapure level. Regular chemical and biological analysis performed for all types of pollutants. All wastewater regularly analyzed both for chemical and biological pollutants or contaminants after being processed in the waste water treatment system. A "closed system" will be used for both the water and waste water systems.
Decommission	the desalination unit will be used by the local government, if operational and cost effective to continue to operate. The pipeline connections to the site will be decommissioned.
Post-decommission	the local communities will benefit from the desalination unit.Pipelines connecting to public water systems providing fresh water on a daily basis.

Pollutants in the water is greatly decreased by using a "closed system" from intake pipeline in the Gulf of Guinea to desalination plant located on the proposed site. A micro-mesh screen at the opening of the intake pipeline drawing seawater into the polypropylene pipeline system physically remove pollutants at the millimeter level.

8.3 Pollutants in Environmental Media-Land

Concentrations of Pollutants

PreConstruction	both seismic and Landsat activities will enable the geophysical and geologist to determine the present morphology (surface and subsurface) the environmental study during the pre-construction phase to include the following: Soil chemistry, Soil physics, and Soil organisms Detection of, septic tanks, cespools,hazardous waste,nonhazardous waste (brine disposal) land fills,open dumps,surface impoundments waste tailings,animal burials,graveyards, and under ground storage tanks.
Construction	during the construction phase,all morphologies,deformations,and lithologies have been recorded and reviewed by both the geophysics and geologist. Structural and Soil engineers review the surface and subsurface morphology,deformations, and the basic lithology to finalize the basic construction plans. Trenches dug during this phase to confirm the basic lithology of the proposed site. Basic foundations of Portland cement is laid to support the processing units, i.e.atmospheric tower(s) and FCCU. Basically, there will be no use of chemicals or any biologicals in the construction phase. The potential for land pollutants in the construction phase is very minimal. All processing units are placed by heavy cranes or helicopters (industrial). Fuels managed with environmental concerns in mind for the construction equipment.
Decommission	the land will undergo soil analysis for both chemical and biological pollutants during the decommission phase of the project. Removal of all processing equipment and recycling of other units or metals to be smelted. Landscaping of surface to point of the original background is the objective during the decommission phase.
Post-decommission	the post-decommission phase will include that the property being monitored to include any discoloration of both soils and grasses. All soil surfaces returned to its original background level or close as possible to the original background level.

The major pollutants of the land are chemicals, hazardous waste, and surface water coupled with the presence of heavy metals. Air emissions as pollutants are controlled by the pollution control equipment in the refinery, incinerator, and power generating unit.

8.4 Direct Ecological Changes, Pollutants Concentrations Affecting Communities

The direct ecological changes, pollutants concentrations affecting communities will involve contaminants of the air, water, and land. Anoe Village is approximately 300m south of the primary site for the processing of crude oil and production of methanol.

	Communities
PreConstruction	pollutants concentrations in the pre-construction phase will be at the ambient level for air. Air monitoring units will be employed to determine the actual back ground level. There will be no direct ecological changes during the pre-construction phase of the proposed petrochemical-refinery complex. No gases, chemicals, or significant changes in the moisture content level will take place at this time.
Construction	during the construction phase, fuel emissions from the construction equipment will be present. There will be no significant changes in the gases normally found in the trophosphere, which is the main level of concern. Anoe Village inhabitants are at the ground level and should be affected by the fuel emissions from the heavy construction equipment. All modeling studies are concerned with the trophosphere and not the ground level air as related to air emissions.
Operation	during the operational phase, there will be no significant changes in the trophosphere due to the presence of environmental pollution equipment that will significantly reduce the emission of gases The case study of Kingsport,Tennessee has shown that with the proper environment, pollution equipment, gases, i.e. sulfur dioxide can be controlled to acceptable levels in the atmosphere Anoe Village is about 300m south from the primary site of processing crude oil. EPA procedure indicate that areas of **100m** are not to be considered as significant. Landscaping include the planting of trees to serve as barriers or buffers to include moisture the Anoe Village. A 10m rectangular area will be the primary area monitored for gases,moisture,and all chemicals.

Decommission	in the decommission phase, monitoring units will remain in place and functioning. Botanical and Zoological specimens examined, classified, and followed up in a six month period of time. The general communities topography examined and activities needed to return to original conditions.
Post-decommission	during the post-decommission phase, air models for air dispersion performed to insure that ambient levels of air do exist for the communities

8.5 Direct Ecological Changes,Pollutants Concentrations Affecting Habitats

PreConstruction	direct ecological changes to the habitats of the proposed site within the Sekondi Export Processing Zone is not significant during the pre-construction phase. During the environmental study phase, all habitats will be recorded and activities subsequent to improve conditions before the construction phase. Pollutants concentrations in air will be at ambient levels. All water will be in a close system and no water well drilled on site. Demarcation of land will take place during the pre-construction phase.
Construction	the habitats will be affected directly during the construction phase of the petrochemical-refinery complex. Any breeding areas in the primary zones of construction will be relocated to an area considered environmentally safe. Areas of hunting or natural food resources will be directly affected in the primary construction zone. Habitat areas on the 500 acres of land will be moved to areas isolated from the normal business of the petrochemical-refinery complex.
Operation	during the operation phase,about 100 to 120 acreas of land will be initially used as the primary zone of operation or crude oil processing. This 100 to 120 acres will have perimeters that are fenced to show the delineation between the plant and the habitat areas.
Decommission	the decommission phase will bring about a blending of the primary petrochemical-refinery zone and the habitat,almost to its natural setting. Planting of natural grasses and trees to include landscaping to serve as natural barriers if needed

Post -decommission	the area, close to its natural setting for the habitat should bring back the normal functions of breeding,seeking shelter, and hunting for food.

8.6 Direct Ecological Changes, Pollutants Concentrations Affecting Flora

PreConstruction	all trees will be carefully plotted to determine the path of construction for the primary site, i.e. the processing units (atmospheric towers,FCCU). The areas of natural grass plotted to determine the amount of grasses to be removed during the actual construction phase. No significant air, water, or land pollutants should effect the flora.
Construction	the construction phase, no significant pollutants are present but some flora will suffer visible ecological changes. Natural grasses and vines will be removed during the construction phase. The area is not considered a mangrove area, area with pristine and dense growth,not areas adjoining mouth of a major river system Mapped areas for the primary construction zone will be maintained and honored during the construction phase. All grasses and trees spared in accordance with the mapped area. The planting of natural grasses and trees needed for the various oxygen, nitrogen, and carbon cycles completed at the end of the construction phase.
Operation	the operation phase, flora planted at the end of the construction phase, should be visible and somewhat functional. Whole trees can be planted to quickly provide the natural function of such vegetation. Air pollution control equipment will significantly reduce any gases,chemicals, and steam. All steam will be used in the generation of electricity. An ongoing environmental study of the area will be the monitoring of the flora of the entire 500 acres of land. The unused acreage serving as the control areas and the surrounding primary zone flora as the study area. The con-concentrations of pollutants in the operation phase should be within acceptable limits.
Decommission	during the decommission phase, a study will be made to determine the present baseline condition. Compare the present baseline condition to the original baseline of the flora to determine the general health of each species.

Post-decommission	monitoring during the post-decommission phase is essential for its natural growth. The area should display many of the natural features to include full growth of the indigenous flora.

8.7 Direct Ecological Changes, Pollutants Concentrations Affecting Fauna

PreConstruction	all fauna during the pre-construction phase will be surveyed on the proposed site within the Sekondi Export Processing Zone. All pollutants concentrations will be at the ambient levels as related to affecting the fauna in the preconstruction phase The Environmental Study will include a survey of all fauna present, area of breeding, hunting, and the nocturnal conditions of the major species. All fauna within 100 to 120 acres or primary operating will be affected ecologically significantly , but not in a significant range as related to being affected by pollutant concentrations during this phase.
Construction	active displacement of the fauna located in the primary zone, 100 to 120 acres is significant. No pollutants other than emissions from the construction equipment will be present during the construction phase
Operation	during the operation phase, the physical contact by fauna within the primary zone, area of the processing equipment, i.e. atmospheric towers, perimeters will be fenced to protect the fauna. The outer boundary of the 10m rectangular zone will be fenced to remove fauna from being apart of the atmospheric dispersion modeling exercise. Atmospheric dispersion modeling is ongoing during the operation phase. The presence of surface water has not been detected to date and no pollutants in significant concentration should be present. There are no waterbodies characterized by (a) that is trapped for domestic purposes, (b) within a controlled and/or protected area, and (c) which supports wildlife and fishery activities. Contamination of the land (soil) is not evident at this time. The area is not considered near adjacent or traditional grounds or natural buffers against shore erosion,strong winds,or storm floods.

Decommission	during the decommission phase, the outer boundary fencing will not be removed immediately until the final environmental study has been completed and report submitted to the governmental authorities. The controlled area in terms of the ongoing environmental monitoring and the active primary zone should be delineated for at least a six month period of time.
Post-decommission	the post-decommission period, should be used to monitor the area in terms of growth as related to the fauna present in the 500 acres of land. A time frame to declare the whole area close to the original background in terms of fauna presence and growth should be made at this time.

8.8 Alteration in Ecological Processes Affecting Community,Habitat,Flora,and Fauna

The alteration in ecological processes such as transfer of energy through food chains, decomposition and bio-accumulation which could affect any community, habitat, or specie of flora or fauna are not significant in terms of the present use of the proposed site. The proposed site is located in the Sekondi Export Processing Zone, which is acreage for the construction and operation of heavy industrial firms.

The following are important fundamental terms and concepts in biological impact studies listed below.

1. Biogeochemical cycles (**nutrient cycles**) are the series of bigeochemical by which the earth's inorganic elements (1) are made available for use by the living organisms (2) find their way into the food chain, and (3) are later broken down to begin the cycle again.

   These cycles tie together the biosphere (the global system consisting of the totality of life) and its interaction with the nonliving environment (the geosphere). The fundamental to most of the cycles- and the most important set of biochemical reactions in the biosphere-is photosynthesis.

   Within the total biosphere, as within each ecosystem,organisms are catergorized by their role in these cycles-that is, by how they get their energy,as follows:

   a. Primary producers-"Primary producers" are organisms,mostly green plants,that draw on the sun's energy to make the fuel for others to use.

b. Consumers-"Consumers" are those beings who can eat the food produced by plants, starting with plant-eating (herbivorous) organisms and extending into a chain of larger, animal-eating (carnivorous) organisms.

c. Decomposers-"Decomposers" are microorganisms that break down the remains of dead plants and animals for eventual recycling within the biosphere.

Biological diversity refers to the variety and variability of living organisms and the biological communities in which they live. Biological diversity, or "biodiversity", exist at several levels. For example, "ecosystem diversity" refers to different types of landscapes that act as home to living organisms.

Carrying capacity is the total number of plants and animals that can be supported by a particular ecosystem, without reducing the environment's long-term ability to sustain life at the desired level and quantity. It varies with the type of soil and its inherent productivity, the climate, and the useable products that grow well in that ecosystem, as well as - in the case of cultivated land-the methods used to produce them.

Ecosystem is a stable, interacting gathering of living organisms in their nonliving environment, which is unified by a circular flow of energy and nutrients.

a. whose meaning imposes no size limitation
b. which may refer to something as small as the life in and around a fallen log to that of a huge lake or forest even to that of the whole biosphere, depending on the focus of the observer.

Each ecosystem is bound together by the biogeochemical cycles through which living organisms use energy from the sun to obtain, or "fix" non living (inorganic) elements such as carbon,oxygen, and hydrogen from the environment, and transform them into vital food, which is then used and recycled.

The number of organisms in a mature ecosystem, as well as their rate of growth and lifestyle, depends on the availability of energy and key chemical elements,some of which may be in short supply and, therefore, be limiting factors,such as nitrogen.

Plant Species of Proposed Export Processing Zone-Sekondi:

The University of Ghana, Botany and Zoology Departments, performed a survey to determine the existence of various flora and fauna within the proposed Export Processing Zone-Sekondi. Table 1-Plant Species of Proposed Export Processing Zone-Sekondi

has indicated a variety of herbs, trees, and climbers. Listed below are the families names of herbs, trees, and climbers found in the Export Processing Zone-Sekondi(Appendix II).

Acanthazene
Amarylidacea
Anacardiacea
Apocynaceae
Aracea
Asclepiadacea
Bignoniacea
Bombacaea
Cannaceae
Commelinacea
Compositea
Convolvalacea
Cucurbitacea
Cyperacea
Euphorbiacea
Fern
Graminae
Labiatae
Lauraceae
Loganiaceae
Malvaceae
Marantaceae
Meliaceae
Menispermacea
Mimosacdeae
Moraceae
Myrtaceae
Nyctaginaceae
Passifloraceae
Portulaceae
Rubiaceae
Sapindaceae
Solanaceae
Verbenaceae
Vitaceae
Zingiberaceae

The Zoology Report has indicated the presence of various animals, (1) invertebrates and (2) vertebrates. Listed below are the Order/Family/Common Names of some of the animals present in the Export Processing Zone-Sekondi (Appendix II).

Invertebrates:
Molluscs/Gastropods/ snail
Arthropods/ Myriapods
Insecta/ Lepidoptera/Butterflies
Papilionidae
Pieridas
Nymphalide
Hesperide
Orthoptera/Grasshopper
Hymenoptera/ Ants,Bees

Vertebrates

Amphibians/Anura/Frogs & Toads
Bufonidas (Toads)
Giant Toads
Ranidae (Frogs)
Reed Frog

Repitiles

Marsh Terrapins
Hinged Tortoise

Chamaeleonidae (Chameleons)
Graceful Chameleon

Squamata (Serpents (Snakes))
Royal pythons
African pythons

Colubridae (Typical snake)
Green Tree Snakes
Elapidae (Cobras,Mambas)
Green Mambas
Black forest Cobra
Viperidae (Vipers Adders)
Gabon Viper

Birds

Falconiformes (Birds of Prey)
Black Kite
Hooded Vultures

Psitticiformes (Parrots)
Psittaciadae

	Red headed Lovebird
Squamata: Lacertilia (Lizard)	
	Cuculiformes (Cuckoos)
Agama (Rainbow Lizard)	Musophagidae
Gekkonidae (Geckos)	Grey Plantin-cater
Common House Geckos	Cuculidae
Gecko	Sengal Coucal
Scincidae(Skinks/Snakes-Lizards	Coracii formes (Kingfisher)
Skink	
Varnidae (Monitor Lizards)	
Nile Monitor	

8.9 Ecological Consequences, Direct Destruction of Existing Habitats:

The ecological consequences of direct destruction of existing habitats from activities such as dumping of waste and vegetation clearance and fillings are discussed as related to the petrochemical-refinery complex. Ankobra Resources Ltd. project, a petrochemical-refinery complex utilizes modern environmental methods and procedures to protect the existing areas.

8.9.1 Direct Destruction of Existing Habitat-Dumping of Waste

PreConstruction	during the pre-construction phase, the dumping of waste is prohibited. metal containers are used to hold any waste items during the environmental study phase. All recyclable debris will be recycled and other properly disposed of in a site that is acccptablc to thc local rcfusc laws.
Construction	during the construction phase, the dumping of waste is prohibited. Metal containers are used to hold any waste items during the laying of the foundations. All recyclable debris
will	
	be recycled and other properly disposed of in a site that is acceptable to the local refuse laws. Also, small incineration units will be used to burn liquids,gases, and solids.
	All fuels contaminated will be incinerated under safe environmental conditions. All processing units are pre-fabricated and eliminate piles of scrap metal, after cutting or welding metal parts together. The use of degreasers, i.e. MEK and acetone is not needed since the units will all be pre-fabricated before entering the Republic of Ghana.
	All metal storage tanks, i.e. crude oil and petroleum products (fuel oil, diesel, LPG, and unleaded gasolines) use pre-fabricated sections and spot welded into place.

Operation	during the operation phase,the dumping of waste is prohibited Metal containers are used to hold any waste designated for such container. All debris initially recycled and other residual wastes properly in a site that is acceptable to the local refuse laws.
	stormwater will be collected in a stormwater system. spillage of any liquids in cement catch basins around the processing units,storage facilities,and in-plant roads. Waste water recycled within the refinery-petrochemical primary zone. Steam emissions are piped to electrical generation system and condensation returned to an area of the processing units. Internal boilers will burn intermediate liquids,gases,and solids. Liquids,gases,and solids from the alkylation unit is normally subjected to high temperature incineration. Reformer used to re-process crude oil in the system.
Decommission	during the decommission phase, the petrochemical-refinery will operate to utilize the internal boilers to burn most of the liquids,gas,and solids. All clean out liquids,gas, and solids will burn by high temperature incineration.
	All storage units cleaned out and all liquids,gas,and solids will be subjected to high temperature incineration. The metal pieces will be dismantled and shipped to a smelter in Ghana or Europe.
Post-decommission	the incineration units will be the last equipment to remain to clean up and burn any debris that cannot be recycled. The shipment of the incinerator's inside Ghana for further commercial use. Primary zone inspected for soil discoloration or plumes.

8.9.2 Direct Destruction of Existing Habitats-Vegetative Clearance

PreConstruction	during the pre-construction phase,vegetation clearance of the primary zone, 100 to 120 acres are significant and destruction of habitats in the proposed site of the petrochemical-refinery complex. The relocation of habitats before the actual vegetative clearance will reduce the negative effects of the vegetative clearance process.
Construction	the construction phase will not involve large acreage of land being demarcated or the vegetative clearance process being implemented. This phase will further reduce the destruction

	of habitats located within the Sekondi Export Processing Zone. Areas in the primary operations zone have undergone the vegetative removal process and the existing habitat should have been relocated.
Operation	the operation phase, further reduction of vegetative clearance during the petrochemical-refining of crude oil. All primary zones within the complex will have asphalt roads and cement catch basins for spills. The primary zone will be a fenced area to include all storage facilities and docks. All of the relocated habitats will be in the outer boundary fence or isolated areas on the 500 acres of land.
Decommission	during the decommission phase, relocated habitats will serve as a control group to assist in recycling the primary zone into a future natural habitat. The landscaping of areas similar to the "control areas" should enable us to re-create the primary zone that is acceptable to the local habitat dwellers.
Post-decommission	during the post-decommission phase, monitoring of both the previous active primary zone and control area is essential in blending both areas to become one ecosystem.

8.9.3 Direct Destruction of Existing Habitats- Fillings

PreConstruction	the land filling of industrial waste such as liquids,gas, and solids during the pre-construction phase is prohibited.
Construction	the land filling of industrial waste and construction waste is prohibited during the construction phase. All paper and used bags are subjected to high temperature incineration. The use of chemicals will be small, since most of the foundations using Portland cement. The placing of processing equipment by either heavy duty cranes or industrial helicopters will not create a significant amount of debris.
Operation	during the operation phase, less than two (2%) percent of any waste such as liquids, gas, or solids are candidates for the land fill method. internal boilers will burn intermediate liquids, gas, and solids other liquids,gas, and solids not burned by the internal boilers will be subjected to high temperature incineration

	wooden items such as pallets and crates are ideal for high temperature incineration heavy metals such as vandium, carbon, and nickel, are candidate for recyclers in Europe.
Decommission	all waste materials, liquids, gas, and solids that are not for the internal boilers ,will use high temperature destruction, heavy metals will be shipped to Europe for metal recycling.
Post-decommission	all metals shipped to Europe for recycling will be followed to determine that all metal drums of the metal waste have been properly recycled.

8.10 Changes in Social, Cultural and Economic Patterns Relating to-Valued Resources

There will be a significant change in the social, cultural, and economic patterns relating to valued resources as related to the soil or land of the proposed site and adjacent Anoe Village. These changes will be positive in terms of a better social, cultural, and economic developments for the Anoe Village.

Social Change Anoe Village People:

The Anoe Village people will experience a positive social change at the village level. Basic utilities such as electricity, water, and gas (LPG) and waste water treatment (sewage). Farming has been the main occupation of the village people, adult males and female employment in the petrochemical-refinery complex will change the social conditions for many village people.

Cultural Change Anoe Village People:

The adult generation will be engaged in the industrial occupations and poultry farming with the assistance of the University of Ghana consultation. Basic education in a three (3) tier system will enable the younger generations to become educated and retain new skills for the job market.

Economic Change Anoe Village People:

A significant positive economic change will occur in the Anoe Village people. A major portion of the adult generation will be employed in the refinery or the boiler -egg laying project of the village.

PreConstruction	significant changes in the valued resources such as land, community, and population specifically the Anoe Village people a. plans to transform the land from farming to an industrial site for the refining of crude oil Value of the land will increase and payment to the farmers under crop renumeration to the farmers b. the community will receive the basic utilities, such as electricity, sewage connections, and water. LPG can be purchased from the plant.
Construction	basic pipeline for future gas usage, electrical lines, water lines from desalination unit, and wastewater treatment facility during the construction phase. able bodied individuals will be given employment during the construction phase of the project. Landscaping of the flora takes place at the end of the construction phase.
Operation	during the operation phase, the entire project as related to the petrochemical-refinery plant is fully operational. All storage facilities for both the crude oil and petroleum products have been erected and fully operational. a. employment of adult village individuals either at the Ankobra Resources Ltd. Project or in the poultry business.
Decommission	the decommission phase of the Ankobra Resources Ltd project will not affect either Anoe Village nor the poultry business.
Post-decommission	the post-decommission phase of Ankobra Resources Ltd. project will include final survey of the areas south of the primary zone of the refinery. After 5 to 10 years the poultry business should be self sufficient. All housing to include company housing of Ankobra Resources will not be affected and units can be used by the local government as housing units.

8.11 Direct and Indirect Employment Generation

Ankobra Resources Ltd. project will provide both direct and indirect employment for the Anoe Village people and citizens of both Sekondi-Takoradi, Ghana. Many industries are need needed to service a 140,000 bbls. per day crude oil refining unit.

Some industries are to include industrialize food preparation, welding services, municipal services such as sewer pipe inspection, fire hydrant inspections, and electrical meter reading for each household. Several different types of repair shops for both cars and trucks, housing repairs, roads and street lights.

Projected Employment

Project Phase	Direct	Indirect	Number	Duration
Environmental Study	x		10-20	12 months
Construction	x		100-250	36 months
Road Building	x		30-40	12 months
Operation	x		220-250	lifetime
Laboratory (QA/QC)	x		1-2	lifetime
Laboratory (chemistry)	x		1-2	lifetime
Laboratory (environmental)	x		1-2	lifetime
Medical Center	x		4-6	lifetime
Dental Center	x		2-3	lifetime
Security Guards	x		8-10	lifetime
Automechanics	x		1-2	lifetime
Guest houses (two units)	x		6-8	lifetime
Poultry Farms		x	8-10	lifetime

8.12 Immigration and Resultant Demographic Changes

The Anoe Village people will be given the opportunity to become a viable population through the Ankobra Resources Ltd. project. Mass demographic changes will be held in check by establishing joint venture enterprises with the Anoe Village people.

The area that comprises the Sekondi-Takoradi area has approximately 80,000 people in its population. There should be enough people to fill many basic positions with training from Ankobra Resources Ltd. personnel or its designated consultants.

Projected Employment

Project Phase	Anoe Village	Sekondi-Takoradi	Training*
Environmental Study	x		x
Construction	x	x	x
Road Building	x	x	x
Operation	x	x	x
Laboratory (QA/QC)	x	x	x
Laboratory (environmental)	x	x	x
Laboratory (chemistry)	x	x	x
Medical Center	x	x	x
Dental Center	x	x	x
Security Guards	x	x	x
Automechanics	x	x	x
Guest houses (two units)	x	x	x
Poultry Farms	x	x	x

* training in safety and specific field of work

The above chart will allow Ankobra Resources Ltd. project to provide basic employment levels with training. Many of the administrative positions will be held by expatriates and degreed indigenous personnel.

8.13 Provision for Infrastructure (Roads, Schools, and Health Facilities)

Ankobra Resources Ltd. project will construct and operate roads, schools,and health facilities on the proposed site or near the Anoe Village.

Ankobra Resources Projected Roads

Entrance/Exit		Main Road	Plant	Residential
1.	North Road	x		
2.	South Road	x		
3.	Road P-1		x	
4.	Road P-2		x	
5.	Road P-3		x	
6.	Road P-4		x	
7.	Road R-1			x
8.	Road R-2			x
9.	Road R-3			x
10.	Road R-4			x
11.	Road R-5			x
12.	Road R-6			x
13.	Road R-7			x
14.	Road R-8			x

8.14 Ankobra Resources Ltd. Project-Schools

There is a need for education for both the expatriates and indigenous workers for the petrochemical-refinery complex. Education is a key in any part of the world and a foundation for technology and knowledge.

Ankobra Resources Ltd. Project-Schools

School	Employment Area	Employees
Elementary School		
Prinicpal	Anoe Village Sekondi-Takoradi	1
Asst. Principal	Anoe Village Sekondi-Takoradi	3
Teacher	Anoe Village Sekondi-Takoradi	10-15
Food Service	Anoe Village Sekondi-Takoradi	4-6
Custodians	Anoe Village	1-2
Env. Engineers	Sekondi-Takordi	1-2

Middle School		
Principal	Anoe Village Sekondi-Takoradi	1
Asst. Principal	Anoe Village Sekondi-Takoradi	1-3
Teacher	Anoe Village Sekondi-Takoradi	10-15
Food Service	Anoe Village Sekondi-Takoradi	4-6
Custodians	Anoe Village	1-2
Env. Engineers	Sekondi-Takoradi	1-2
Senior High School		
Principal	Anoe Village Sekondi-Takoradi	1
Asst. Principal	Anoe Village Sekondi-Takoradi	1-3
Teacher	Anoe Village Sekondi-Takoradi	10-15
Food Service	Anoe Village Sekondi-Takoradi	4-6
Custodians	Anoe Village	1-2
Env. Engineers	Sekondi-Takoradi	1-2

8.15 Ankobra Resources Ltd. Project-Medical Facilities

The Ankobra Resources Ltd. medical facilities is another opportunity for direct employment for residents in both Anoe Village and Sekondi-Takoradi, Ghana. There will be on-call medical employees in case of emergencies.

Medical Facilities

Facility	Employee Area	Employee (Number)
Medical		
Physician	Anoe Village Sekondi-Takoradi	1
Nurse	Anoe Village Sekondi-Takoradi	2
Attendant	Anoe Village Sekondi-Takoradi	1
Medical Technician	Anoe Village Sekondi-Takoradi	1
X-Ray Technician*	Anoe Village Sekondi-Takoradi	1
Driver-Ambulance	Anoe Village Sekondi-Takoradi	1

Dental		
Dentist	Anoe Village Sekondi-Takoradi	1
Dental Assistant	Anoe Village Sekondi-Takoradi	1

* both Medical and Dental X-Rays

8.16 Local Economy (Sekondi-Takoradi,Ghana)

The local economy will receive an infusion of $ 8.0 to $ 10.0 million dollars per annum into the Sekondi-Takoradi area. Approximately 350 to 400 workers spending in the area provide a significant amount of revenue to the local area.

Ankobra Resources Ltd. Employee Spending

Business	$ 1,000 - $ 2,000	$5,000-$ 8,000*	$ 10,000-$20,000
Banks			x
Groceries	x		
Clothing	x		
Automobile		x	
Education	x		
Housing		x	

* amount on annual basis per household

Ankobra Resources Ltd. after an eight year grace period will provide $ 80.0 million dollars in taxes to the Republic of Ghana. Also, taxes on petroleum products sold within the local economy such as unleaded gasoline, fuel oil, LPG, and ancillary gases.

8.17 Cultural Changes, Possible Conflict-Immigration and Tourism

As previously stated, the Sekondi-Takoradi area has a population of approximately 80,000 people. The entire work force of Ankobra Resources Ltd. are required to be trained after the final employment steps of each worker.

Most technical positions will be manned by expatriates until indigenous personnel has enough training and skills for each specific job. Immigration of other indigenous personnel within the Republic of Ghana will not be a problem as related to hiring for the petrochemical-refinery complex. An influx of tourist at the petrochemical-refinery complex is not permitted in the primary zone of the plant operations.

Notes

9.0 Health

On site inspection of the Anoe Village indicated that the inhabitants are located 300m south of the proposed site. Mainly the inhabitants are farmers, population roughly 387 indigenous people,about 142 females, 125 males, and 120 children. Anoe Village is officially located in the Shama Ahanta East Metropolitan Assembly District.

The major debilitating condition is malaria,but visiting nurses and EMS is available to Anoe Village. Basic utilities such as water, is available from municipal and bottled sources, but modern sewage,power sources and natural gas systems are not available at this time.

Basic education at the elementary level is available to the children of Anoe Village. It is the intent of the Government to connect electrical power to Anoe Village during the calendar year of 2000.

9.1 Present Medical System In Ghana

Is evident of the co-existence of scientific and traditional medical systems. This study is limited to examination of published data and to primary field research. In 1957, the government built the first health centers. They were distributed throughout Ghana with the exception of two regions, the Western and Central Regions.

The reason offered in ignoring these two regions was that the Central Hospital (Koule Bu Hospital in 1934) drew many of its patients from the Central and Western Regions (Table 5.1). Coupled with these health centers of the government came forth with the idea of field units (see Table 5.2).

The essence of this aspect of scientific medical care was to control many of the environmental diseases which were rampart at the time. The mortality rate among mothers and children in the past was very high.

Some authorities put infant mortality as high as 250 deaths out of every 1,000 babies born(6), This high rate was attributed to inadequate and poor service for the pregnant women, lack of doctors,trained midwives,public health nurses,and other health workers.

The pre-school child suffered from such diseases as malaria, bronchopneumonia, measles, diarrhoea, malnutrition, tuberculosis, and worm infestations(7). Poor sanitation, poor water supply and housing greatly contributed to the high morbidity as well as factors such as health education,superstition, poverty and ignorance(8).

Ghana has two main types of hospitals-the district and the regional. The district hospital are small and scattered and both have staff and facilities that are limited. A district medical officer is in charge of the hospital as well as other supportive health services in the district. The regional hospitals are the modern, fully equipped institutions with a full complement of specialist and general duty medical officers.

A modern regional hospital has been completed in 1998 in the Central Region. Ankobra Resources Ltd. petrochemical-refinery project will be located in the Sekondi Export Processing Zone,Western Region. The Shama Ahanta East Assembly District area does not have medical services for the Anoe Village people such as hospitals,dental services,and X-ray facilities. Table 5.6 shows the Health Centers and Health Post in operation in Ghana in 1969.

The smallest unit of health call is health post. The staff include the following personnel: a health post superintendent,community health nurse and medical auxillary. Minor cases are dealth with at this level, but serious ones are referred to an adjacent health center and or nearest district hospital. A medical practitioner may make only periodic visits to the health posts which generally serve a little more than first-aid stations and health observations post.

9.1.1 Nearest Medical Facility to Anoe Village

The nearest	Medical Post	na (km) from Anoe Village
	Medical Center	6.05 (km) from Anoe Village
	District Hospital	11.0 (km) from Anoe Village
	Regional Hospital	8.63 (km) from Anoe Village

Distribution of Manpower and Services

Personnel	District Hospitals	Regional Hospital
Medical Officer	x	
Nurse	x	
Health Inspector	x	
Ward Orderlies	x	
Surgeons		x
Physicians		x
Obstetricians		x
Paedtricians		x
Services		
Laboratory		x
a. hematological		x
b. parasitic		x
c. biochemical		x
d. bacteriological		x

e.	barium study	x
f.	intravenous	x
g.	(X-ray (simple))	x

9.1.2. Present Medical System-Western Region

In accordance with Table 5.1 Health Centers, the Western Region had 1 unit-1955, 2 units-1960,4 units-1962, and 6 units-1969. Table 5.2 has indicated Medical Fields units in operation in Ghana, Western Region,1 unit-1962.

As of 1970, Health Centers and Health Posts in operation in Ghana during 1969, Western Region,Urban Health Centers (1 unit), Rural Health Centers (4 units), Rural Health Posts (1 unit). The cities of Sekondi and Takoradi have approximately 80,000 population at the present time.

Table 6.1, Distribution of 2,674 Female Maternity In-Patients by Residence,Five Regional Hospitals, January to December 1996, has indicated about 390 patients for the Sekondi area. The population of the Anoe Village is approximately 387 people and approximately 142 females.

Ankobra Resources Ltd., has determined a need for a small fifty (50) bed wing for mainly burn patients, and other seriously ill workers. This wing , is equipped with modern cardiovascular monitoring equipment, blood pressure apparatus', EKG and EEG machines, X-ray machine(s), and the various surgical instruments.

9.2 Health Impacts

Direct and Indirect Impacts to the Undertaking

PreConstruction	survey of the nearest community will be performed on the general health conditions of the entire population. Baseline conditions established are related to the physical condition and present medical conditions of the general population.
Construction	another survey of the physical and medical conditions of the general population of the nearest community during the construction period. Survey of medical records to detect significant changes in the population due to construction noise or exposure to any dust generated during the construction phase. Medical and psychological evaluations made on all employees prior to hiring of all employees. Baseline conditions of employees are established during the construction phase.

Table 5.3

Medical and Public Health Personnel in Government and Non-Government Services

	1957	1958	1959	1960	1961	1962	1963
Doctors	330	342	346	586	726	879	904
Government Service	120	123	126	227	292	363	379
Specialists	18	20	22	23	43	120	130
General Duty*	102	103	104	204	249	243	249
Private Practice	90	96	94	132	142	153	146
Dentists	18	14	17	17	22	29	36
Government Service	12	10	14	14	14	17	28
Private Practice	6	4	3	3	8	12	8
Midwives	616	691	789	900	1,008	1,104	1,235
Government Service	345	376	412	481	530	611	954
Private Practice	271	315	377	419	478	493	281
Trained Nurses	800	986	1,627	1,848	2,023	2,191	2,366
Government Service	768	958	1,001	1,130	1,241	1,344	1,453
Private Practice	—	—	601	692	732	769	804
Health Visitors	32	28	25	26	50	78	109
Para-Medical Field Staff	310	439	469	497	588	621	724
Leprosy Service	26	28	33	32	47	150	155
Medical Field Units	105	200	197	217	311	206	233
Malaria Service	—	18	45	50	26	27	55
Health Educational Officers	1	6	6	8	8	17	10
Health Inspectors	178	187	188	190	196	221	271
Qualified Pharmacists	312	311	326	298	329	342	355
Attached to Government Hospitals	96	82	92	91	127	75	91
Attached to non-Government Hospitals	13	12	14	9	9	11	15
Non-attached to Hospitals	203	217	220	198	193	256	249

*Including doctors at mining and missionary establishments.

Source: Statistical Year Book, Accra: Central Bureau of Statistics, Accra, Ghana, 1963, p.33.

Table 5.5

Fig. 7 *Distribution of Professional and Para-Professional Man-Power in the Ministry of Health, Ghana*

1963–67*

Types	1963	1964	1965	1966	1967
Doctors	379	465	548	597	633
Dentists	28	36	37	39	41
Midwives	954	1,189	1,201	1,394	1,481
Nurses	1,453	1,090	2,381	2,660	3,078
Pharmacists	355	355	355	362	367

Sources: Republic of Ghana, Annual Report of the Medical Services of Ghana, Accra: Government Printing Services, 1967, p. 58.

* According to the 1969 Register there were 669 doctors

Table 5.1

Health Centres in Operation in Ghana

Region	1957	1958	1959	1960	1961	1962	1963
Western	—	—	1	2	4	4	6
Central	—	1	1	2	2	2	2
Eastern	1	1	3	4	6	8	12
Volta	1	2	3	3	3	3	3
Ashanti	1	1	1	2	3	3	5
Brong-Ahafo ..	2	2	2	4	4	7	7
Northern ..	3	3	3	3	3	4	4
Upper	2	2	2	2	2	2	2
Total	10	12	16	22	27	33	41

5 *Ghana Government Publication*, "The Health Services in Ghana" (1967), pp. 3–47.
6 *Ibid*, *p.* 11.
7 *Ibid*, *p.* 12.
8 See a foreword to the Ministry of Health Report by the Director of Medical Services, *The Health Services in Ghana* (Accra: Ministry of Health, 1967).

Table 5.2

Medical Field Units in Operation in Ghana

Region	1957	1958	1959	1960	1961	1962	1963
Western ..		—	—	—	—	1	—
Central		—	—	—	—	—	1
Eastern		1	1	1	1	1	1
Volta	1	1	1	1	1	1	1
Ashanti	1	1	1	1	1	1	1
Brong-Ahafo ..	2	1	2	2	1	1	1
Northern ..	2	1	1	2	1	1	1
Upper	2	3	2	2	1	1	2
Total	8	8	8	9	6	7	8

Source: Republic of Ghana *Annual Report* of the Medical Services of Ghana, Accra: Government Printing Services Accra, 1967 p. 11.

Figure 6. Health Centres in Operation Ghana (Table 5.1)
Medical Field Units in Operation in Ghana (Table 5.2)

Table 5.6

Health Centres and Health Posts in Operation in Ghana during 1969

Name of Region	*Urban Health Centres*	*Rural Health Centres*	*Rural Health Posts*
Accra	4	—	—
Eastern	—	8	1
Volta	—	4	—
Central	—	2	—
Western ..	1	4	1
Ashanti	2	6	2
Brong-Ahafo ..	—	7	1
Northern ..	—	4	1
Upper	—	3	1
	—	—	1
Total	7	38	9

Source: The Health Services in Ghana, Accra: Ministry of Health. Government Printing Services, 1970.

(d) The Health Post

The smallest unit of health care is the health post. The staff include the following personnel: a health post superintendent, a community health nurse and a medical auxiliary. Minor cases are

Table 6.1

Distribution of 2,674 Female Maternity In-Patients by Residence—Five Regional Hospitals, January to December 1966

Residence of Patient		*Korle Bu*	*Cape Coast*	*Sekondi*	*Koforidua*	*Kumasi*	*Total*
Same Region as that of the hospital	Same urban areas as hospital	851 (93.20%)	198 (61.30%)	390 (90.91%)	187 (77.59%)	500 (65.88%)	2,126 (79.51%)
	Different urban areas as hospital	5 (0.54%)	39 (12.07%)	9 (2.10%)	3 (1.24%)	17 (2.24%)	73 (2.73%)
	Rural area	1 (0.11%)	78 (24.15%)	20 (4.66%)	50 (20.75%)	223 (29.38%)	372 (13.91%)
Region other than that of the hospital	Urban area	33 (3.25%)	5 (1.55%)	91 (2.10%)	(0.44%)	7 (0.92%)	55 (2.06%)
	Rural area	32 (3.10%)	3 (0.93%)	1 (0.23%)	—	12 (1.58%)	48 (1.80%)
Total		922 (100.00%)	323 (100.00%)	429 (100.00%)	241 (100.00%)	759 (100.00%)	2,674 (100.00%)

Source: Ministry of Health, *Medical Statistical Report No. 1*, Ghana Government Publication, 1967, p. 9.

Figure 8. Health Centres and Health Post in Operation in Ghana during 1969
Distribution of 2.674 Female Maternity In-Patients by Residence

Operation	annual physicals of all employees will be given to determine the general physical and medical condition of each employee.Monitoring of all activities by the Health and Safety Department to ensure that working conditions are safe and not detrimental to the medical condition of the employees.
Decommission	upon the removal of the entire plant(i.e. processing equipment and storage facilities), medical and dental facilities will conduct exit medical ,dental, and psychological examinations on all employees.
Post-decommission	during a six month monitoring program,all employees records will be reviewed for serious medical conditions or chronic illnesses that need regular medical attention. Medical files will be forwarded to the nearest Medical Post, Medical Centre, District Hospital or Regional Hospital with the written consent of the employee.

9.3 Vehicle Traffic Generation and Potential-Road Accidents

The Ankobra Resources Ltd. project will be concern with traffic generation mainly, (1) during the construction phase, and (2) during the operation phase. The construction equipment will consist of heavy machinery s listed below:

Earth Moving Equipment:

1. Construction (rollers)
2. Front loaders
3. Backhoes
4. Tractors
5. Scrapers,graders
6. Pavers
7. Trucks

Material Handling

1. Concrete mixers
2. Concrete pumps
3. Cranes,movable
4. Cranes,derrick

Stationary:

1. Pumps
2. Generators
3. Compressors

Impact Equipment:

1. Pneumatic wrenches
2. Jackhammers and rock drills
3. Impact pile *drivers,peaks*

The construction equipment will be confined to the site and not to the open highway nor public streets of either Sekondi or Takoradi, Ghana. Initially, receipt of shipment of the construction equipment will be received through the Port of Takoradi. The Ankobra Resources Ltd. project will construct a private docking system used to both import and export goods and machinery.

In the operation phase, shipping of petroleum products will be 90% by railway system. The use of tractor trailers will be used for the local transport from the railway depot site to consumer markets such as local service stations.

Direct and Indirect Impacts to the Undertaking-Traffic

PreConstruction	during the pre-construction phase, service will be made to map out the routes for supplies in accordance with the appropriate off-traffic hours. Heavy traffic hours logged vs density of population to become efficient in delivery of product and service and safety to entire community.
Construction	planned routes for evacuation and contingency plan covered in safety classes during the construction phase. Schedules showing the hours that specific products or equipment (i.e. processing equipment) that will be transported on the public highway or the Takoradi Habor. Placing of all processing equipment at the specific hours of the day will be known at each briefing session. Traffic control maintained and plant construction time will differ from housing construction time. Scheduled docks facilities will eliminate a 95% usage of local harbor area and public roads in the local area.
Operation	the entire site traffic will be controlled from the point of entry to point of exit. Safety for workers is a priority as related to ongoing traffic in the plant environment. The petrochemical-refinery complex will be 90% to 95% self sufficient in terms of routine products and service. Therefore,traffic will be at a minimum in the public roads in the local area.
Decommission	removal of processing equipment, plant buildings, and housing will have increased traffic. The private docking facility will assist in shipping all processing equipment without an increased usage of public highway.
Post-decommission	a team of security personnel will patrol the area on a scheduled basis per contract to see that the property is not used for purposes such as dumping of materials or waste. Permanent fencing will be in place and security post will remain activated per contract to terminate at an agreed upon time.

9.4 Air Quality-Regulated Pollutants

Table 5.1.4, Qualitative Summary of the Effects Attributed To Specific Pollutants express such air pollutants as ,(1) particulates, (2) sulfur dioxides, (3) hydrocarbons (in solid and gaseous states),(4) carbon monoxide, (5) nitrogen oxides, (6) Oxidants (Ozone) and (7) Peroxyacetyl nitrates (pan) . Fig. 14.3 Characteristics of particles and particle dispersoids show types of gas clearing equipment such as, (1) centrifugal separators, (2) liquid scrubbers, (3) cloth collectors, (4) impringement separation, (5) thermal precipitation,and (6) electrical precipitators.

The electrical precipitators can be used for (1) common atmospheric dispersoids, and (2) typical particles and Gas Dispersoids. The effective ranges for the electrical precipitators and particle types have been listed below.

Typical	1.	viruses, bacteria
	2.	combustion nuclei, damaging dust, and nozzle drops
	3.	atmospheric dust,spores,Pollens (partially)
	4.	colloidal silica, zinc oxide fumes,insecticide dust
	5.	paint pigments,sulfuric mist, carbon black
	6.	ammonia chloride,sulfuric acid concentrated,cement dust
	7.	coal dust(partially)
Common Atmospheric Disperoids	1.	Smog,cloud and fog

Table 5.1.4 Qualitative Summary of the Effects Attributed To Specific Pollutants, i.e. sulfur oxides, particulates, hydrocarbons (in solid and gaseous states), carbon monoxide, oxidants(ozone) and peroxyacetyl. These specific pollutants are attributed air emissions from many different types of industrial operations.

Mainly these specific pollutants have effects on humans, metals, books, leather, buildings and plant growth. Many can be detrimental to our ecosystem and more specifically to plant growth.

The Effects Attributed To Specific Pollutants

Air Pollutants	*Effects*		
	Human	Plants/Crops Atmosphere	Metals/Books buildings, textiles,leather rubber,

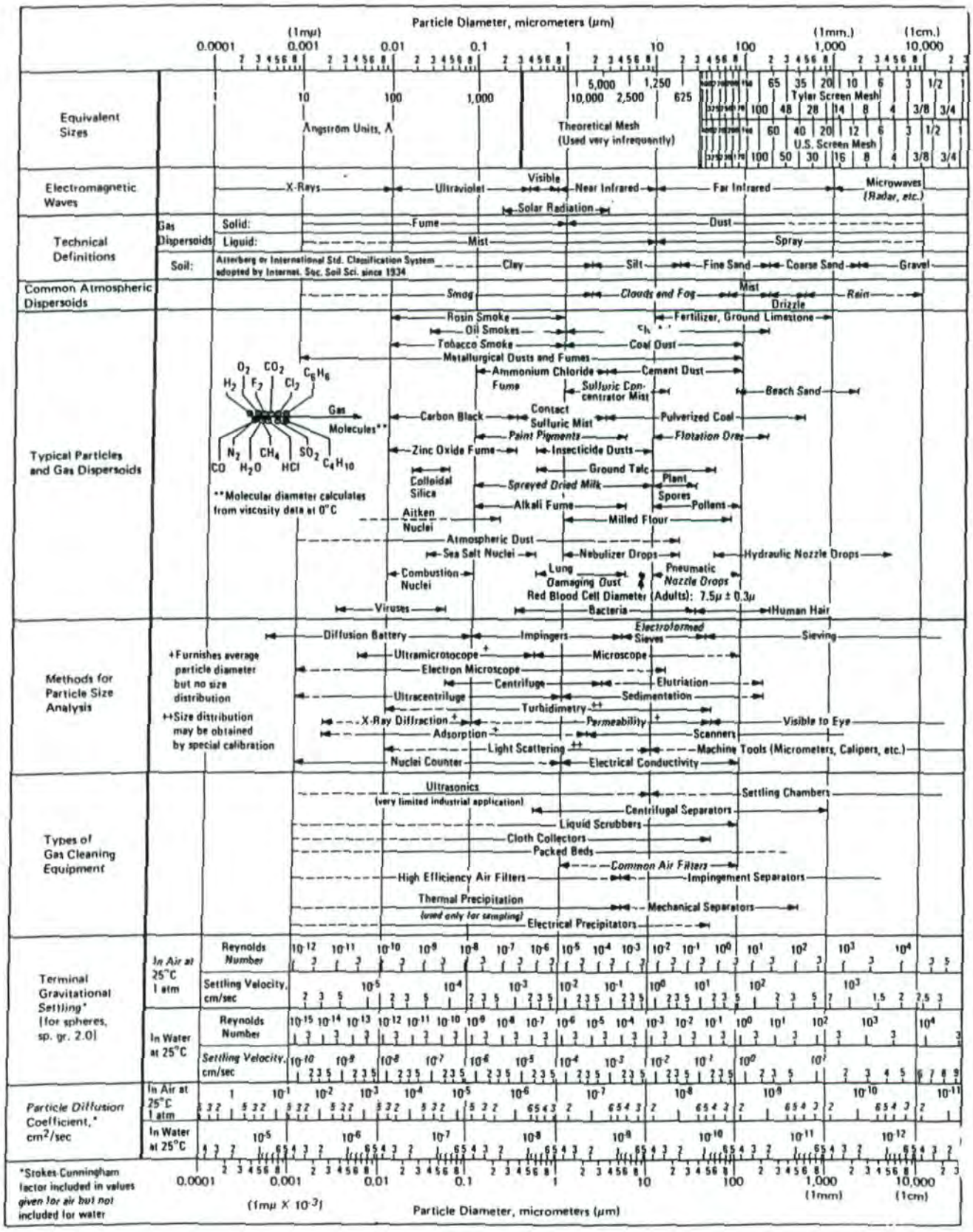


Fig. 14.3 Characteristics of particles and particle dispersoids.

TABLE 5.1.4 *QUALITATIVE SUMMARY OF THE EFFECTS ATTRIBUTED TO SPECIFIC POLLUTANTS*

Air Pollutant	*Effects*
Particulates	Speeds chemical reactions; obscures vision; corrodes metals; causes grime on belongings and buildings; aggravates lung illness
Sulfur oxides	Causes acute and chronic leaf injury; attacks a wide variety of trees; irritates upper respiratory tract; destroys paint pigments; erodes statuary; corrodes metals; ruins hosiery; harms textiles; disintegrates book pages and leather
Hydrocarbons (in solid and gaseous states)	May be cancer-producing (carcinogenic); retards plant growth; causes abnormal leaf and bud development
Carbon monoxide	Causes headaches, dizziness, and nausea; absorbs into blood; reduces oxygen content; impairs mental processes
Nitrogen oxides	Causes visible leaf damage; irritates eyes and nose; stunts plant growth even when not causing visible damage; creates brown haze; corrodes metals
Oxidants:	
Ozone	Discolors the upper surface of leaves of many crops, trees, and shrubs; damages and fades textiles; reduces athletic performance; hastens cracking of rubber; disturbs lung function; irritates eyes, nose, and throat; induces coughing
Peroxyacetyl nitrate (PAN)	Discolors the lower leaf surface; irritates eyes; disturbs lung function

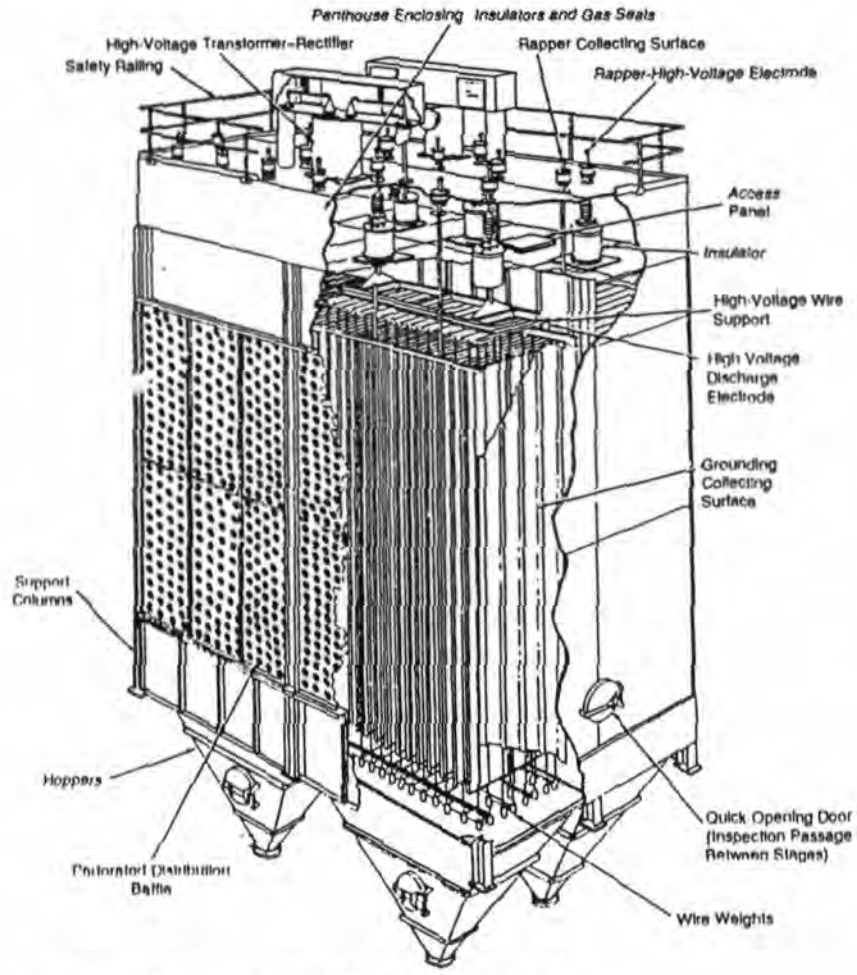


Figure 12. Table 5.1.4 Qualitative Summary of the Effects Attributed To Specific Pollutants
Figure 5.17.1 Single-stage parallel plate ESP with accessories

Particulates	obscure vision,aggravates lung illness	speeds chemical reactions	corrodes metals grime/buildings
Sulfur oxides	irritates upper respiratory tract	acute and chronic leaf injury	destroys paint pigment,metals harms textiles, distintegrates book pages, and leather. erodes statuary
Hydrocarbons	may be cancer producing (carcinogenic)	retards plant growth causes abnormal leaf and bud development	
Carbon monoxide	causes headaches,dizziness and nausea,absorbs into blood,reduces oxygen content, impairs mental processes		
Nitrogen oxides	irritates eyes and nose	cause visible leaf damage,stunts plant growth create brown haze	corrodes metals
Oxidants:			
Ozone	disturbs lungs functions, irritates eyes, nose, and throat;induces coughing athletic performances	discolors the upper surface surface of leaves of many crops, trees and shrubs	damage and fade textiles
Peroxyacetyl nitrate(PAN)	disturbs long function irritates eyes	discolors the lower leaf surface	

9.5 Material Handling

Exposure of handling any types of materials by human hands will be limited and to a minimum. Simply, all crude oils, petroleum products,waters and wastewaters are all handled via pipeline.

Catalyst will be handled in a separate system, either tote bags (like burlap bags) or tote bins (metal containers) by a forklift operator. Sulfuric acid, handled in bulk quantity in large ship loads in metal containers such as tote bins. Again, transported or moved by a forklift operation.

9.6 *Waste Handling and Disposal*

All gases or air emissions are vented by pipe and disposed of by either refinery flare or on-site incineration(piped). Liquid waste or stream to an electroprecipitator or scrubber.

Catalyst that has become non-active is packaged in 55 gallon drums and shipped to an European recycler and re-activation of the catalyst. All drums are handled by a fork lift operator, with proper PPE, if needed.

Calcium fluoride can be packaged and incinerated in the kiln section of the incinerator. This chemical can be used in the steel making industry. PPE clothing worn during the packaging of the Calcium fluoride.

Sulfuric acid sludge solid waste incineration and packaged in 55 gallon drums. Personnel performing the packaging operation will wear the proper protection equipment.

Inorganic or organic waste water sludge piped to the on-site incinerator. These sludges can be piped to the rotary kiln or smaller incineration unit to burn up to 1500 deg F.

9.7 Marine Environment

Ankobra Resources Ltd., a land based petrochemical-refinery complex has an environmental responsibility to the marine environment of the Gulf of Guinea. Monitoring of the marine environment has equal priority as air emissions as the land based management responsibility.

The marine environment, Gulf of Guinea, is sensitive to the environmental pollutants, principally due to the aquatic spawning grounds. Specifically, Sardinella sp. and shrimp have significant economical valve to the economy of the Republic of Ghana.

The marine environment baseline during the preconstruction phase will become definitive in respect to (1) developing a program to enhance the growth of the aquatic spawning area(s) and (2) data and analysis and effects of the discharged wastewater into the Gulf of Guinea.There is a significant amount of baseline information on the marine environment sponsored in part by the World Bank.

We are aware that the aquatic spawning area begins at the 100 fathom level contour line (Fig. 32). Marine investigations by a University team of consultants will be commissioned to further delineate areas of importance as aquatic spawning areas related to environmental
management.

Monitoring of the marine environment as related to the aquatic spawning area is a permanent activity of environmental management. Development of gridding or coordinates will enable us to determine how well the growth management is progressing.

9.8 Health and Safety

The possible health effects of the undertaking on persons within and around the undertaking is positive. All potential workers are given a physical examination before *being hired for Ankobra Resources Ltd. petrochemical-refinery complex.*

9.8.1 Pre-Employment Physical

All employees will be given a pre-employment physical as a requirement for employment. The pre-employment physical will include the following.

1. Blood Examination (CBC, Whole Cell Count,etc.)
2. Blood Pressure Reading
3. Physical Deformations(swollen glands, swollen joints, signs of arthritis,etc.)
4. Eye Examination
5. Hearing Examination

Safety and health personnel will be involved with the local Public Health Department to become knowledgeable on the general diseases that are debilitating to the local population. I have listed some of the most significant debilitating diseases on a world wide basis.

1.	Cardiovascular	Hypertension
2.	Respiratory	Emphysema, Asthma (severe), Chronic Bronchitis
3.	*Nervous System*	*Multiple Scelerosis,Strokes,Mental Illness*
4.	Endocrine System	Diabetes (severe condition)
5.	Liver Functions	Chronic Liver Disease
6.	Abnormalities	To include back disorders,hands, feet, ankles, and severe joint disorder.

A medical center which includes a dental center for the maintenance of each worker. Each waste has the ability to use the dental center as part of Ankobra Resources Ltd. medical care services.

9.8.2 Safety

Ankobra Resources Ltd. is concerned with the safety of all employees,Anoe Village, and the cities of the Shama Ahanta East Assembly District. Negative impacts caused by the

140,000 bbls. per day petrochemical-refinery complex can be detrimental to the safety of the employees, Anoe Village people and citizens of the Sekondi-Takoradi area.

Safety and Health Program

Course	Administration	Manager	Operations
Asbestos	x	x	x
Bloodborne Pathogens	x	x	x
Confined Space Entry	x	x	x
Electrical Safety	x	x	x
Emergences-Incidents Preventions	x	x	x
Indoor Air Quality	x	x	x
Lead Exposure	x	x	x
Biological Hazards	x	x	x
Carbon Dioxide	x	x	x
Carcinogens,Mutagens & Tetragens	x	x	x
Chlorine Safety	x	x	x
Safety Showers	x	x	x
Eye wash	x	x	x
Heat Stress	x	x	x
Back Injury	x	x	x
Eye Protection	x	x	x
Hand Fingers	x	x	x
Wrist Safety	x	x	x
Head & Arm Protection	x	x	x
Respirators and How To Use Put Them	x	x	x
Forklift Safety	x	x	x
Material-Handling	x	x	x
Equipment Safety	x	x	x
Fire Extinguishers Training	x	x	x
Eye & Face Protection	x	x	x

A significant amount of funds have been budgeted for training of all workers at Ankobra Resources Ltd. petrochemical-refinery complex. Courses on the mechanism of crude oil refining and production of methanol are part of the training program. The local indigenous personnel with a basic education will be qualified to work as a operator in different units of the complex. Therefore, immigrates from other areas would not be more skilled than the hired local indigenous workers.

9.9 Emergency Response

All safety, fire figthing techniques, evacuation route(s), and emergency services are an integral part of the operation of the petrochemical-refinery complex. Training of all personnel during various emergencies is vital to the petrochemical-refinery complex.

The Team Concept will be used in various emergencies such as oil spills, and fires within the petrochemical-refinery complex. Various types of equipment are always needed on a stand-by basis in such as industrial environment.

Equipment:

Medical	Portable surgical rooms, surgical tools, operating tables,X-ray equipment,EKG machine,EEG machine,artifical respirations, and oxygen tents, ambulances for delivering patients.
Supplies	Bandages, gauze, needles, thermometers, surgical towels or gauze,saline, glucose, and D (5) W.
Personnel	Medical and Surgical physicians,Nurses,Attendants,X-ray techincian, and ambulance driver
Fire Equipment	Two fully equipped fire engines. Also, a ladder truck to reach areas in the tank farm. Fire Chief vehicle and one truck for air respirators.
Oil Spill Equipment	Two small vacuum trucks,approximately 70 bbls. each to pick up liquid hydrocarbons. Foam or absorbent materials to soak up small areas of liquid hydrocarbons. Front end loaders for areas involving contaminated soil/hydrocarbons.
Disposal of Oil Spill Materials	Efforts will be made to salvage liquid hydrocarbons such as crude oil, unleaded gasoline,fuel oil, and naphtha for separation by centrifugal force. All contaminated debris or solids/sludge will be incinerated on-site.
Laboratory Sampling Kits	All marine oil spills will require that samples of the water, aquatic life involved, and correlation with areas not involved with the spill is necessary.

Medical -Dental Center

Personnel	Medical	Dental
Physician	x	
Dentist		x
Dental Assistant		x
Nurse	x	
Attendant	x	
X-ray Technician*	x	x
Ambulance Driver	x	

* X-ray Technician will provide service to both medical and dental patients.

There will be a small wing that is utilized only for emergencies equipped with oxygen,cardiac monitoring equipment,burn pads, and medicines with fifty (50) bed capacity. The next level of treatment for emergency patients,transport to a local hospital (s) with intensive care capabilities.

Through BUPA International, local services provided to the workers of Ankobra Resources Ltd. Also,emergencies beyond local capabilities allows such patients to be airlifted to Europe for such medical treatment.

BUPA International Oil & Gas Scheme

Benefits	Essential	Classic	Gold
Annual overall maximum	US$900,000	US$900,000	US$1,200,000
In-Patient & Day-Care Charges	Full refund	Full refund	Full refund
Hospital Accomodation, nursing ancillary charges, drugs and dressing	Full refund	Full refund	Full refund
Surgeons' anaesthetist' and physicians' charges	Full refund	Full refund	Full refund
Cancer Treatment including radiotherapy & chemotherapy	Full refund	Full refund	Full refund
Physiotherapy,X-Ray & diagnostic tests	Full refund	Full refund	Full refund
MRI & CT scans	Full refund	Full refund	Full refund

Medical Evacuation Cover	Full refund	Full refund	Full refund
Out-Patient Charges	N/A	USD$4,800*	USD$4,800*

* up to maximum / year

Contingency Plan

Safety	Preconstruction Independent Contractors will be required to train all of his personnel Safety Engineer will have the responsibility of providing log of all attendance Minimum courses: Blood Borne Pathogens Confined Space Entry Electrical Safety Emergencies-incidents Prevention Lead Exposure Biological Hazards Carbon Monoxide Protection: Eye,Head,Hand Arm,Face,Ear Back Injury Safety Shower & Eye Washer Foot Protection Use/Respirator Fire Extinguisher Training: Forklift Safety Material Handling Equipment Safety Use of Ladder Lifting of Objects	Construction Same during the Construction phase as in the PreConstruction as in the phase	Operations Safety engineer employed by Ankobra Resources Ltd. will have the responsibility to train all employees and keep a log of all attendance. The minimum courses must be taught to the hired employee.

The Fire Figthing Techniques are inclusive in the Contingency Plan as mentioned above. Knowledge of the health and safety courses coupled with fire fighting training techniques should enable the employees to manage any major incident in the plant. Medical staff is a part of the contingency and evacuation plans for industrial incidents.

Fire Fighting Techniques

PreConstruction	Construction	Operation
Training:		
Purchase of a fire Engine and its related equipment. Hand fire extinguishers of the A,B,C, type Basic training in grease fires, chemical,& electrical fires Use of PPE in fire activities Develop fire alarm system,and routine training on each specific duty for all personnel involved Designate a Fire Chief & Assistant. Set up communications to the local fire Dept. in case of brush fires or fires that are a threat to the local community.	Purchase of additional equipment needed for the new buildings. All purchases will be the same as in the Pre Construction Phase & Training	Basically the training of 350 to 400 persons to include the office staff. Hiring of full time Fire Chiefs and Up grade the designated fire brigade of 20 operations & engineers
Notification: The Local Fire Dept.on all fires	Same Pre-Construction	Same as Construction

Evacuation Plan:

The evacuation plan depends on the severity of the incident and type i.e. fire vs catastrophic weather. On-site medical wing is placed in an area that is almost isolated from the actual processing zone in the petrochemical-refinery complex.

A fire in the processing zone would not be a threat to the medical-dental center. In the event a fire becomes a threat, the civic center, is the area for injured workers. Temporary beds can be set up in the gymnasium area in the petrochemical-refinery complex residential area.

Catastrophic weather conditions are coordinated with the Ministry of Defence and directed from the Commander. All processing units are set on low operating levels and outdoor activities severely curtailed. The gymnasium area can be used for temporary operations as the need arises with the weather.

Severe medical patients would use Tier II and Tier III medical scheme to assist the injured patient. Large stake bed lorries can be used to transport large numbers of uninjured workers to the next staging area in the evacuation plan.

9.10 Emergency Response Spill Control

Pre-planning of a response can make a major difference in assuring the eventual outcome. Training includes the functions, methods, and procedures necessary to ensure the safety and health of employees conducting small scale emergency response clean up in the petrochemical-complex. The following standard emergency procedures will be used on-site emergencies and the Site Supervisor shall be responsible for ensuring that the appropriate procedures are followed.

Spills of materials will be contained with absorbents and booms. The absorbents and booms will be disposed of as hazardous waste. Large volumes of free liquid will be pumped into drums for storage or picked up by small vacuum truck. Any contaminated soil resulting from the spill will be excavated and stored on-site pending analysis (if needed) and properly disposed.

Safety:

The safety equipment required for this procedure will vary for each type of spill clean up incident. However, in all cases the next higher level of Personnel Protection Equipment must be employed for this response procedure than was worn during the operation in which the incident occurred.

Example: If wearing a modified level D, the emergency or spill must be approached with level C.

Equipment:

A. Spill Kit
- (1) 85 gallon Salvage drum
- (2) 20 gallon poly drums
- (3) 50 lbs. bags of clay based absorbent
- (1) 32 ft. spill sock(much more for marine spills.)
- (1) plastic shovel
- (2) Saranex Tyvek (XL)
- (2) pair of Nitrile or "Trionic" gloves
- (2) pair Butyl Rubber gloves
- (2) pair of Large Boots
- (1) roll of duct tape

B. Fire Extinguisher
C. Eye wash and/or Emergency Shower
D. Shovel
E. First Aid Kit
F. Fire Blanket

Site Preparation:

1. Review the site emergency response and spill control procedures with the area supervisor
2. Survey the work area for on-site safety equipment or response equipment
3. Make modifications to the procedure as site conditions warrant. All changes must be noted on the Site Safety Plan.

Procedure:

1. Emergency Response

   A. Personnel Injury In the Exclusion Zone

      1. Sound the designated emergency signal
      2. The nature of the injury should be determined and the affected person(s) should be decontaminated as best as possible prior to movement.
      3. If the injured party (ies) can be evacuated without further injury, the party (ies) should be moved to a clean area outside the exclusion zone, otherwise a stretcher should be used.
      4. All other personnel must be immediately exit the exclusion zone until cause of injury is determined
      5. The appropriate first aid shall be administered and contact should be made with the designated medical facility
      6. Determine the cause of the injury or symptoms
      7. When medical help arrives, give them all information about the injury chemical information (ex. Material Safety Data Sheet, Chemical Dictionary)
      8. Notify the appropriate Supervisor or Health and Safety Manager
      9. Proper changes in work plan and/or Site Safety Plan to prevent recurrence. All changes are required to be reviewed and approved by the Operations Supervisor and Health and Safety Manager or Operation Manager prior to implementation.

   B. Prevention Injury Outside the Exclusion Zone

      1. Notify the Site Supervisor
      2. The appropriate first aid shall be administered and contact should be made with the designated medical facilty.

3. *Determine the cause of the injury or symptoms*
4. When medical help arrives, give them all information about the injury (ex. MSDS,Chemical Dictionary infor,etc.)
5. Notify the appropriate Supervisor or Health and Safety Manager
6. Proposed changes in work plan and/or Site Safety Plan to prevent resources. All changes are required to be reviewed and approved by the Operations Supervisor and Health and Safety Manager or Operational Manager prior to implementation.

C. Fire and Explosion in Work Area

1. Activate fire alarm system. Sound the designated emergency signal or call the fire department
2. Remove all contaminated equipment if able. Leave the exclusion zone, and assemble at a pre-determined site. Check personnel for injuries.
3. Move all personnel upwind of the involved area
4. Small fires which can be put out with on-site fire extinguishers may be done by trained personnel outfitted in the appropriate safety equipment.
5. Notify the Operations Supervisor

D. Personal Protection Equipment Failure

1. Move to clean area of the exclusion zone with your buddy (Buddy System)
2. Remove all contaminated equipment and leave work area
3. Notify Supervisor of any equipment failure. Supervisors will arrange for repair or replacement of defective equipment.
4. Re-enter area only after the defect has been repaired or replaced

E. Other Equipment Failure

1. Report equipment failure to the Site Supervisor
2. If the failure affects the safety of personnel or prevents the completion of work, all personnel must leave the exclusion zone until appropriate action is taken

F. Air Quality Deterioration

1. Immediately leave the area. Determined the nature and source of emissions
2. Determine the appropriate PPE required to protect against contamination. Set up air monitoring equipment if necessary
3. Don all PPE and re-enter area. If possible, remove or control *the hazard causing the air quality deterioration*

II Spill Control

A. In the event of a spill, the Site Supervisor shall implement these steps in controlling and minimizing the spill.

1. Identify the material, the source,and extent of the spill
2. Don all appropriate safety equipment based on material evaluation
3. Stop the source,drum and contain the leaking material
4. Notify appropriate supervisors, managers and State and Federal agencies (as required)
5. Remove spilled material
6. Stabilize the soil or sludge with absorbent(if spilled on the ground and if required)
7. Excavate area (if required)
8. Package, mark, and label as required
9. Test surrounding environment, if warranted.

This process will be carried out in a timely manner to avoid further contamination. Large volumes of liquids will be transported by a small vacuum truck for high temperature incineration.

General Precautions-Drum Handling:

1. Treat all drums as unknown hazards until analysis are complete or until contents have been verified
2. Avoid unnecessary handling of drums
3. Always work upwind of any fumes or vapors
4. Inspect drums for stress, jagged edges, burns, rough or slippery surfaces
5. Get a firm grip on the drum
6. Keep fingers away from punch points, especially when setting down drums
7. Keep gloves clean of waste materials

8. Use safe lifting techniques,use teamwork, or drum handling equipment to handle load safely.
9. When possible, use equipment to move and/or handle drums to minimize personal contact

Drum Opening:

1. Use only non-sparking (e.g.,beryllium or beryllium alloy) tools.
2. A full-face respirator with appropriate cartridges or supplied air and the proper personnel equipment, including protective outerware and gloves, must be worn when opening drums that contain hazardous materials or the residues of hazardous materials.

3. Caps, plugs and bungs on full and empty drums are to be open slowly to permit gradual release of pressure (opened to point of a slow hiss). When pressure may be present, cover the drum opening with rubber or plastic sheeting before the cap or plug is removed, loosening same under the sheeting, so that any spurt of contents well be confined.
4. Caps, plugs and bungs are not to be removed until all hissing or pressure release has stopped,and then open slowly. Caution, corroded threads can give a false impression that pressure has been relieved.

5. Once removed the bung must be kept on top of drum with the contaminated side up so the top of the drum does not become contaminated.
6. If a gasket (one that covers the entire opening) remains in place on the drum after removing the cap, it may hold pressure. After removing the cap, pry off these gaskets carefully.
7. When using drum deheader remember that only the blade is non-sparking and to work slowly.

Drum Sampling:

The following safety equipment must be used in addition to the standard uniform,when sampling drums.

1. Respiratory Protection: select one of the following.

    A. Full face cartridge respirator
    B. Supplied air

        (1) Bottled air with air-line are escape bottle
        (2) SCBA

2. Tyvek suit with boots cover
3. Latex, Nitrile, or "Trionic" inner gloves with PVC outer gloves

Equipment:

The following materials will be needed to perform this operation:

1. Barrier tape and/or warning signs to isolate area.
2. Sampling tube (1/4" or 1/2") and bulb or coliwasa
3. Nalgene bottles (1 pt)
4. *Spill pillows or sock for diking & spills*
5. Bung wrench
6. Organic vapor monitor (if needed)
7. Drum deheader (if needed)
8. Fire extinguisher (dry chemical or ABC Type)
9. Standard tool kit

Preparation:

For large scale sampling jobs (over 20-55gsd) or uncontrolled sites or specific hazard analysis must be performed prior to project commencement.
Check work area for radioactivity.
Set up exclusion zone with barrier tape and place warning signs in plain view.
Set up organic vapor monitor, if required.

Procedure:

1. Don all protective equipment
2. *Assign each drum a unique serial number and mark that number on the drum*
3. Open drum slowly be aware of any hissing or pressure inside drums. Check for reaction of material with the air
4. Insert the coliwasa a sample tube the entire length of the drum (make sure glass tube is not broken on the end)
5. Remove tube and place material in nalgene bottle. Repeat until the nalgene is full. Fill a second nalgene.
6. *Complete Sample Log for each sample taken Label each sample jar with the* appropriate drum number
7. Use a new sample tube for each drum. Place used tube in a drum marked for for contaminated debris
8. Close drum.

Site Mobilization:

1. Breakdown work area. Place any non-reusable contaminated item in drums for disposal. Plastic and other non-contaminated material may be placed in municipal trash.
2. Decontaminate any reusable equipment. Decontamination of equipment.
3. Remove personal protective equipment.
4. Complete a Chain of Custody Form,if required.

9.10.1 Marine Oil Spill

The Team Concept is used in various emergencies such as oil spills, and fires during marine oil spills in the Gulf of Guinea. Various types of equipment are always needed on a stand-by basis in such offshore emergencies.

Equipment:

Medical	Portable surgical rooms, surgical tools, operating tables, X-ray equipment, EKG machine, EEG machine,artifical respirators,and oxygen tents.Ambulances for delivery of patients.
Supplies	Bandages, guaze,needles,thermometers,surgical towels, glucose,saline,and D (5) W.
Personnel	Medical and Surgical physicians, Nurses, Attendants X-ray technicians, and Drivers Fire fighting Team and Security Guards Marine Personnel (to man the boat)
Fire Equipment	Two fully equipped fire engines. Also, a ladder truck to reach areas in the tank farm. Fire Chief vehicles and one truck for air respirators
Offshore-Equipment	One fully equipped emergency marine vehicle(boat),to include,pumps, hooks, absorbents(rolls),surfactants, first aid kit(s), oxygen, and basic medicines for injured workers. Large fish nets for sampling to include large jars.

Oil-Spill Equipment (On shore)	Two small vacuum trucks,approximately 70 bbls. each to pick up any liquid hydrocarbons. Foam or absorbent materials to soak up small areas of liquid hydrocarbons. Front end loaders for area involving contaminated soil/ hydrocarbons
Disposal of Oil Spill	Effects will be made to salvage liquid hydrocarbons such as crude oil, unleaded gasolines, fuel oil, and naphtha for separation by centrifugal force. All contaminated debris or solids/sludges are incinerated on site(on-shore).

A marine oil spill, i.e. crude oil or petroleum products, need to be contained and removed as quickly as possible. Most petroleum products are lighter than seawater. The use of oil skimmers or surfactants are extremely useful for spills.

During a marine spill on the Gulf of Guinea, the proper authorities must be notified on an immediate basis. The General Alert Procedure has been noted for a marine oil spill on the Gulf of Guinea.

General Alert Procedure:

The General Alert Procedure,consist of initially discovery and notification phase, of the marine spill on an immediate basis to the National Reporting Center. The Duty Officer, National Oil Spill Response Center and Environmental Protection Council will notify the National-On-Scene Commander, Ministry of Defence of the marine oil spill.

The National-On-Scene Commander (Ministry of Defence will contact the following agencies and NGO's.

1.	Navy-On-Scene	6.	EPC Regional/District (in area of Threat)
2.	Local Communities (Fire Brigade,Police)	7.	Game & Wildlife Service
3.	Maritime Safety Authorities	8.	Ghana Port Authority
4.	Other Ministries or State Department	9.	Advisory Services (Meterological Services Department)
5.	Neighboring States (within WACAF)	10.	Regional/Internal Operations

General Alert Procedure

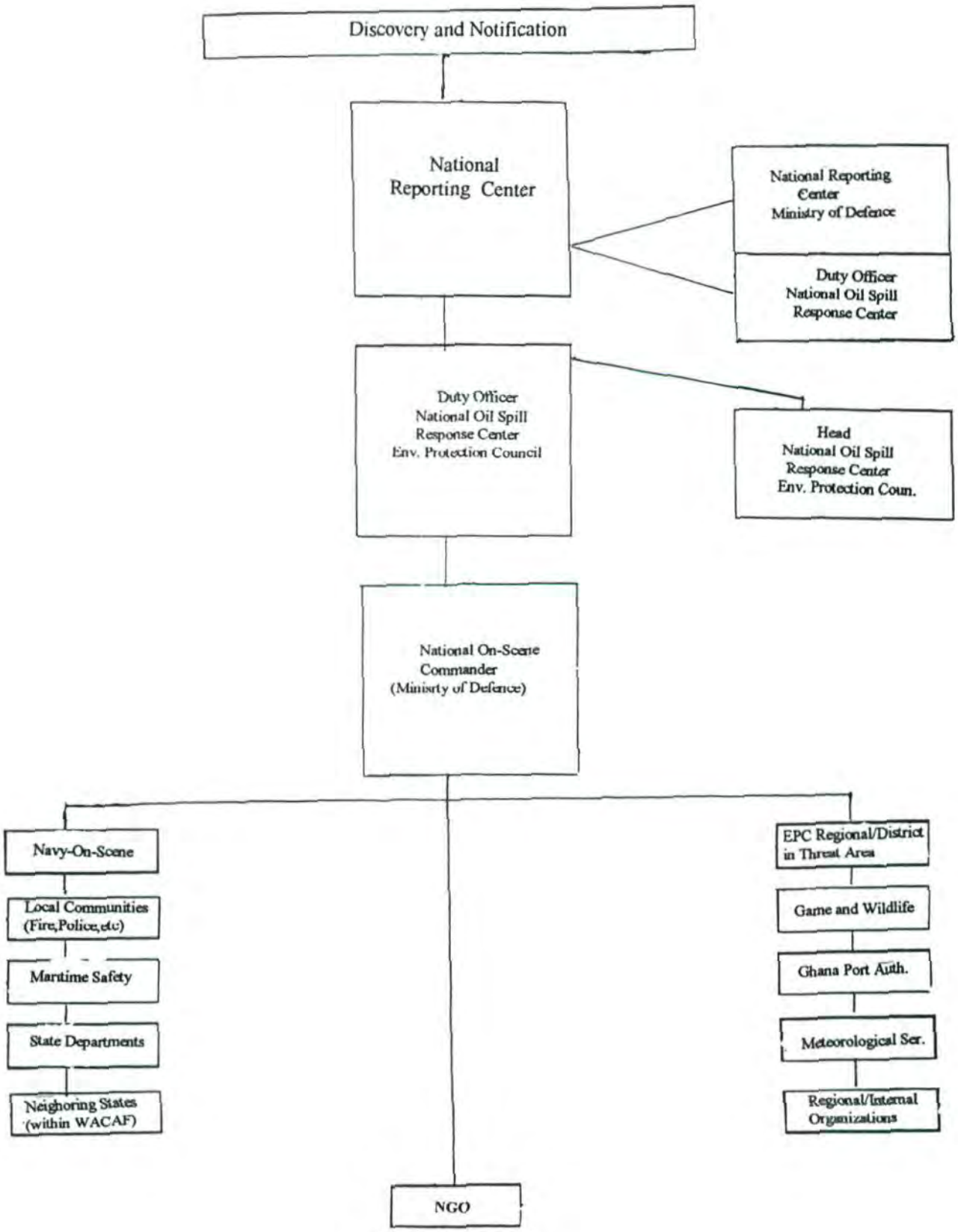


Figure 35, General Alert Procedure (Marine)

The use of absorbent material is needed to remove oil sheen as quickly as possible. Some crude oil may be removed by pumps of heavy oil on top of seawater. Containment and removal are the key steps in a marine oil spill.

Efforts during the marine oil spill is coordinated with the Plant Manager, Health and Safety Manager, and Operations Manager. If employees were injured during the marine spill, the same procedures to move the injured personnel from the area of exclusion as quickly as possible are valid.

Samples of marine life is taken to determine the impact of the marine oil spill. Seawater samples are taken to determine the baseline, quantity of contaminant, estimated area of contamination, depth of contamination, and operational clean up status of the seawater in the Gulf of Guinea.

9.11 Training, Documents, Manuals and Presentation Material

Training documents includes three major areas, (1) crude oil refining, (2) operations and maintenance, and (3) health and safety documents and manuals. Personnel to include administration, operations and maintenance, and operators.

Crude Oil Refining:

Basic courses in crude oil refining to include basic petrochemical processes and specifically the production of methanol. Understanding the structure and function of each unit,i.e. Atmospheric Tower, FCCU, Visbreaker, Gas Concentration Unit, Splitter, Syngas Conversion Unit, and Unibon Unit.

The production of methanol, includes basic knowledge of hydrocarbon chemistry, i.e. alkanes and alkenes. Understanding the use of heat treatment and catalytic reactions involved in methanol production. API materials will be used to instruct the employees on crude oil refining.

Operational Procedures and Maintenance:

Each operator will be presented with the basic knowledge of instrumentation in the control room. Modules used to give the operators experience and hand on knowledge of the instrumentation panels in the control rooms.

Maintenance training includes all sections of the petrochemical-refinery complex. Manufacturers such as Siemens and Honeywell will provide materials and instructional manuals on electrical instrumentation.

Scheduled maintenance activities to include documents used to develop a history on the maintenance of each machinery and equipment group. Corrosion and preventive maintenance are taught to develop an operating and maintenance history. Also, evaluate each metal component to determine any activity of corrosion.

Health and Safety:

All courses in health and safety are mandatory for employees to include the Chairman, Ankobra Resources Ltd. A record of courses are kept by the Health and Safety Manager. Basic CPR is essential in case of an emergency and injured workers.

Most of the manuals on health and safety will be purchased from the National Safety Council, Washington,D.C. Video tapes will be used and each completed unit will end with an exam of the basic materials presented. Software programs using various OSHA standards will be used to maintain a safe environment for the petrochemical-refinery workers.

The National Safety Council will do in-house training for employers on a world -wide basis. Many industrial and educational firms have the same capabilities internationally.

Training and Training Standards

Materials	Trainer	Refining	Maintenance Operations	Safety	Health	OSHA
API Documents	Professional	x	x			
Int'l Refinery Assn.	Professional	x	x			
API Video	Engineer*	x	x			
Fire Fighting						
Regulatory Laws	Health**					x
Medical Records	Health**					x
Instrumentation (electrical-panels)	Professional	x	x			
Computer (software programs)	Professional	x	x	x	x	x
Safety Courses	Professional			x	x	
Video tapes	Safety**			x	x	
Health Courses	Professional			x	x	
Video tapes	Health**			x	x	
CPR basic		x	x	x	x	x
Noise-Indoor	Professional	x	x	x	x	x
Video tapes	Safety**	x	x	x	x	x

* in-house staff with training background and experience and attendance of train the trainer program

** both health and safety staff will meet the same requirements to include attendance of train the trainer program.

9.12 *Monitoring Programs*

The proposed Environmental Management Programme will focus on the management of major environmental impacts of air quality,water quality,wastewater discharge,soil, noise, and groundwater. Our environmental management plan will start in the first year of construction and span the entire life cycle of the petrochemical-refinery complex operations.

Proper management of the environmental factors such as air quality, water quality, wastewater discharge, drainage, soil, noise, and groundwater monitoring are the responsibilities of the environmental engineer. All sampling of the air, water, wastewater, soil, noise, and groundwater during the operational phase is the responsibility of the environmental laboratory of the petrochemical and crude oil refining complex.

The key components of the Environmental Management Systems, includes commitment, preparatory review, environmental policy, organization & personnel, evaluation & register of effects, registration of regulations,objectives and targets, management programme, management manual,operational control, records, audits, and reviews. All functions and implementation of the Environmental Management Systems is the responsibility of the Board of Directors, Ankobra Resources Ltd.

Commitment of the Board:

The Board of Directors, Ankobra Resources Ltd has the responsibility of creating and maintaining an environmental safe conditions for its employees, Anoe Village, and other regional inhabitants potentially to be impacted. Listed are the commitments of the Board of Directors, Ankobra Resources Ltd. as related to environment compliance.

1. environmental compliance on all air emissions to include off-gases within the perimeter of the proposed petrochemical-refinery complex. Specifically, NOx, SOx, CO, particulates, and suspended solids,but not limited to these pollutants.

2. environmental compliance in terms of water quality,whether usage is for drinking or industrial use within the perimeters of the petrochemical-refinery complex. Specifically, physical parameters (color, odor, temperature, solids (residues), turbidity, oil content, and grease), characteristic of solids (suspended solids,

Environmental Committee Flow Chart

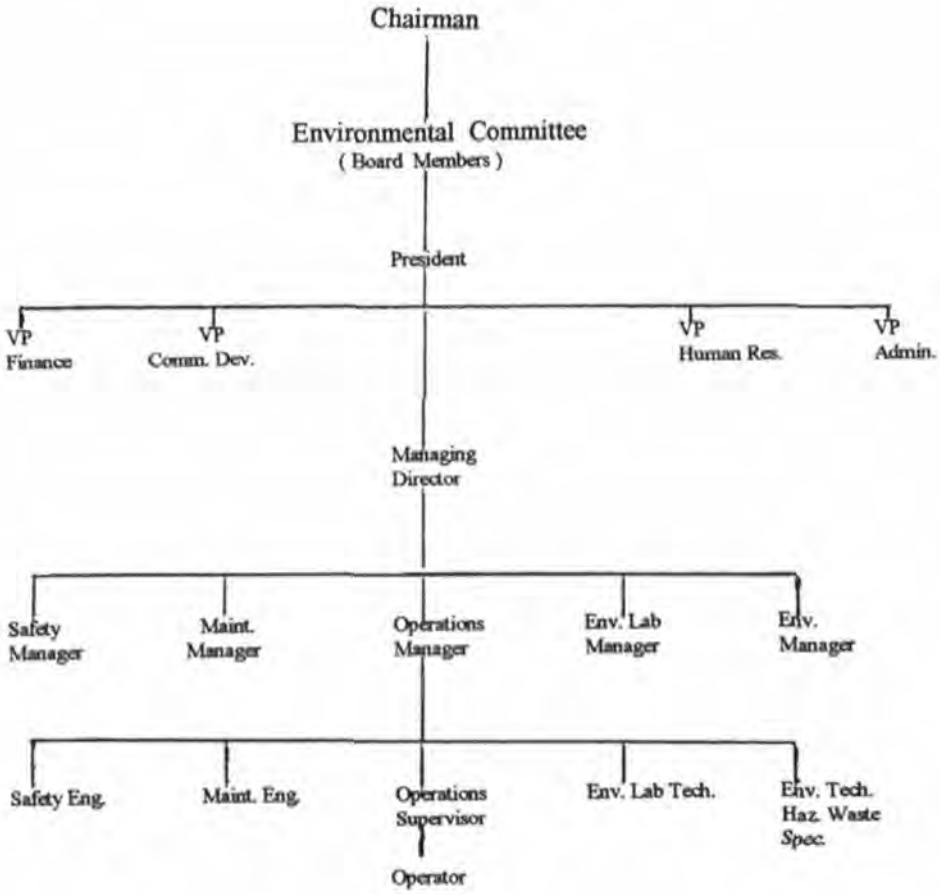


Figure 34, Environmental Committee Flow Chart

dissolved solids (size and setteability), organic (volatile) fraction, and inorganic fraction), chemical parameters (biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), and total organic demand (TOD)), inorganic chemicals parameters (salinity, hardness, pH,acidity, alkalinity, iron, manganese, chlorides,sulfates,sulfides,heavy metals (mercury,lead,chromium, copper and zinc) , nitrogens (organic,ammonia,nitrate,and nitrites), phosphorous, biological properties of water (coliforms, fecal coliforms,and pathogens).

3. environmental compliance in terms of wastewater monitoring, includes sampling, analysis, and waste water treatment before discharge. Specifically, flow, BOD, COD, TOC, TSS, Sulfides, Oil and Grease, phenols, ammonia,and chromium. The environmental compliance includes wastewater discharge into the Gulf of Guinea, specifically, temperature, fecal coliforms,pathogens, organic,ammonia, nitrates,nitrites,heavy metals,salinity, hardness, pH, acidity, alkalinity, iron, manganese, chlorides, sulfates,sulfides, nitrogen, phosphorous,BOD,COD, TOC,TSS,odor, and color.

4. environmental compliance in terms of land contamination to include the proper disposal of hazardous waste chemicals and materials. Proper use of land mass as bermed areas in case of spills of crude oil or petroleum products.

5. environmental compliance of the inhabitants in the immediate area to areas of influence (i.e. 100m distance of the proposed site of operation) as related to petrochemical-refinery complex. Specifically, by monitoring with the Opsis system, using most stringent air emission regulations(mutually agreed between proponent and Ghana EPA), design of the petrochemical-refinery units to meet the air emission regulations imposed.

   The primary monitoring area, 10km from the center of the proposed processing equipment zone. An outer perimeter, approximately 100m in a rectangular configuration, and a Opsis monitoring unit at the boundary line of Anoe Village.

Preparatory Review:

The preparatory review has been partially made during the gathering of data on the proposed site. Specifically, the spatial relationship of Anoe Village and the proposed petrochemical -refinery primary zone of processing equipment, use of desalination , wastewater treatment facility for wastewater treatment and discharge,pipeline monitoring, and land contamination on air emissions, potential groundwater contamination, and hazardous waste disposal.

Preparatory Review Chart

Environmental Factor	*Strengths*	*Weakness*	*Opportunities*	*Threats*
Air Emissions	x			
Water	x			
Wastewater		x		
Pipeline (SPM)		x		x
Hazardous Waste Management			x	
Power Plant Generation			x	
Anoe Village People			x	

Strengths:

1.	Air emissions	use of pollution control equipment,Opsis monitoring systems and low sulfur crude allows meeting stringent air emissions
2.	Water	"closed system" from the Gulf of Guinea, significant reduction of both land and water contamination
3.	Wastewater	only 10% of wastewater is expected to be *discharged into the Gulf of Guinea on an* annual basis. Discharging of wastewater into the Gulf of Guinea is controlled decision and not a routine function

.Weakness and Threat:

1.	Pipeline (SPM)	marine oil spils in the Gulf of Guinea near the SPM is a weakness. Mainly employee operated errors cause of spills. It is a threat to the aquatic organisms.

Opportunties:

1.	Hazardous Waste Mgt.	the capability of virtually using about 90% of raw material through reforming of crude. Use of inetrnal boiler for intermediates and significant reduce sludges/solids.
2.	Power Plant Generation	use of steam to produce electricity and sell excess power to local power grid system.

Environmental Policy:

Many of the environmental policies are modified policies of existing regulatory bodies to concur with the present environmental policies of the Ghana Environmental Protection Agency. Each environmental policy adopted by Ankobra Resources Ltd. priority is the environmental compliance of the Ghana Environmental Protection Agency regulations and *a more stringent applicable such as air emissions, water quality, wastewater discharge,* and hazardous waste disposal (Appendices III).

Example:

Ankobra Resources Ltd will use the mandated air emissions parameters from the Ghana Environmental Protection Agency plus the more stringent air emission parameters such as the NAAQS, U.S. EPA. Modern pollution equipment is designed to meet such regulatory parameters.

Table 2.1 The National Ambient Air Quality Standards

Pollutants	Average Time	Primary Standard	Secondary Standard	Measurement Method
Sulfur dioxide	Annual average	80 ug*/m(3)	----	Pararosanaline
	24 h	365 ug*/m(3)		or equivalent
	3 h	----	1300ug*/m(3)	
Particulate matter (1)				
PM (10)	Annual average	50 ug*/m(3)	same	Size selective
	24 h	150 ug*/m(3)	same	samplers
Carbon Monoxide	8 h	10,000 ug*/m(3)	same	Nondispersive infrared
	1 h	40,000 ug*/m(3)	same	Spectroscopy
Nitrogen dioxide	*Annual average*	*100 ug*/m(3)*	*same*	*Colorimetry*
Hydrocarbons	3 hour (6-9AM)	160 ug*/m(3)	same	Flame ioniza-
	(corrected for methane)			tion detector
Ozone	1 h (4)	235 ug*/m(3)	same	Chemilumin-
				escent method
				or equivalent
Lead	8 h (5)	160 ug*/m(3)	same	Atomic
	Calendar quarter	1.5 ug*/m(3)	same	adsorption
	Maximum arithmetic average			

Standards based on other annual average are not to be exceeded more than once per year.
Primary standards-set to protect human health. Secondary standards-set to protect public welfare

(1) Only particles with an aerodynamic diameter less than 10 um or 2.5 um.
(2) Areas will be in compliance when the three year average of the annual arithmetic mean concentration,from single or multiple community monitors,is less than or equal to 15 ug/m(3).
(3) Based on the 98th percentile of the 24-h concentrations in a year average over 3 years at the population-oriented monitoring site with measured values in the area.
(4) This standard will not be revoked until area has achieved 3 consecutive years of air quality data meeting the 1-h standard.
(5) Areas are in compliance when the 3-year average of the annual 4th highest daily maximum 8-h concentration is below 160 ug/m(3)

Wastewater:

Raw Wastewater Petroleum-Refinery Industry

	Cracking subcategory		Petrochemical subcategory	
Characteristics	Range (b)	Median	Range(b)	Median
Flow(c)	3.29-2,750	93.0	26.6-443	109
BOD (5)	14.3-466	72.9	40.9-715	172
COD	27.7-2,520	217	200-1,090	463
TOC	5.43-320	41.5	48.6-458	149
TSS	0.94-360	18.2	6.29-372	48.6
Sulfides	0.01-39.5(d)	0.94(d)	0.009-91.5	0.86
Oil and Grease	2.86-365	31.2	12.0-235	52.9
Phenols	0.19-80.1	4.00	2.55-23.7	7.72
Ammonia	2.35-174	28.3	5.43-206	34.3
Chromium	0.0008-4.15	0.25	0.014-3.86	0.234

(a) After refinery oil separator
(b) Probability of occurrence less than or equal to .10 or .90,respectively
(c) 1,000 m(3)/1,000 m(3) of feedstock throughput
(d) Sulfur
Source: U. S. Environmental Protection Agency, 1980, p.II.14-17.

Water Quality:

Maximum Contaminant Levels in Community Water Systems

Contaminant category	Contaminant	Maximum contaminant level

Primary standards

Inorganic chemicals	Arsenic	0.05 mg/L
	Barium	1
	Cadmium	0.010
	Chromium	0.05
	Fluoride	4.0
	Lead	0.05
	Mercury	0.002
	Nitrate(as N)	10
	Selenium	0.01
	Silver	0.05
Organic chemicals	Chlorinated hydrocarbons	
	Endrin	0.0002 mg/L
	Lindane	0.004
	Methoxychlor	0.1
	Toxaphene	0.005
	Chlorophenoxys	
	2,4,-D (2,4-dichlorophenoxyacetic acid)	0.1
	2,4,5-TP Silvex (2,4,5,-trichlorphenoxy-propionic acid)	0.01
	Total trihalomethane (the sum of the concentrations of bromodichloromethane,dibromochloromethane, *tribromomethane (bromoform)*, and trichloromethane (chloroform)	0.10
Turbidity	Turbidity	1.0 JTU (turibidity units)
Radioactivity	Combined radium 226 and radium 228	5 pCi/L
	Gross alpha-particle activity(including radium 226 but excluding radon and uranium)	*15pCi/L*
Bacterological	Total Coliform	1/100mL

Secondary standard

Miscellaneous	Aluminum	0.05 to 0.2 mg/L
	Chloride	250 mg/L
	Color	15 CU(color units)
	Copper	1.0 mg/L
	Corrosivity	Noncorrosive
	Fluoride	2.0 mg/L

Foaming agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 Ton (a)
pH	6.5 to 8.5
Silver	0.1 mg/L
Sulfate	250 mg/L
Total dissolved solids (TDS)	500 mg/L
Zinc	5 mg/L

(a) Threshold odor number

Source: Compiled using data from U.S. Environmental Protection Agency,1991e, and 1991f.

Both the Raw Wastewater-Refinery Industry values and Maximum Contaminant Levels in Community Water Systems are used additionally to the Ghana EPA. Provided such values are more stringent than the Ghana EPA values for both wastewater and water quality.

Organization and Personnel:

Ankobra Resources Ltd. as related to the Environmental Management System has given specific responsibilities to both line workers and management concerning the environmental management system. There are five areas that designated personnel are needed to carry out the duties and responsibilities in the areas of ,(1) air emissions, (2) water quality, (3) wastewater discharge, (4) hazardous waste disposal, and (5) inhabitants.

The Board of Directors will form an Environmental Committee that monitor and implement any forms of mitigation to continue on an environmentally safe and compliant course. Managing Director, reports in writing on a monthly and quarterly basis the environmental conditions of the petrochemical-refinery complex. The weekly report includes the following:

1. air emissions, daily output to include SOx, NOx, CO, Suspended particles, color of plume,downtime from air emissions, and meteorological conditions. Also, Opsis gas emissions readings from the 10km, 100m, and Anoe boundary

2. water quality, daily output of organics, inorganics, heavy metals, nitrogen, phosphorous,BOD,COD, TOC, etc.

3. wastewater discharge, totals for recycling,total for incineration,total for discharge into the Gulf of Guinea on a daily basis. Also, the organics and inorganics and many of the parameters noted in water quality.

4. hazardous waste, daily output in the forms of liquid, solids, and gases. Totals for each group such as liquids,solids, and gases. Total amount of metals that are candidates for recycling.

5. Incidents involved in crude oil /petroleum products that were potentials for spills

The weekly reports have been received from the personnel listed below.

1. Environmental Engineer

    a. Environmental Technician
    b. Hazardous Waste Specialist

2. Environmental Laboratory Manager

    a. Environmental Laboratory Technician

Evaluation & Register of Effects:

The Managing Director provides the monthly and quarterly environmental report to the Environmental Committee. The Environmental Committee review,discuss, and make recommendations on the monthly and quarterly environmental reports.

Factors such air emissions are over the mandated regulations by the Ghana EPA, efforts are made on an immediate basis to make the necessary correction to remain in compliance. Compliance is the key issue, the petrochemical -refinery complex is not operating as designed when specific values exceed the regulations for such activities.

The analytical results of water being used in the petrochemical-refinery complex shows value greater than the mandated Ghana EPA regulations corrections are taken on an immediate basis. A clean and healthy water source is vital to both man and machinery in the petrochemical-refinery industry.

Wastewater analytical results are key indicators of the entire system. Many functions are dependent upon the value of water as a cooling medium, an excessive deposit of metals can cause serious problems for the entire system.

The Environmental Committee will be empowered to contact the manufacture of any modular unit to seek expert advice on any problem in a specific processing unit. Also, the manufacturer of any pollution equipment and electronic instrumentation devices.

The President, Ankobra Resources Ltd. has the administrative responsibility to carry out the recommendations of the Environmental Committee. All recommendations received by the President are directed to the Managing Director for implementation.

Register of Regulations:

The register of regulations are the responsibility of the environmental compliance officer. All environmental regulations as mandated by the Ghana EPA are accepted, becomes the regulations of use, review the legal ramifications of such regulations, and monitor the petrochemical-refinery complex and its use of such regulations.

The environmental compliance officer has to interface with the Ghana EPA on compliance issues such air emissions, water quality, wastewater, and hazardous waste when the petrochemical-refinery is not in compliance.

Other environmental issues involving the nearby inhabitants are the responsibility of the environmental compliance officer. Any issues pertaining to infractions of the environmental permit such as illegal dumping of waste on-site is the responsibility of the environmental compliance officer. A report of such activities shall be investigated and the proper personnel at the Ghana EPA are to be notified of such incident(s).

Objects and Targets:

The main objects of the petrochemical-refinery project is to remain compliant for its air emission, water quality, wasterwater discharge, hazardous waste, and areas of influence (i.e. Anoe Village). The targets of the petrochemical-refinery complex is the values of and analytical data from air emissions, water quality, wastewater discharge, hazardous waste disposal (i.e. methods and procedures) are within the mandated environmental regulations to include stated values of the EPA.

Targets- Air Emissions

Environmental Factors	NAAQS	
	Primary	Secondary
Air emissions		
a. sulfur dioxide	80 ug/m(3)	----
	365 ug/m(3)	----
	-----	1300 ug/m(3)
b. particulate matter (PM 10)	50 ug/m(3)	same
	150 ug/m(3)	same
c. carbon monoxide	10,000 ug/m(3)	same
	40,000 ug/m(3)	same
d. nitrogen dioxide	100 ug/m(3)	same
e. hydrocarbons	160 ug/m(3)	same
f. ozone	235 ug/m(3)	same
g. lead	160 ug/m(3)	same
	1.5 ug/m(3)	same

The targets for water quality will enable the entire petrochemical-refinery complex to operate all processing units to decrease pitting and corrosion of metal components. Ultra-pure water allows the petrochemicals to reduce the levels of potential contaminants and provides product of higher quality.

Targets-Water Quality

Environmental Factor	Maximum Contaminant Level
Water quality	
a. arsenic	0.05 mg/L
b. barium	1
c. cadmium	0.010
c. chromium	0.05
d. fluoride	4.0
e. lead	0.05
f. mercury	0.002
g. nitrates (as N)	10
h. selenium	0.01
i. silver	0.05
j. endrin	0.0002 mg/L
k. lindane	0.004
l. methoxychlor	0.1
m. toxaphene	0.005
n.. 2,4, D	0.1
o. 2,4,5-TP	0.01
p. total trihalomethane	0.10
q. combined radium 226 and radium 228	5 pCi/L
r. gross alpha-particle activity	15pCi/L
s.. total coliform	1/100 mL
t. aluminum	0.05 to 0.2 mg/L
u. chloride	250 mg/L
v. color	15 CU (color units)
w. copper	1.0 mg/L
x. corrosivity	noncorrosive
y. fluoride	2.0 mg/L
z. foaming agent	0.5 mg/L
aa. iron	0.3 mg/L
bb. manganese	0.05 mg/L
cc. odor	3 Ton (a)
dd. pH	6.5 to 8.5
ee. silver	0.1 mg/L
ff. sulfate	250 mg/L
gg. TDS	500 mg/L
hh. zinc	5 mg/L

Targets-Raw Wastewater Parameters

Characteristics	Cracking subcategory Range(b)	Median	Petrochemical subcategory Range (b)	Median
flow (c)	3.29-2,750	93.0	26.6-443	109
BOD (5)	14.3-466	72.9	40.9-715	172
COD	27.7-2,520	217	200-1,090	463
TOC	5.43-320	41.5	48.6-458	149
TSS	0.94-360	18.2	6.29-372	48.6
Sulfides	0.01-39.5(d)	0.94(d)	0.009-91.5	0.86
Oil and Grease	2.86-365	31.2	12.0-235	52.9
Phenols	0.19-80.1	4.00	2.55-23.7	7.72
Ammonia	2.35 -174	28.3	5.43-206	34.3
Chromium	0.0008-4.15	0.25	0.014-3.86	0.234

The targets for the air emissions are applicable to both the incineration unit and the electrical power generating unit. All three areas, are designed to emit steam, which includes NOx, SOx, Suspended solids, CO, and Particulate matter.

Values listed as targets for the raw wastewater parameters are shown before being subjected to the wastewater treatment facility. Therefore the values should be much lower than the raw wastewater values stated as targets.The same values apply to the incineration and electrical power generating units as related to raw wastewater values and the wastewater treatment facility.

Management Programme:

Proper management of the environmental factors such as air quality, water quality, wastewater discharge, drainage, soil, noise, and groundwater are part of the management programme. Theses environmental factors are the essence of the entire management programme.

An environmental management programme involves, (1) qualified environmental personnel, (2) monitoring of the specific parameters to meet environmental standards, and (3) solutions and resolution to environmental problems. Management of hazardous waste or materials implements the needed action to remain compliant under such programme.

Environmental Management Plan-Pre-Construction

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost
Soil,Air,Water	Baseline Study	First year	Env.Contractor	$ 500,000
Groundwater,Noise	Engineering	First year	Env. Contractor	
Geomorphological Conditions				
Landsat data				
Seismic				
Marine Study	Baseline Study	First year	Env. Contractor Universities	$1,000,000

Environmental Management Plan-Construction

Air Dust	Air Quality Specialist	2nd year	Env. Contractor	$ 60,000*
Meterological Patterns	Meteorological	2nd year	Env. Contractor	$ 20,000
Drainage waste water	Engineering Firm	2 nd year	Env. Contractor	$ 50,000**
Groundwater	Engineering	2nd year	Env. Contractor	$ 30,000**
Water Quality	Engineering	2nd year	Env. Contractor	$ 20,000*

* debited from the University funded study for both land and marine biota

** debited from feasibility study budget

Environmental Management Plan-Operation

Environmental Factors	Resources	Implementation	Contractor	Cost
Soil	Environmental Engineer	Third year	Env. Contractor	$ 30,000
Sampling	Environmental Lab	Third year	Env. Contractor	$ 5,000
Air Quality	Environmental Engineer	Third year	Env. Contractor	$ 60,000
Sampling	Environmental Lab	Third year	Env. Contractor	$ 10,000
Water Quality	Environmental Engineer	Third year	Env. Contractor	$ 30,000

Sampling	Environmental Lab	Third year	Env. Contractor	$ 20,000
Groundwater	Environmental Engineer	Third year	Env. Contractor	$ 20,000
Sampling	Environmental Lab	Third year	Env. Contractor	$ 5,000
Meteorological Patterns	Environmental	Third year	Env. Contractor	$ 20,000
Drainage	Environmental Engineer	Third year	Env. Contractor	$ 20,000
Sampling	Environmental Lab	Third year	Env. Contractor	$ 5,000

The environmental laboratory will be responsible for the management of all sampling procedures, shipping, crating, completion of work, and testing results within its capacity. Also, control samples for dual testing and sampling as required for any certified study.

The environmental laboratory will be sectionalized in accordance to work responsibilities. Those areas will be chemistry, water chemistry, air measurement, noise measurement, wastewater analysis, soil analysis, and pesticide analysis.

Many of the basic monitoring duties as related to the petrochemical refinery complex will have sensors in line and monitored by computer with digital output. All tankage will be monitored for gases, measurement of volume by sensors connected to computers.

In the first and second year of construction of the petrochemical-refinery complex (1) baseline data for air,water, soil, groundwater, and wastewater will be collected,and (2) implementation of control points for each environmental factor established. Third and fourth year will entail actual methods and procedures of implementing the management program.

Environmental Management Plan- Operations*

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost
Soil	Environmental Engineer	Fourth year (1)	Env. Contractor	$ 20,000
Air Quality	Environmental Engineer	Fourth year	Env. Contractor	$ 60,000
Water Quality	Environmental Engineer	Fourth year	Env. Contractor	$ 30,000
Drainage	Environmental Engineer	Fourth year	Env. Contractor	$ 20,000

Meteorological	Environmental	Fourth year	Env. Contractor	$ 20,000
Sampling a. air b. water c. groundwater d. wastewater e. soil	Environmental Lab	Fourth year (1)	Env. Contractor	$ 45,000

* Permanent operations,daily,weekly, and monthly sampling for different parameters for specific environmental factors.

(1) All activities on a permanent basis will start in the fourth year in the construction of the petrochemical - refinery complex on an annual basis. Permanent air monitoring locations to include adjacent boundaries to the petrochemical - refinery complex and domestic housing.

Monitoring of the air quality in terms of emissions is one of the key duties in our environmental management program. This monitoring program will include monitoring of gaseous materials,vapors, and particulate matter.

Meteorological patterns is a key parameter in the dispersion of any gases, vapor, or particulate. Efforts will be made to determine such wind movement by season and the effect the Gulf of Guinea has on the Sekondi Export Processing Zone unit.

Environmental Management Plan-Water Quality:

The management of water quality is dependent upon natural runoff, stormwater, and drainage from both the petrochemical -refinery complex and domestic housing area. Early sampling of natural runoff is accomplished during the Pre Construction phase.

Data will be collected during the first year by the universities on both land and the littoral area of the Gulf of Guinea. Many water samples will be taken to compare the quality of the natural runoff and water quality of the Gulf of Guinea

Environmental Management Plan-Pre Construction

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost (Annually)
Water	Engineering	First year	Env. Contractor	$ 10,000
Sampling	Engineering	First	Env. Contractor	$ 2,000

The first year during the PreConstruction phase is used to develop a baseline of data for water quality. During rain fall and areas with significant water not infiltrated into the soil, samples are taken in demarcated areas before actual construction.

Environmental Management Plan-Construction

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost
Water	Engineering	Second year	Env. Contractor	$ 10,000
Sampling	Engineering	Second year	Env. Contractor	$ 5,000

Since the area was previously used as agricultural land, development of the baseline data is within years one and two. Mapping of potential areas for runoff during years one and two will assist greatly in compiling such data.

Environmental Management Plan-Operation

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost (Annually)
Water Map of the area of runoff Review data from marine study	Environmental Engineer	Third year	Env. Contractor	$ 20,000
Sampling	Environmental Lab	Third year	Env. Contractor	$ 5,000

Environmental Management Plan-Water Operations*

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost
Water Develop water quality plan. Develop the schedule for annual sampling. Generate reports to management.	Environmental Engineer	Fourth year	Env. Contractor	$ 20,000

Sampling Generate report of sampling to environmental engineer. Develop a data base for such results	Environmental Lab	Fourth year	Env. Contractor	$ 5,000

* Permanent operations, daily, weekly, and monthly sampling for different parameters for specific environmental factors.
All activities on a permanent basis will start in the fourth year in the construction of the petrochemical-refinery complex on an annual basis. Permanent water monitoring locations to include adjacent boundaries to the petrochemical-refinery complex.

Environmental Management Plan- Wastewater Discharge

Environmental management of wastewater discharge includes all waters that have collected as drainage from domestic and industrial sewer systems, spent cooling waters, and stormwaters. Drainage from domestic and industrial sewer systems, spent cooling water, and stormwaters are available during the operational phase.

Environmental Management- Operations*

Environmental Factors	Resources	Implementation Schedule	Contractors	Cost
Wastewater a. cooling waters b. stormwaters c. drainage Development of the routine wastewater monitoring system. Generate report to management. Interface with the EPA-Ghana or Public Health. Compare baseline of wastewaters on site with baseline of Gulf of Guinea. Plot the effects of the wastewater discharge into the Gulf of Guinea in terms of physical,	Environmental Engineer	Third and Fourth year	Env. Contractor	$ 20,000

biological, and chemical parameters.				
Sampling	Environmental Lab.	Third and Fourth	Env. Contractor	$ 5,000

The wastewater monitoring is a priority along with air quality, the main reason for the "closed system" during the design and construction phase is so important. The wastewater treatment facility is a key element in keeping the wastewater discharged into the Gulf of Guinea as clean and pure as possible. One objective is to be able to reuse at least 70% to 90% of the wastewater for "cooling water" in the petrochemical-refinery complex maintaining a "closed system" nearly 99% excluding gas, vapor, and particulate emissions.

Environmental Management Plan-Soil:

The importance of the soil cannot be merely taken for granted, the whole project and its structures are depending on the soil condition. That soil conditions are free of plumes indicating significant groundwater problems, inconsistency of geomorphological formations, and terrain not acceptable for industrial use are the main requirements.

As previously stated the soil in the Sekondi Export Processing Zone site has the typical low plains terrain. Demarcated areas have not indicated any terrain with fault lines that are open areas exposing the underlying strata of rock formations.

Environmental Management Plan- Soil

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost (Annually)
Soil Geomorphological Conditions Landsat data	Baseline Study Engineering Firm	First year	Env. Contractor	$ 500,000
Marine Study (soil samples)	Research Universities	First year	Env. Contractor	$ 1,000,000
Mapping of soil from Landsat data Identifying the rock formation with seismic activities.	Engineering Firm	Second year	Env. Contractor	$ 20,000
Implementation of soil erosion program.	Engineering Firm	Third year	Env. Contractor	$ 5,000

Soil engineering data on stress by foundation	Engineering Firm	Fourth year	Env. Contractor	$ 10,000

Environmental Management Plan-Groundwater

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost
Groundwater Landsat data Mapping of the potential groundwater location in the substrata	Engineering Firm	First year	Env. Contractor	$ 20,000
Drilling boreholes for sampling Analysis of samples Soil and structural engineers determine the actual stress to the specific area with consultation with geologist.	Engineering Firm	Second year	Env. Contractor	$ 30,000
Sampling				$ 5,000
Mapping entire groundwater area to include potential drainage of water.	Engineering Firm	Third year	Env. Contractor	$ 20,000
Landsat data to determine the origin of such groundwater on the site with extra satellite shots. More drilling of boreholes if needed.	Engineering Firm	Fourth year	Env. Contractor	$ 20,000

The presence of groundwater existence in the Sekondi Export Processing Zone site designated to Ankobra Resources Ltd. initially does not give indications of such body of water is present. Visual inspection, September, 1997 did not indicate any stream of water is deep, then the outflow into the Gulf of Guinea would not be noted unless Landsat is used.

Environmental Management Plan-Ambient Noise

Environmental Factors	Resources	Implementation Schedule	Contractor	Cost (Annually)
Ambient Noise Define population in the adjacent communities and boundaries. Use of mathematical model to determine dBA levels present	Engineering Firm	First year	Env. Contractor	$ 20,000
Use of Sound Level Datalogger-store sound measurements to download to computer at specific locations in the adjacent communities and boundaries to develop a baseline.	Engineering Firm	Second year	Env. Contractor	$ 10,000
Use of sound meters in the immediate area of the petrochemical-refinery area "A", "B' or "C" weighting.	Environmental Engineer	First,Second & Third year	Env. Contractor	$ 5,000
Use in work place for all employees. Combination use of both the sound meter and sound level datalogger in all the essential areas.	Environmental Engineer	Fourth year	Env. Contractor	$ 5,000

Management Manual(s):

Ankobra Resources Ltd. enviromental management manual(s) are to to be written by the Environmental Compliance Officer in conjunction with the Corporate Environmental Scientist.The environmental management manual (s) will include the terms and conditions of the Environmental Permit, Environmental policies,targets, and objectives as it applies to the operation of the petrochemical -refinery complex.

The Environmental Management Manual(s) should contain the language corresponding to topics listed below.

1.	Environmental Permit	all parameters as they apply to the operation of the petrochemical-refinery complex.
2.	Environmental Personnel	documents should state the general job description of all environmental personnel inclusive of Environmental Technician(s) and Hazardous Waste Specialist(s).
3.	Methods and Procedures a. air emission b. water quality c. wastewater discharge d. hazardous waste disposal e. inhabitants f. soil and dust g. groundwater (if applicable) h. noise	all methods and procedures for applications needed to monitor, sample, compile data, atmospheric and aquatic conditions and land based environmental conditions
4.	Report Format	all methods and procedures for applications needed to monitor, sample, compile data, atmospheric and aquatic conditions and land based environmental issues to be properly reported to both the management of Ankobra Resources Ltd. and Ghana EPA.
5.	Health & Safety Procedures	environmental personnel will be involved with the general plant population and must be aware of health & safety procedures.

Operational Control:

The task of operational control as related to Environmental Management Systems will start during the first year or PreConstruction. Use of the management manuals by the Environmental Engineer, Environmental Technician(s), Hazardous Waste Specialist, and Environmental Lab personnel serve as the operational controls in implementing the management programme.

Air Emissions

Environmental Factor	Schedule Monitoring	Sampling	Personnel	Report Schedule Managing Director
Air Emissions	daily	daily	Env. Technician	weekly (refinery)
Air Emissions	daily	daily	Hazardous Waste Specialist	weekly (incinerator)
Air Emissions	daily	daily	Env. Lab. Tech.	weekly(power plant)

Water Quality

Environmental Factor	Schedule Monitoring	Sampling	Personnel	Report Schedule Managing Director
Water Quality (desalination plant)	daily	daily	Env. Lab. Tech.	weekly
Water Quality (cooling water)	daily	daily	Env. Lab. Tech.	weekly
Water Quality (stormwater)	daily	daily	Env. Lab. Tech.	weekly
Water Quality (Storage Tanks)	daily	daily	Env. Lab. Tech	weekly
Water Quality* (Gulf of Guinea)	weekly	weekly	Env. Lab. Tech.	weekly

* petrochemical-refinery will use small boats for sampling of the Gulf of Guinea

Groundwater

Environmental Factor	Schedule Monitoring	Sampling	Personnel	Report Schedule Managing Director
Groundwater (processing zone)	weekly	weekly	Env. Technician	weekly
Groundwater (Storage Tanks)	weekly	weekly	Env. Technician	weekly

Groundwater (unspecified)	weekly	weekly	Env. Technician	weekly

Wastewater Discharge

Environmental Factor	Schedule Monitoring	Sampling	Personnel	Report Schedule Managing Director
Wastewater (processing zone)	daily	daily	Env. Technician	weekly
Wastewater (treatment facility)	daily	daily	Env. Technician	weekly
Wastewater (Gulf of Guinea*)	daily	daily	Env. Technician	weekly
Wastewater (incinerator)	daily	daily	Hazardous Waste Specialist	weekly
Wastewater (power plant)	daily	daily	Env. Lab. Tech.	weekly

* Gulf of Guinea secondary outlet for wastewater or breakdown in system.

Operational controls environmentally will be the responsibility of the various department supervisors and managers. All operations in the processing zone will practice environmental safe and accepted practices. This involves providing the data for emission of all gases that have been electronically recorded to the designated personnel for collection. A copy of all environmental reports are forwarded to the Environmental Compliance Officer for review and to determine if the plant is in compliance with Ghana EPA regulations.

Noise

Environmental Factor	Schedule Monitoring	Sampling	Personnel	Report Schedule Managing Director
Noise (processing zone)*	daily-weekly	daily-weekly	Safety Engineer	weekly

Noise (control rooms)*	daily-weekly	daily-weekly	Safety Engineer	weekly
Noise (incinerator)*	daily-weekly	daily-weekly	Safety Engineer	weekly
Noise (power plant)*	daily-weekly	daily-weekly	Safety Engineer	weekly
Noise (wastewater treatment facility)*	daily-weekly	daily-weekly	Safety Engineer	weekly
Noise (Anoc Village)	daily-weekly	daily-weekly	Safety Engineer	weekly
Noise (indoor offices)*	weekly	weekly	Safety Engineer	weekly

* all internal and external walls are constructed to reduce the noise under 20dBA. Daily monitoring and data recording for data base, activities then performed on a weekly basis.

Soil and Dust

Environmental Factor	Schedule Monitoring	Schedule Sampling	Personnel	Report Schedule Managing Director
Soil and Dust (processing zone)	daily-weekly	weekly	Env. Technician	weekly
Soil and Dust (Storage Tanks)	daily-weekly	weekly	Env. Technician	weekly
Soil and Dust (wastewater treatment facility)	weekly	weekly	Env. Technician	weekly
Soil and Dust (power plant)	weekly	weekly	Env. Technician	weekly
Soil and Dust (incinerator)	weekly	weekly	Hazardous Waste	weekly
Soil and Dust (desalination)	weekly	weekly	Env. Technician	weekly

Soil and Dust (Anoe Village)	weekly	weekly	Env. Technician	weekly

Records:

Recordkeeping is vital to any Environmental Management Programme. Monitoring, sampling, and recording data becomes a function of recordkeeping as related to the environmental conditions.

The Managing Director, Ankobra Resources Ltd. receives a weekly report from the personnel involved in environmental functions, which are mainly to make operational decisions to remain in compliance with Ghana EPA. The Environmental Compliance Officer actually receives copies of all environmental reports and has the responsibility of having records on file.

All environmental reports that are destined for Ghana EPA is the responsibility of the Environmental Compliance Officer. Listed are the types of records that are kept on file by the Environmental Compliance Officer.

1. air emissions, gas emissions, steam, vapors, and particulate readings or data
2. water quality, i.e. heavy metals, organics, inorganics, physical parameters, biological and pathogens, radioactivity
3. wastewater discharges for various areas within the petrochemical-refinery complex. Also, any wastewater discharges in the Gulf of Guinea.
4. groundwater contamination and the specific areas with the petrochemical-refinery site.
5. soil contamination throughout the history of the petrochemical-refinery operations.
6. noise data recording for the petrochemical -refinery site and Anoe Village.
7. dust contamination on the site and Anoe Village. Data on dust abatement program.
8. Complaints from nearby industries or villages on air emissions, noise,dust, water quality or illegal dumping of hazardous waste.
9. Marine environmental data on the acquatic environment and oil spills of all types.

Audits:

Ankobra Resources Ltd plans to conduct all environmental audits under the Ghana EPA plus ISO 9000 terms and conditions. Audits are performed on the international scale for environmental audits. Additional audits have to be made for Ankobra Resources Ltd to be recognized as an international supplier of petroleum products and ISO 14000 specifications will be used during this specific audit.

There will be scheduled audits and some unscheduled audits as related to the environmentally safe operation conditons. Safety audits will be conducted on a scheduled and unscheduled basis as related to safety issues.

Personnel will be audited on a quarterly basis for health issues that may lead to massive illness within the petrochemical-refinery complex. If their is an increase of illness in the number of employees being in a specific area (i.e. processing area), an audit will be performed to determine if the causative agent is in the work place,drinking water, air ducts or change room (i.e. shower fungus).

Reviews:

The reviewing of environmental policies are conducted by the Environmental Committee on a quarterly basis. The reviewing of the environmental reports are performed on a weekly basis by the Managing Director.

Reviewing of the weekly data from the processing area, tank storage area, power plant, incinerator, wastewater treatment facility, and Anoe Village is performed by the Environmental Compliance Officer. Every two weeks a review is made by the Managing Director, the Environmental officer is present to discuss the data as related to being in compliance with the Ghana EPA regulations.

A summary of data from the environmental compliance reviews becomes part of the monthly report to the Environmental Committee.The quarterly report is a compilation of the previous monthly reports as submitted by the Managing Director.

Environmental Reviews

Environmental Documents	Weekly	Bi-weekly	Monthly	Quarterly	From	To
Weekly Env. Report	x				Env. Manager	Managing Director
a. air emissions b. water quality c. wastewater discharge					Env. Lab Manager*	Managing Director

d. hazardous waste
e. noise,dust,soil
f. pipeline
g. Anoe Village
h. environmental compliants

Env. Compliance Report a. includes all computer generated data from the processing, storage tanks, pipeline, water quality, wastewater discharge, incinerator and power plant.	x		Env. Compliance Officer	Managing Director
Env. Compliance Report inclusive of the entire months or incorporates four weeks of data instead of two weeks		x	Env. Compliance Officer	Managing Director
Plant Environmental Report four week report inclusive of the weekly reports and bi-weekly reports forwarded to the Managing Director		x	Managing Director	Environmental Committee
Plant Quarterly Env. Report inclusive of three months of the four week reports prepared by the Managing Director.		x	Managing Director	Environmental Committee

* sampling for the water chemistry lab and require numerical values in reports

10.0 Monitoring

10.1 Monitoring Plan Air Quality

Environmental Category:	Air Quality
Environmental Impact:	Potential increase of SOx,NOx, and Particulates PreConstruction-Development of baseline on Air Quality Construction - collect data on parameters and compare with baseline data Operation- collect data on parameters and

compare with baseline and national/international standards

Decommission collect data and compare to baseline, construction,operations and national/international standards

Parameters: Sulfur dioxide, Particulate Matter, Carbon Monoxide,Nitrogen dioxide,Hydrocarbons,Ozone & Lead.

Monitoring Equipment: Gas Sampling Pump and Detection Tubes

	Range	*TLV*
Sulfur dioxide	1 to 60ppm	2ppm
Nitrogen dioxide	0.5 to 30ppm	3ppm
Carbon Monoxide	0.1 to 20%	5000ppm
Hydrocarbon	0.05 to 0.6%	—
Ozone	0.05 to 3.0ppm	0.05ppm

Monitoring Procedure: Air monitoring will be performed on a daily basis,approximately three (3) times per day. Listed are the specific areas below.

a. processing zone perimeter
b. Tank farm perimeter
c. One Hundred Meter Perimeter
d. Anoe Village Boundary
f. All boundaries facing the populated areas in the region.

The OpsisSystem will be used to provide a continuous electronic beam to detect gas/vapor properties on a twenty-four basis.

Comparison of samples with relevant national/ international standards.

The monitoring is for the life time of the operating petrochemical-refinery complex to include the Decommissioning phase.

10.2 Water Quality

Monitoring Plan Water Quality

Environmental Category:	Water Quality
Environmental Impact:	Increase in chemicals(inorganic/organic),turbidity, radioactivity, and metals. PreConstruction-Develop baseline for Water Quality *Construction* *collect data and compare to Pre-Construction phase* Operation collect data and compare to Pre-Construction,Construction,and national/international standards Decommission collect data and compare to Pre-Construction,Construction, Operation, and national/international standards
Parameters:	Inorganic chemicals arsenic, barium, cadmium,chromium,fluoride,lead, mercury,nitrate (as N), selenium,silver. Organic chemicals chlorinated hydrocarbons a. Endrin b.Lindane c.Methoxychlor d. Toxaphane e. Chlorophenoxys f. 2,4-D (2,4-dichlorophenoxyacetic acid) g.2,4,5-TP Silvex h. total trihalomethane Turbidity a.turbidity Radioactivity a. combined radium 226 and 228 b. Gross alpha-particle activity Miscellaneous: aluminum,chloride,color,copper,fluoride,foaming agent, iron,manganese,odor,pH,silver,sulfide,total dissolved solids (TSS) and zinc.
Monitoring Equipment:	1. *Reusable Bailer (3ft-1000ml)* 2. Polyester Cord (82ft (25 km) 3. Planton Net Sampler and Marine vessel(s) 4. Alpha Water Sampler(oceans) 5. Petersen Dredge (deep lakes & oceans)

6. Steel Aircraft Cable
   a. steel aircraft cable 33ft.
   b. steel aircraft cable 82ft.
   c. steel aircraft cable 328ft.

Monitoring Procedures:

The proposed site, Sekondi Export Processing Zone and the specific coordinates did not exhibit any surface water bodies, creeks, or tributaries in accordance with the fieldwork performed by the Botany Department,University of Ghana.

Water samples will be collected from designated areas in the Gulf of Guinea on a weekly basis.

Comparison of samples with revelant natural/ international standards

This monitoring is for the life time of the operating petrochemical-refinery complex to include the Decommissioning phase.

10.3 Groundwater

Ankobra Resources Ltd. will be particularly concerned about the presence of groundwater on the proposed site, Sekondi Export Processing Zone. The Botany-Zoology Survey did not indicate any tributaries, creeks, lakes, or surface water on the proposed site.

Groundwater activities in search of such conditions will be made during the PreConstruction, Construction, Operation, and Decommission phases. The Landsat and seismic studies are invaluable in denoting the presence of groundwater on the proposed site.

Monitoring Plan Groundwater

Environmental Category: Groundwater

Environmental Impact: Increase in contaminants such as metals, chemicals, and biological and/or microorganisms. During the PreConstruction, Construction, Operation, and Decommission phases.

Develop or discover the presence of groundwater in areas suspected of groundwater

a. identification of the types and quantities of soil and /or groundwater pollutants
b. groundwater quantities to be withdrawn as a result of the project
c. groundwater flows and quality,hydrogeological characteristics
d. existing point(s) and non existing point(s)
f. pollution loadings and existing groundwater withdrawals

Parameters:

Cl, Br, NO(2), SO(4), HCO (3), PO(4), Na, K, NH(4), Ca, Mg, Fe, Mn, Fe and Mn (oxyhydroxides), Organic solutes, and Micro-organisms

Monitoring Equipment:

1. Portable Vacuum Sampler (max. lift 28ft-8.2m)
2. Sludge Nabber (4 to 6.5 ft long)

3. Water Testing Strips*

Testing Parameters	Graduations
aluminium	0,10,25,50,100,250 ppm
ammonium	0.30,60,100,200,400ppm
arsenic	0,0.1,0.5,1.0,1.7,3 ppm
chloride	0,500,1000,1500,2000ppm
copper	10 to 300ppm
cyanide	0,1,3,10,30ppm
lead	0,29,40,100,200,500ppm
nickel	0,10,25,100,250,500ppm
nitrate	10 to 500ppm
pH	0,1,2,-14pH

4. Titrimeter Test Kits*

Test	Range
Color	0 to 100 units
Turbidity	5 to 100NTU

5. Colorimeter Test Kits*

Test	Testing Range
Ammonium/nitrogen	0.5 to 8 ppm
Iron	0.1 to 10ppm
Zinc	0.5 to 10ppm

6. Coliform Water Test Kit*

7. Bacterial Assay Kit*

8. Microbial Test Kits*
   a. acrobic bacteria test kit
   b. yeast and mold test kit
   c. bacteria and fungi test kit
   d. bacteria test kit

9. Pathogel Test*
   a. coliform
   b. salmonelle
   c. E. coli

* all test kits can be used in water, wastewater, and stormwater

a water chemistry laboratory is needed to monitor the parameters of water.

Monitoring Procedures:

The monitoring of groundwater will be performed on a weekly basis of suspected areas on the proposed site. Landsat and seismic studies are the key in locating these areas.

Comparison of samples with relevant national/international standards as related to water quality.

This monitoring is for the life time of the operating petrochemical-refinery complex to include the Decommissioning phase.

10.4 Stormwater

During the initial PreConstruction phase, areas of the proposed site are walked to determine the actual potential of low surface areas as related to the construction of the petrochemical-refinery complex. Low ground areas can contribute to potenial natural stormwater areas, which are shown on the Landsat studies.

Monitoring Plan Stormwater

Environmental Category:	Stormwater	
Environmental Impact:	PreConstruction	develop potential natural stormwater drainage areas collect samples to develop a baseline
	Construction	collect samples and compare to baseline samples.
	Operation	collect samples and compare to the baseline, construction and national/international standards.
Parameters:	The same parameters used for water quality.	
Monitoring Equipment:	1. Portable Vacuum Sampler (max. lift 28ft-8.2m) 2. Sludge Nabber 3. *Water Testing Strips** 4. Trimeteric Test Kits* 5. Colorimeter Test Kits* 6. Coliform Water Test Kit* 7. *Bacterial Assay Kit** 8. Microbial Test Kit* 9. Pathogel Test*	
Monitoring Procedure:	The monitoring of stormwater on a daily-weekly basis dependent upon the season of the year(i.e. rainy season). All culverts and stomwater systems will be accessible to collect samples in all major areas of the gathering and holding systems. Comparison of samples with relevant national/international standards as related to stormwater analysis.	

Monitoring of stormwater, there is a stormwater system to handle in-plant stormwater for the petrochemical-refinery complex. Through landscaping of the 100 to 120 acres, the in-plant system will handled the run-off within the stated acreage(Fig. 17).

10.5 Soil

The soil of the proposed site has been discussed previously in the EIA Report, Ankobra Resources Ltd. The soil has to be monitored for contamination by chemicals, metals and regular debris (i.e. foodstuffs, plastics, and odorous waters).

Monitoring Plan Soil

Environmental Category:	Soil	
Environmental Impact:	Increase in calcium,phosphorous, nitrates,nitrites, chloride, iron, manganese, magnesium,potassium, **pH**	
	PreConstruction	inspect soil for areas of contamination by chemicals (inorganic or organic), metals sample soil for basic soil chemistry
	Construction	collect samples and compare to the PreConstruction phase.
	Operation	collect samples and compare to the PreConstruction, and Construction phases. Soil samples in processing zone may show an increase in sulfides and nitrites or nitrates as air emissions.National and international *standards* are compared.
	Decommission	collect samples and compare to the PreConstruction

Construction,Operation and national/ international standards.

Monitoring Equipment:

1. Soil Sampling Kit
   a. handle,wet sampling tube,dry sampling tube
   b. wet/dry sampling tube
   c. rod extensions,T-handle and mallet
   d. universal wrench,sampling tube cleaner
   e. carrying case
2. Soil pH Electrode
3. Soil Test Kit

Test	Test Range
texture	determines sand,silt, & clay fractions
aluminum	L-H (5-125ppm)
calcium	150-2800ppm
chloride	25-500ppm
Humus(organic)	L-H(11/2-8%)
Iron (ferric)	5-125 lbs/acre
Magnesium	L-H(5-150ppm)
Manganese	L-H(4-40ppm)
Nitrogen(NH(4))	L-H(5-150ppm)
Nitrogen(nitrate)	10-150 lbs/acre
Nitrogen(nitrite)	1-50ppm
pH	3.8-9.6pH
Phosphorous	10-200 ibs/acre
Potassium	100-400 lbs/acres
Sulfate	50-2000ppm

Monitoring Procedure

The monitoring of soil is performed on a weekly basis to generate data and compare basically to the air emissions data chart. The processing zone and tankfarm is completely on Portland cement foundation.

Comparison of samples with relevant national/international standards as related to soil analysis.

This monitoring is for the life time of the operating petrochemical-refinery complex to include the Decommission phase.

10.6 Anoe Village

Anoe Village has to be monitored, specifically for air emissions and soil contamination as related to an impact concerning the health of the people. The water is being supplied by the Sekondi municipal water system.

Monitoring Plan Air Quality

Environmental Category:	Air Quality	
Environmental Impact:	Increase in NOx and SOx,and Particulates	
	PreConstruction	collect data/samples to develop a baseline
	Construction	collect data/samples and compare to PreConstruction
	Operation	collect data/samples and compare to PreConstruction Construction and national/ international standards
	Decommission	collect data/samples and compare to PreConstruction Construction,Operation and national/international standards.
Monitoring Equipment:	Same as equipment,	10.0 Monitoring.
Monitoring Procedure	Same as procedures,	10.0 Monitoring
Standards:	Same as standards,	10.0 Monitoring
Monitoring Duration	This monitoring is for the life time of the operating petrochemical-refinery complex to include the Decommission phase.	

Monitoring Plan Soil

Environmental Category:	**Soil**	
Environmental Impact:	Potential increase of NOx, SOx, Particulates	
	PreConstruction	collect data/samples and develop baseline
	Construction	collect data/samples and compare to PreConstruction phase.
	Operation	collect data/samples and compare to PreConstruction Construction, and national/ international standards
	Decommission	collect data/samples and compare to PreConstruction Construction,Operation and national/international standards.
Monitoring Equipment:	Same as equipment,	10.5 Soil
Monitoring Procedure	Same as procedure,	10.5 Soil
Standards:	Same as standards,	10.5 Soil
Monitoring Duration:	This monitoring is for the life time of the operating petrochemical-refinery complex to include the Decommission phase.	

11.0 Stakeholders

Consultation with Members of the Public To be Affected

Public Servants	1997	1998	1999	2000	Comments
Ministry of Trade	x				received brochure on Sekondi Export Processing Zone
Habor Engineer	x				received map of the area pictures taken of the site and made an environmental inspection

Western Minister*	x		x		initial review of the Proforma document
Mayor Sekondi	x		x		out of town, has to Mayor on telephone many times
Metro Planning Board	x		x		in 1999 received the base map for the proposed site
Metro Engineer			x		discussed the base map and the electrical potential for the area The pipeline under public road was not a concern
EPA Regional Officer			x		discussed air emissions and venturi scrubber
GFZB Tech. Rep.			x		discussed base map and soil samples taken
Min.of Mines & Energy	x	x	x	x	discussed the status of the project and received positive positive response
Ministry of Finance	x	x	x	x	discussed the status of the project and received positive letter on guarantee

* photographs taken on property of the Western Minister of the coastline adjacent to the Free Zone property.

An EPA meeting was held on August 16,2000, Accra, Ghana with the various Ministries and the proponent, Ankobra Resources Ltd. Listed below are the names of the stakeholders and their respective governmental agencies.

1.	Dr. Peter C. Acquah	Executive Director(EPA)-Chairman
2.	Dr. Thomas Ansah	Executive Secretary,Energy Commission
3.	Mr. Daniel Hogan	Ghana Free Zones Board
4.	Mr. Benjamin Amoah	Ghana Free Zones Board
5.	Dr. Rexford Osei (TRC Member)	Min. Env. Science & Technology
6.	Mr. C. M.K.Normeshire (TRC Member)	Council for Sci. & Ind. Research
7.	Mr. John Richter (TRC Member)	Factories Inspectorate Dept.
8.	Mr. Theophilus Mohenu	Ministry of Mines and Energy
9.	Mr. Dan A. Amoah	Ministry of Mines and Energy
10.	Mr. Roland T. Cain	Proponent(CEO Ankobra Resources Ltd.)
11.	Mr. W. K. Agyemang-Bonsu	EPA
12.	Mrs. Margret Ahiadeke	EPA
13.	Mr. Larsey Mensah	EPA
14.	Mr. Samuel Anku	EPA
15.	Dr. Harry Tetteh Owodo	EPA
16.	Mr. Ebenezer Kwei Mensah	EPA
17.	Mr. D.S. Amlalo	EPA
18.	Mr. Y. Amoyaw Osei	EPA
19.	Mr. J.A. Allotey	EPA
20.	Mr. Kwabena Badu-Yeboah	EPA

The outcome of the meeting has been denoted by placing a copies of the letters dated September 08,2000 and September 19,2000 in Appendices III. A copy of the pages 39,40,41,43,44, and 45, "The Ghana Environmental Impact Assessment Procedures (1995) have been enclosed for the record.

APPENDIX I

Base Map, Ankobra Resources Ltd.

Basic Data- Anoe Village People

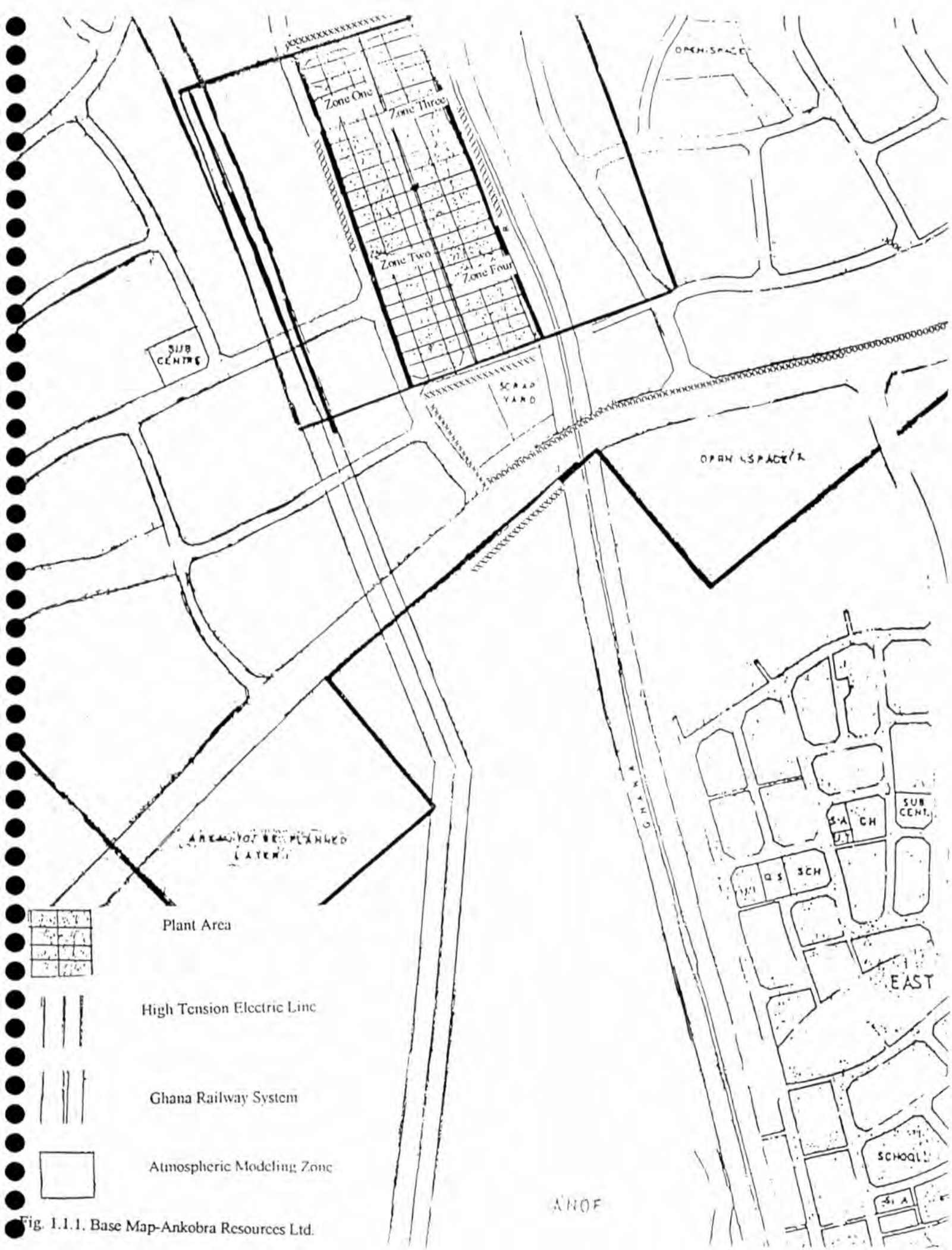
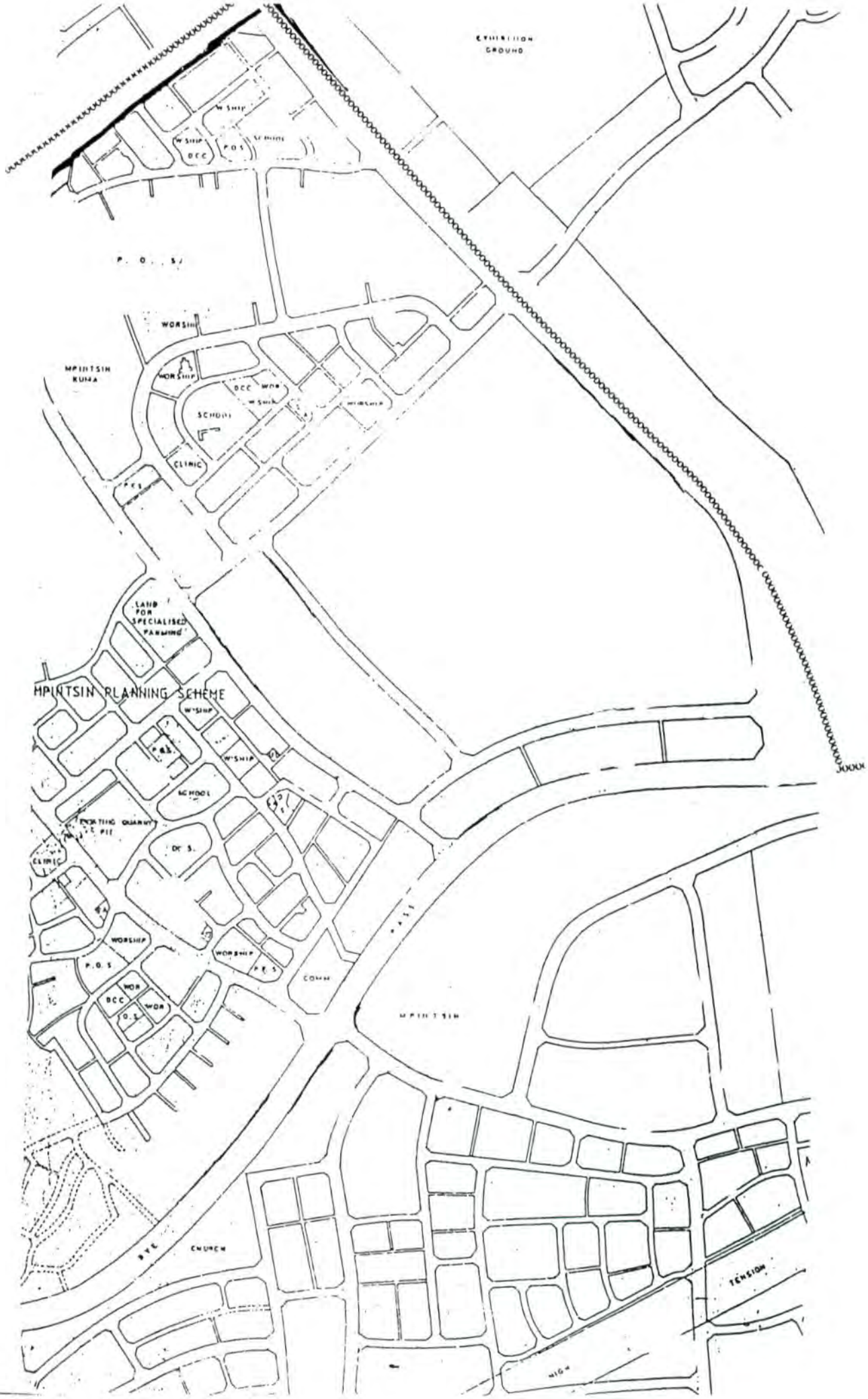
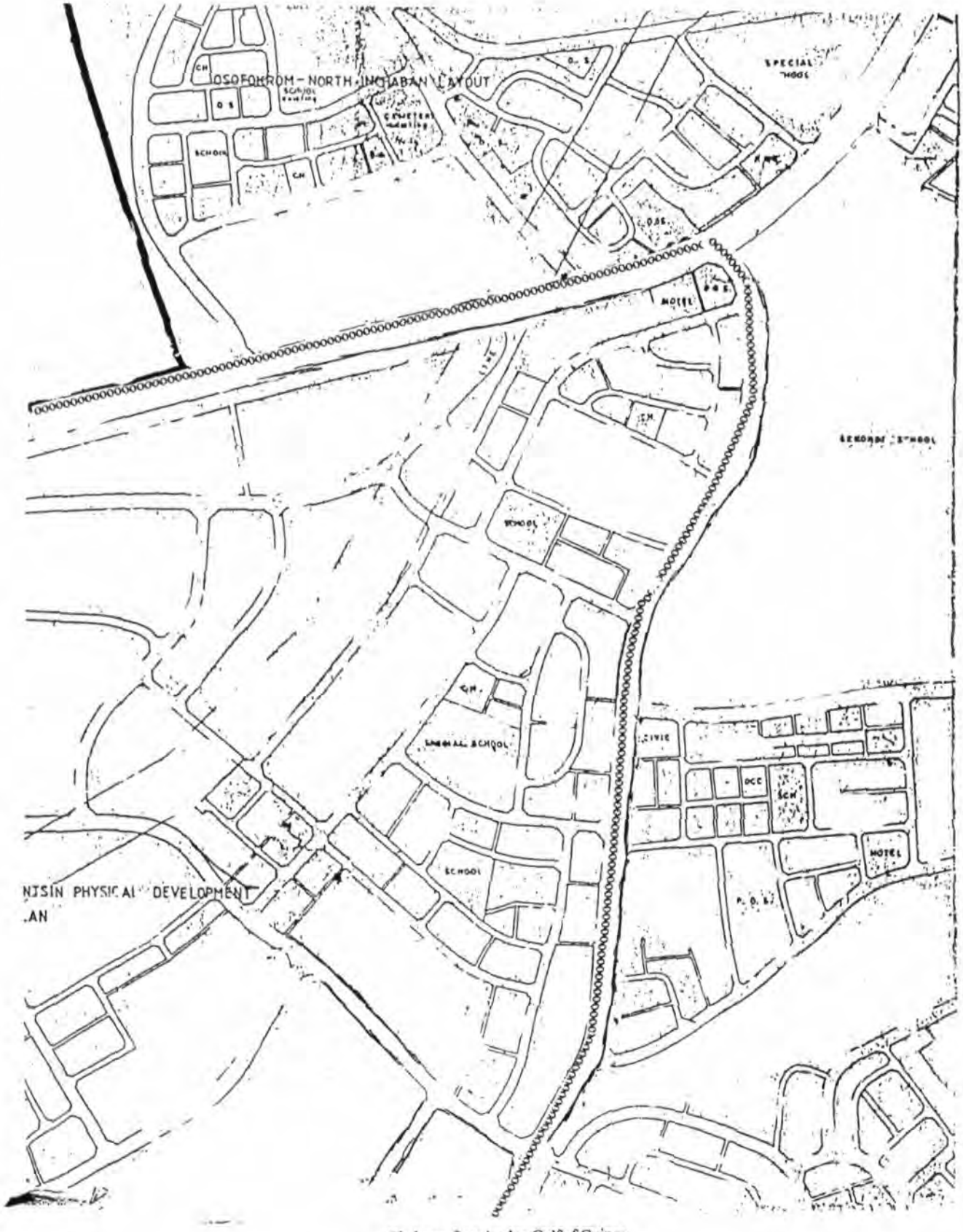


Fig. 1.1.1. Base Map-Ankobra Resources Ltd.


EXHIBITION GROUND
W'SHIP
P.O.S.
SCHOOL
MPINTSIN KUMA
WORSHIP
CLINIC
LAND FOR SPECIALISED PLANNING
MPINTSIN PLANNING SCHEME
EXISTING QUARRY
COMM
MPINTSIN
BYE
CHURCH
TENSION



Discharge from land to Gulf of Guinea

oooooo represent the pathway of the pipelines, dual pipeline (crude/petroleum products) desalination intake pipe,and wastewater discharge pipeline.

xxxxxx represent the Opsis System for the detection of air emissions,i.e. NOx,SOx.

_____ *represent the boundary line, Ankobra Resources Ltd.*

Zones represent the areas testing for noise,air emissions (incinerator/power plant)

Roland T. Cain
P.O.Box 450485
Houston,Texas 77245-0485
713/433-7672
713/433-8050(Fax)

The Village of Anoe, Ghana

Location: SHAMA AHANTA EAST
Latitude/ 114000
CO-ORDINATES

Longitude/ 634000
CO-ORDINATES

Population:
Total 387

Female 142
Male 125
Children 120

Water Source
River ANANKWRA
Municipal ✓ Yes ___ No
Bottled ✓ Yes ___ No

* Power Source
Hydro ___ Yes ✓ No
Municipal ___ Yes ✓ No
Generator ___ Yes ✓ No

Sewage System
Natural ✓ Yes ___ No
Municipal ___ Yes ___ No

Fire Protection
Village ___ Yes ✓ No
Municipal ✓ Yes ___ No

Medical Services
Hospital ___ Yes ✓ No
Dental ___ Yes ✓ No
X-Ray ___ Yes ✓ No
Visting Nurse ✓ Yes ___ No
EMS ✓ Yes ___ No

Natural Gas System
Pipeline ___ Yes ✓ No
Bottled Propane ___ Yes ✓ No

Dominant Occupation:
Farmers YES 100 to 200
___ < 50
Skilled Laborers YES 100 to 200
✓ < 50
Unskilled Laborers ___ 100 to 200
___ < 50
___ ___ 50 to 100
___ < 20
___ ✓ 50 to 100
___ < 20

Major Debilitating Conditions
___ Cholorea ___
✓ Malaria ___
___ Diabetes ___
___ ___
___ ___

Schools: ___ Yes ___ No
✓ Elementary
___ Secondary
___ High School

Total School Population 77

* Comments: Power: They are to be hooked to the national grid in the year 2000

Shama Ahanta East Metropolitan Assembly
P.O.Box 74
Sekondi, W/R, GH
Tel: 233-31-46282 Fax: 233-31-46908

Co-ordinates For Ankobra Resources Ltd. Project
(Sekondi Export Processing Zone)

Refinery Site: Latitude:	35100N-36700N	degrees	___ ' ___ "	___
Longitude:	192400E-194200E	degrees	___ ' ___ "	___
Residential Site: Latitude:	34400N-35400N	degrees	___ ' ___ "	___
Longitude:	194400E-195400	degrees	___ ' ___ "	___
Anoe Villagee: Latitude:	34400N-34700N	degrees	___ ' ___ "	___
Longitude:	192300E-192700E	degrees	___ ' ___ "	___

Nearest Medical Facilty to Anoe Village:

The nearest
- Medical Post ___ (km) from Anoe Village.
- Medical Centre 6.05 (km) from Anoe Village
- Distnct Hospital 11.00 (km) from Anoe Village
- Regional Hospital 8.63 (km) from Anoe Village

Refinery Site
1 North Bounded by INDUSTRIAL SITE
2 East Bounded by FARM LANDS
3 South Bounded by RESIDENTIAL (NOT FULLY DEVELOPED)
4 West Bounded by INDUSTRIAL SITE / RAIL LINE

Co-ordinating Director

Date:

APPENDIX II

Botany - Zoology Survey Report

Case Study-Air Modelling, Kingsport,Tennessee

Fig. 2.1 Proposed Refinery-Kingsport, Tennessee
Fig. 2.5 Base Map, Stack Parameters and Coordinates
Fig. 2.6 Allowable Emissions for the New Sources
Fig. 2.7 PSA Increments,in micrograms/m(cubic),Class II Region
Fig. 2.8 Stack Parameters and Emissions for Other PSD Sources
Fig. 2.9 Sulfur Dioxide Monitors at Kingsport,Tennessee
Maximum Concentration in micrograms/m (cubic)
Fig. 2.10 Results of ISC4 Modelling Study of Chemical Petroleum
Complex Sulfur Dioxide Concentration in micrograms/m (cubic)

FLORAL & FAUNA SURVEY OF PROPOSED SITE FOR PETROCHEMICAL REFINERY PROJECT

Introduction.

The survey was commissioned by Ankora Resources Ltd. for the purposes of providing baseline data for preparation of Environmental Impact Assessment for the proposed Petrochemical Refinery Project to be established on the site which is a secondary forest.

This report includes an account of plants species encountered on the site, including lichens; animals, birds and some data on wetlands and water status.

The results obtained are shown in Tables attached:

- Tables1- Higher plants (attached)
- Table 2 - Lower plants (lichens on tree trunks)
- Table 3 - Animals

The survey has been completed as requested by the Project Manager.

Prof. G.T. Odamtten
University of Ghana
Department of Botany
Legon.

Date: 28th March 2000

TABLE 1 - PLANT SPECIES OF PROPOSED EXPORT PROCESSING ZONE - SEKONDI

Family	Scientific Name	Habit	Medicinal Uses
Acanthaceae	Justicia flava	herb	febrifuge
Acanthaceae	Asystasia calycina	herb	
Amarylidaceae	Scadoxus multiflora	herb	
Ampelidaceae	Leea guineensis		
Anacardiaceae	Spondias mombin	tree	
Apocynaceae	Rauvolfia vomitoria	tree	roots as sedative
Apocynaceae	Funtumia africana	tree	
Apocynaceae	Voacanga africana	tree	
Araceae	Anchomanes difformis	herb	tubers for bathing weakly children
Araceae	Culcasia scandens	herb	
Asclepiadaceae	Secamone afzelii	climber	
Bignoniaceae	Spathodea campanulata	tree	
Bombacaeae	Bombax buonopozense	tree	
Bromiliaceae	Ananas comosus		peels decoction for jaundice
Cannaceae	Canna indica	herb	
Caricaceae	Carica papaya	tree	seeds as anthelmintic
Commelinaceae	Commelina sp	herb	
Compositae	Chromolaena odorata	herb	styptic
Compositae	Aspilia africana	herb	styptic
Compositae	Tridax procumbens	herb	poultice applied to whitlow
Compositae	Vernonia cinerea	herb	decoction arrests miscarriage
Connaraceae	Cnestis ferruginea	climber	
Convolvulaceae	Ipomoea involucrata	climber	juice for conjunctivitis
Convolvulaceae	Ipomoea cairica	climber	fodder for rabbits
Cucurbitaceae	Indet	climber	
Cucurbitaceae	Momodica charantia	climber	febrifuge
Cyperaceae	Cyperus sp	herb	
Euphorbiaceae	Alchornea cordifolia	shrub	anti-rheumatic
Euphorbiaceae	Mallotus oppositifolius	shrub	febrifuge
Euphorbiaceae	Margaritaria discoideus	tree	
Euphorbiaceae	Phyllanths sp	herb	
Euphorbiaceae	Mezoneuron benthamianus	climber	root decoction as aphrodisiac
Euphorbiaceae	Bridelia micrantha	tree	anti-diabetic
Euphorbiaceae	Securinega virosa	shrub	medicinal
Euphorbiaceae	Euphorbia sp	herb	
Euphorbiaceae	Euphorbia heterophylla	herb	lactogenic
Fern	Pneumatopteris afra	herb	
Graminae	Pennisentum giganteum	grass	
Graminae	Panicum sp	grass	
Graminae	Setaria barbata	grass	
Graminae	Sacharium officinale		sugarcane
Labiatae	Lantana camara	shrub	
Labiatae	Hoslundia opposita	shrub	lactogenic; diuretic
Lauraceae	Persea americana	tree	
Liliaceae	Crinum jagus	herb	
Loganiaceae	Anthocleista djalonensis	tree	
Loganiaceae	Spigelia anthelmia	herb	anthelmintic
Malvaceae	Hibiscus sp	herb	
Malvaceae	Cochorus sp	herb	

Family	Scientific Name	Habit	Medicinal Uses
Marantaceae	Marantochloa sp	herb	
Meliaceae	Trichilia monadelpha	tree	decoction for piles
Meliaceae	Turraea heterophylla	shrub	
Menispermaceae	Triclisia subcordata	climber	
Mimosaceae	Albizia zygia	tree	
Mimosaceae	Schrankia leptocarpa	climber	
Mimosaceae	*Mimosa pudica*	*climber*	
Mimosaceae	Albizia adianthifolia	tree	
Moraceae	Ficus sur	tree	
Moraceae	Milicia excelsa	tree	
Moraceae	Antiaris toxicaria	tree	
Moraceae	Ficus exasperata	tree	leaves as fodder
Myrtaceae	Psidium guajava	tree	for cough & toothache
Nyctaginaceae	*Boeharvia diffusa*	*herb*	*leaves for boils*
Palmae	Cocos nucifera	tree	fruit/oil
Palmae	Elaies guineensis	tree	oil
Papilionaceae	Abrus precatorius	climber	seeds poisonous
Papilionaceae	Centrosema plumieri	climber	
Papilionaceae	Millettia zechiana	liane	
Papilionaceae	Baphia nitida	tree	anti-asthmatic
Papilionaceae	*Desmodium adscendens*	*herb*	*anti-asthmatic*
Papilionaceae	Teramus labiales		
[illegible]	[illegible]	[illegible]	
Passifloraceae	Adenia lobata	climber	
Passifloraceae	Smeathmannia pubescens	shrub	
Portulacaceae	*Talinum triangulare*	*herb*	*spinach*
Rubiaceae	Pavetta corymbosa	shrub	
Rubiaceae	Morinda lucida	tree	decoction for colic
Rubiaceae	Psychotria sp	shrub	
Rubiaceae	indet		
Rubiaceae	Canthium sp	shrub	
Rutaceae	Citrus sinensis	tree	fruit
Sapindaceae	Paullinia pinnata	climber	
Sapindaceae	Blighia sapida	tree	fruit
Sapindaceae	Deinbollia pinnata	shrub	
Sapindaceae	Blighia welwitschii	tree	
Solanaceae	Solanum torvum	shrub	haemostatic after childbirth
Solanaceae	*Capsicum frutescens*	shrub	
Sterculiaceae	Sterculia tragacantha	tree	edible gum
Verbenaceae	Clerodendrum sp	climber	
Verbenaceae	Coleus sp	herb	
Verbenaceae	Priva lappulacea		
Vitaceae	Cissus quadrangularis	climber	enable children to walk
Zingiberaceae	Costus afer	herb	purification rites

TABLE 2 - LICHENS ON TREE TRUNKS	
	Scientific Name
	Lecanora sp
	Squamoria muralis
	Xanthoria sp
	Coccocarpia sp
	Hyperphysica sp
	Physcia sp
	4 unidentified species
WATER BODIES	
Wetlands	No
Water	Yes
Creeks	No
River	Yes
Lakes	No
Oceans	No
Dams	No

ANKOBRA RESOURCES FIELD PROJECT: FAUNAL LIST

Order/Family/Common Name	Species
INVERTEBRATES	
MOLLUSCS	
GASTROPODA	
Snail	*Archachatina sp.*
ARTHROPODS	
MYRIAPODA	
Millipede	*Julus sp.*
INSECTA	
LEPIDOPTERA (Butterflies)	
Papilionidae	*Papilio demodocus*
Pieridae	*Colotis euippe*
	Eurema senegalensis
Nymphalidae	*Acraea eponina*
	Acraea sp.
	Catacroptera cloanthe
	Danaus chrysippus
	Hamanumida daedalus.
	Hypolimnas misippus
	Junonia terea
	Junonia eonone
	Junonia sophia
	Junonia chorimera
	Junonia hierta
	Neptis sp
	Phalanta phalanta
	Salamis anacardii
Hesperidae	*Pyrrhochalcis iphis*
Satyridae	
Lycaenidae	
ORTHOPTERA (Grasshoppers)	*Cyrtacanthacris sp.*
	Zonoceros variegatus
HYMENOPTERA (Ants, Bees)	*Palthothyreus sp.*
ODONATA (Dragonflies)	
VERTEBRATES	
AMPHIBIANS	
ANURA (Frogs and Toads)	
Bufonidae (Toads)	
Common Toad	*Bufo regularis*
Giant Toad	*Bufo superciliaris*
Ranidae (Frogs)	
Common Frog	*Hylarana galamensis*
Common Frog	*Dicroglossus occipitalis*
Reed Frog	*Hyperolius viridiflavus*
REPTILES	
CHELONIA (Tortoises/Turtles)	
Pelomedusidae (Terrapins)	
Marsh Terrapin	*Pelomedusa subrufa*
Testudinidae (Land Tortoises)	

Hinged Tortoise	*Kinixys homeana*
SQUAMATA: Lacertilia (Lizards)	
Agamidae (Agamas)	
Agama (Rainbow) Lizard	*Agama agama*
Gekkonidae (Geckos)	
Common House Gecko	*Hemidactylus brookei*
Gecko	*Lygodactylus conraui*
Scincidae (Skinks/Snake-Lizards)	
Skink	*Panaspis togoensis*
Varanidae (Monitor Lizards)	
Nile Monitor	*Varanus niloticus*
Bosc's (Savanna) Monitor	*Varanus exanthematicus*
Chamaeleonidae (Chameleons)	
Graceful Chameleon	*Chamaeleo gracilis*
SQUAMATA: Serpentes (Snakes)	
Boidae (Pythons)	
Royal Python	*Python regius*
African Python	*Python sebae*
Colubridae (Typical Snakes)	
Green Tree Snake	*Philothamnus semivariegatus*
Elapidae (Cobras, Mambas)	
Green Mamba	*Dendroaspis viridis*
Black/Forest Cobra	*Naja melanoleuca*
Viperidae (Vipers, Adders)	
Gaboon Viper	*Bitis gabonica*
Rhinoceros Viper	*B. nasicornis*
BIRDS	
FALCONIFORMES (Birds of Prey)	
Accipitridae	
Black Kite	*Milvus migrans*
Hooded Vulture	*Neophron monachus*
PSITTACIFORMES (Parrots)	
Psittacidae	
Red-headed Lovebird	*Agapornis pullaria*
CUCULIFORMES (Cuckoos)	
Musophagidae	
Grey Plantain-eater	*Crinifer piscator*
Cuculidae	
Senegal Coucal	*Centropus senegalensis*
CORACIIFORMES (Kingfishers)	
Alcedinidae	
Senegal Kingfisher	*Halcyon senegalensis*
Bucerotidae (Hornbills)	
Allied Hornbill	*Tockus faciatus*
PASSERIFORMES (Songbirds)	
Corvidae	
Pied Crow	*Corvus albus*
Hirundinidae	
[illegible]	*Psalidoprocne obscura*
Copper Sunbird	*Nectarinia cuprea*
Ploceidae	
Village Weaver	*Ploceus cucullatus*
Red Bishop	*Euplectes orix*

MAMMALS	
ARTIODACTYLA	
Bovidae (Antelopes. Duikers, etc.)	
Maxwell's Duiker	*Cephalophus maxwelli*
Royal Antelope	*Neotragus pygmaeus*
Bushbuck	*Tragelaphus scriptus*
Suidae (Pigs)	
Red River Hog	*Potamochoerus porcus*
CARNIVORA	
Herpestidae (Mongooses)	
Mongoose	*Mungos gambianus*
Viverridae (Civets)	
African Civet	*Civettictis civetta*
PRIMATES	
Galagonidae (Bushbabies)	
Senegal Bush Baby (Galago)	*Galago senegalensis*
Loridae (Pottos)	
Bosman's Potto	*Perodicticus potto*
RODENTIA	
Muridae (Rats, Mice)	
Zebra Mouse	*Lemniscomys striatus*
Brush-furred Mouse	*Lophuromys sikapusi*
Shaggy Swamp Rat	*Dasymys incomtus*
Cricetidae (Giant Rats)	
Gambian Giant Rat	*Cricetomys gambianus*
Thryonomyidae (Grasscutters)	
Grasscutter (Cutting Grass)	*Thryonomys swinderianus*
Hystricidae (Porcupines)	
Crested Porcupine	*Hystrix cristata*
Brush-tailed Porcupine	*Atherurus africanus*
INSECTIVORA	
Soricidae (Shrews)	
White-toothed shrew	*Crocidura oliveri*
Hedgehog	*Erinaceus albiventris*
PHOLIDOTA	
Manidae (Pangolins)	
Tree Pangolin	*Phataginus tricuspis*
Long-tailed Pangolin	*Uromanis tetradactyla*
HYRACOIDEA	
Procaviidae (Hyraxes)	
Tree Hyrax	*Dendrohyrax dorsalis*

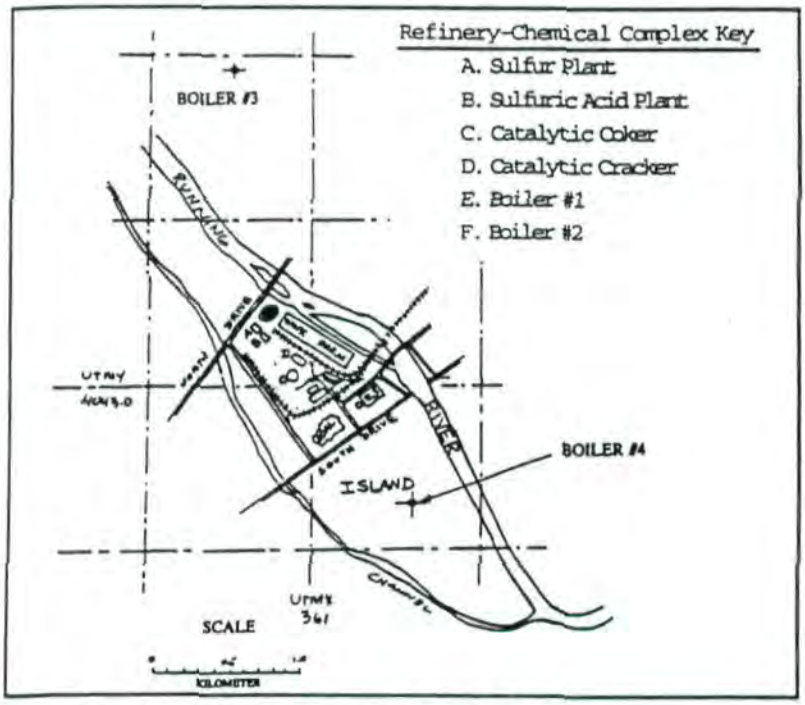


Figure 2.1 Proposed refinery-chemical complex.

Table 2.5 Refinery-Chemical Complex Information

Processes	Uncontrolled Emissions (g/s)	Stack Parameters Height[1] (m)	Dia. (m)	Vel. (m/s)	Temp (K)	Coordinates[2] UTMX (km)	UTMY (km)
Sulfur plant	53.94	100.6	1.83	3.31	664	360.64	4043.35
Sulfuric acid plant	16.62	100.6	1.07	10.38	339	360.64	4043.3
Catalytic coker	201.9	76.2	3.66	21.81	561	360.8	4043.1
Catalytic cracker	100.2	76.2	3.05	15.71	561	360.84	4043.2
Boiler #1	133.6	100.7	4.59	13.4	478	361.31	4042.85
Boiler #2	111.1	100.7	4.59	11.2	478	361.34	4042.87

(1) Stack height conforms to good engineering practice.

(2) Coordinates are Universal Transverse Mercator Grid Ties (blue ticks on Geological Survey maps). Spacing between ticks = 1000 m.

Table 2.6 Allowable Emissions for the New Sources

Process	Sulfur Oxide Standards NSPS	BACT (g/s)	Actual Emissions (g/s)	Allowable Emissions (g/s)	Percent Reduction
Sulfur plant	BACT	500 PPM	53.94	5.66	89.5
Sulfuric acid plant	2 kg/MT of 100% acid	–	16.62	4.75	71.4
Catalytic cracker	BACT	500 PPM	201.90	171.50	15.1
Catalytic cracker	BACT	500 PPM	100.20	85.75	14.4
Boiler #1	1.2 lb per million BTU's	–	133.60	117.30	12.2A
Boiler #2	1.2 lb per million BTU's	–	111.10	97.20	12.5

Table 2.7 PSD Increments, in μg/m³, Class II Region

Averaging Time	Sulfur Oxide	Total Suspended Particulates
3 h	512	Not applicable
24 h	91	37
Annual maximum	20	19

Table 2.8 Stack Parameters and Emissions for Other PSD Sources

Processes	Uncontrolled Emissions (g/s)	Stack Parameters Height[1] (m)	Dia. (m)	Vel. m/s	Temp (K)	Coordinates[2] UTMX (km)	UTMY (km)
Coal fired tunnel kiln	126.1	4.57	1.22	38.4	478	360.50	4044.90
Boiler #3	174.2	12.8	1.37	3.90	533	343.26	4044.63
Asphalt plant	67.3	9.75	1.22	21.8	405	358.2	4045.90
Boiler #4	217.2	114.3	3.05	18.9	411	361.72	4042.05

(1) Stack height conforms to good engineering practice.

(2) Coordinates are Universal Transverse Mercator Grid Ties (blue ticks on Geological Survey maps). Spacing between ticks = 1000 m.

Table 2.9 Sulfur Dioxide Monitors at Kingsport, Tennessee, Maximum Concentrations in μg/m³

Monitors #47-163-	0007	0009
Year	1996	1997
Maximum 3-h value	458	392
Second highest 3-h value	390	371
Maximum 24-h value	253	107
Second highest 24-h value	131	105
Annual arithmetic mean	31	24
UTM coordinates for monitor:		
UTMX	364.178	360.211
UTMY	4044.13	4041.88

Table 2.10 Results of ISC3 Modeling Study of Chemical-Petroleum Complex Sulfur Dioxide Concentrations in μg/m³

Averaging Time	Allowed PSD Increment	Maximum Calculated Increment	Measured at PSD Monitor (1)	All PSD Sources (2)	NAAQS	Sum (1)+(2)
3-h	512	55.2	371	649	1300	1020
24-h	91	29.7	105	225	365	330
Annual	20	3.7	24	27.9	80	51.9

APPENDIX III

EPA Ghana Letters, September 08,2000 and September 21,2000

Participants,August 16,2000 Meeting. Accra,Ghana

Environmental Policy (Synopsis)-Ankobra Resources Ltd.

Tel. (021) 664697/664698,
780175 - 9
Fax: 233 (021) 662690
Tlx: 2609 Environ - Gh

Environmental Protection Agency
P. O. Box M 326
Ministries Post Office
Accra, Ghana

Our Ref:. CE 413/01/37

September 8, 2000

ROLAND T. CAIN
ANKOBRA RESOURCES LTD
HOSTON, TEXAS 77245-1485
U. S. A

Dear Sir,

GUIDANCE FOR EIA REVISION
PROPOSED ANKOBRA RESOURCES PETROCHEMICAL REFINERY PROJECT, SEKONDI

We acknowledge receipt of your fax message of August 28, 2000 requesting for guidelines to help you revise the EIA for the above proposal.

We have attached a copy of the minutes of the Meeting (at your request) held on August 16, 2000 at the EPA Conference Room for your information and reference.

We wish to indicate that the advice to view the VRA Thermal Plant EIA at the EPA Library was only for your guidance purposes. The Report must not be used as the standard, (the Ghana EIA Procedures is the standard reference). Projects are required to comply with the relevant national environmental guidelines. Where none exists for a given parameter, the necessary agreement must be reached with the Agency in order to apply the appropriate international/foreign standards.

We have provided also (in an attachment) for your guidance the specific references in the Ghana EIA Procedures (A copy already available to you), that will facilitate the required EIA revision.

It is however your responsibility to relate these to the real issues and situation on the ground where the project's impacts are likely to be felt. It was on this important subject of helping to make the EIA and related decision options reflect practical ground conditions that the Agency offered at the scoping stage to assist your technical staff in the field. Unfortunately however, you did not avail yourself of that unique opportunity. The Agency for example has not had the benefit of precise knowledge of

(i) proposed facility locations or sitings eg. pipeline routes for crude oil delivery, sea water uptake and waste (hot) water discharges
(ii) the basis for the proposed resettlement, consultations held with the affected/interested parties and decisions reached to that effect.
(iii) potential emission status and what this translates into on the ground, who or what are likely to be affected and to what extent.

(iv) type of sludge generation, and other wastes, disposal means and site and who/what are likely to be affected

(v) the "affected" coastal environment and resources, etc. Appropriate maps and diagrams relevant to the project area are not provided to help illustrate text and facilitate verification.

Against the above background, the Agency is highly limited in the extent of specificity and detail to which the requested guidelines can be given.

Furthermore, baseline information given were in most respects incomplete. For instance, the report indicated on Page 21 under "Social" - that "survey of cultural aspects of the community and needs or central issues that drive the surrounding communities will be done" at Pre-construction, instead of at the EIA stage. This leaves major gaps for the required decision making considerations.

It must be emphasized that comprehensive baseline information is useful and provides a full understanding of the current status of the environment of the project area and "affected" surroundings, in terms, for instance of social, landuse, flora and fauna, noise, air quality, etc. The importance of this is to help predict and determine changes likely to arise from introducing or superimposing a project in an area, what resources or communities are at risk and the extent to which they are affected.

In the end the EIA must provide all the answers needed to facilitate decision-making on all aspects of the project by the appropriate authorities. It is important therefore that the findings of the EIA to be submitted provides clear decisions on all major aspects of the project, the various options considered, how the preferred option was arrived at and who were involved in the various decision-making processes.

We hope this will help in the revision exercise.

Yours faithfully,

J. A. ALLOTEY
DIRECTOR/REGIONAL PROGRAMMES
for : EXECUTIVE DIRECTOR

cc: The Hon. Minister, Ministry of Environment, Science & Technology, Accra
The Hon. Minister, Ministry of Mines & Energy, Accra
The Executive Secretary, Ghana Free Zones Board, Accra
The Executive Secretary, Energy Commission, Accra
H.E. The Ambassador, American Embassy, Accra
Mr. John K. Offeh, Attorney and Director, Ankobra Resources Ltd
Mr. S. K. Bhattacharjee, Director, Ankobra Resources Ltd.
Issifu Ali and Company, Auditors, Ankobra Resources Ltd.

SPECIFIC REFERENCES IN THE GHANA EIA PROCEDURES

The presentation format for an Environmental Impact Statement is as follows (as provided for in the Ghana EIA Procedures)

1. Non-Technical Executive Summary (for details see Pages 40 and 45 Section 4.3 of the of the Ghana EIA Procedures)
2. Introduction
3. Description of Development (Pages 39(a & b) and 43 Sections 1.1 & 1.3 and 44 Section 3.1)
4. Description of Existing Environment (Pages 39 (c & d), 43 Sections 1.2 & 1.4 and 44 Section 3.1)
5. Assessment of Impacts (Pages 39 (e & f), 41 and 44 Section 2). It is very important to pay particular attention to the sections 2.1, 2.2 and 2.3 of Page 44 of the Procedures
6. Mitigations (Pages 39 (g, i &j)
7. Monitoring Plan (Page 39 (h)
8. Provisional Environmental Management Plan (Pages 39 (i) and 45 Section 3.3)
9. Decommissioning

- ❖ Guidance on report presentation (see Pages 40, 45 sections 4.1 and 4.2)

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Accra, Ghana

Our Ref: CE. 413/01/39

September 19, 2000

ROLAND T. CAIN
ANKOBRA RESOURCES LTD
HOUSTON, TEXAS 77245-0485
U. S. A
FAX 713/433-6050

Dear Sir,

STANDARD REFERENCES – GHANA EIA PROCEDURES (1995)
NOT ENVIRONMENTAL ASSESSMENT IN GHANA, A GUIDE (1996)

We refer to your letter on the apparent confusion on the "specific references" provided in our letter of September 8, 2000 to guide you on the revision of the Proposed Ankobra Refinery EIA.

Please take notice that there are two key documents on EIA in Ghana. These are:

1. The Ghana Environmental Impact Assessment Procedures (1995) and
2. Environmental Assessment in Ghana, A Guide (1996)

We did indicate in our letter that the Document – Ghana Environmental Impact Assessment Procedures contains the standard requirements on EIA and must be followed.

All references made in our September 8, 2000 letter were therefore to the Ghana EIA Procedures Document, but not the Environmental Assessment Guide (1996). This is attested to by the first sentence of your response letter of September 15, 2000 and so there is no basis for your apparent confusion. For the avoidance doubt, we have attached the Pages 39, 40, 41, 43, 44 and 45 of the Ghana EIA Procedures document.

Yours faithfully,

J. A. ALLOTEY
DIRECTOR/ REGIONAL PROGRAMMES
for: EXECUTIVE DIRECTOR

cc: The Hon. Minister, Ministry of Environment, Science & Technology, Accra
The Hon. Minister, Ministry of Mines & Energy, Accra
The Executive Secretary, Energy Commission, Accra
The Executive Secretary, Ghana Free Zones Board, Accra
The Embassy of Ghana, Washington, D. C.
The U.S. Embassy, U.S. Department of Commerce, Accra
All Directors and Auditors, Ankobra Resources Ltd.

Environmental Policy
(Synopsis)

The Environmental Policy includes the guidelines and regulations that governs the areas of *air quality, water quality, waste-management, and environmental science management.* These guidelines and regulations include core scientific and technological factors, environmental systems, and pollution control.

All guidelines and regulations involving both environmental standards and pollution controls, provides level of comptence needed by the environmental personnel. The macro-picture as related to environmental regulations, i.e. Clean Water Procedures and Methods, Conservation of Resources and Recovery, Emergency Planning and Community Right-To-Know, Occupational Safety and Health Regulations, Toxic Substances Control and the Endangered Species List-Ghana.

Air Quality:
Applicability:

Provides that technical standards are applicable to all air quality that all processing equipment is designed and rated to meet such standards as related to air quality. These technical standards meet or exceed the standards established by the Ghana EPA or applicable governmental agency(s).

General Standards:

(a) Requires company to acquire and maintain an Environmental Permit
(b) Develop and maintain air quality programs for the petrochemical-refinery complex
    1. Program to meet or exceed NAAQ or Ghana EPA Air Standards to include mobile sources,HAPs, Acid Rain, Emissions, and Ozone
    2. Requires that environmental personnel submit a written report on a scheduled basis through the appropriate chain of command at the scheduled time.

(c) Specifies that latest industry standards/codes are to be used.
(d) Environmental personnel are required to receive training in air quality issues

Variances and Alternative Procedures:

(a) Requires the Board of Directors, Ankobra Resources Ltd.'s approval of various alternative procedures

(b) Authorizes Managing Director to approve various/alternative procedures if protective of health and the environment
(c) Authorizes request for approval for new or alternative equipment and techniques and when compliance with technical standards is unreasonable.
(d) Specific that requests be in writing and accomplished by support materials
(e) Requires that Environmental Compliance Officer maintain record of variance or alternative procedure

Implementation Schedule:

(a) Requires that company develop and maintain Air Quality Programs on an immediate basis, with release detection, electronic monitoring,air emission, recordkeeping, and air quality report to become due on an immediate basis during the operational phase
(b) Requires that all processsing equipment, incineration equipment and power plant equipment be rated in terms of air emission values. Storage tanks are rated and data filed on an immediate basis in terms of gas emissions, whether it is crude oil or petroleum products(to include LPG) and gas or vapor levels of any spilled crude oil or products.
(c) Establish technical standards for new piping. Prescribe acceptable industry standards for piping. Requires release detection for piping.
(d) Requires secondary containment system for hazardous substances. Provide design standards for monitoring wells
(e) Requires maintenance records of the processing equipment and storage tank facility.

Installation Standards for New Processing Equipment-Storage Tank Facility

(a) Prescribe general industry standards for new processing equipment and storage tank facility. Requires proper handling of processing equipment and Storage Tank Facility prior to and during installation, inspection of tanks and piping prior to installation,and replacement of damaged processing equipment,storage tanks or piping in accordance with manufacturer's recommendations.

Specific general excavation standards. Prescribed suitable bedding and backfill materials.Prohibits processing equipment and tank placement directly on native soils,saddles or pads.

(b) Requires anchorage systems in high water tables areas. Specific acceptable anchoring methods. Prescribe corrosion protection for metal components.
(c) Prescribes installation procedure for non piping systems.

(d) Requires air testing prior to installation of new tanks and piping. Requires processing equipment, tank and piping pressure tightness tests prior to beginning system operations.
(e) Prescribe installation standards for cathodic protection systems
(f) Prescribe installation requirements for secondary containment system.
(g) Establish installation standards for monitoring wells, including requirements for qualified personnel, minimum depth, and sealing.
(h) Requires owner/operator or designated expert and installer to certify the adequancy of the installation
(i) Prescribe required installation records,including as built -site drawings, equipment specifications and operating instructions, and test results.

Technical Standards for Existing Processing Equipment-Storage Tank Facility

(a) Requires existing processing equipment and storage tank facility to be brought up to minimum standards either by replacement with new processing equipment or upgrading to minmum standards. Requires non-compliant existing tanks to be removed from service 60 days after prescribed compliance date
(b) Requires metal integrity assessment and cathodic protection,where applicable on an annual basis. Allows integrity assessment by external release detection, tightness testing and internal inspections. Allows site repair or relining,where applicable to metal components of both processing equipment and storage tanks (unsound conditions)

    1. Requires spill/overfill prevention equipment on existing processing equipment, where applicable, and storage tanks.
    2. Requires line tank detection on existing or new pressurized piping on an annual basis.

(c) Require existing hazardous substances tanks to be equipped with a secondary containment system and associated release detection system.
(d) Requires owners/operators to maintain records of processing equipment and tanks/piping with a secondary containment system and associated release detection system.

General Operating and Manifest Requirements

(a) requires owners/operators to operate systems to prevent releases
(b) requires systems to be operated in accordance with industry standards
(c) requires inventory control procedures in the processing and storage tank areas
(d) requires owners/operators to employ spill/overfill prevention and control
(e) prescribes operational requirements for release detection system

(f) prescribe operational requirements for corrosion protection systems
(g) requires owners/operators to maintain operational and maintenance records for the life time of the petrochemical-refinery complex.

Reuse of Used Tanks

(a) prescribe general requirements for reuse of used tanks, including compliance with new tanks installation, spill/overfill prevention,corrosion protection,release detection and other requirements
(b) prescribe requirements for applying fibre glass extensions coating to used steel tanks, including compliance with industry standards and requirements for cathodic protection
(c) requires owner/operator to maintain records related to reuse of used tanks, and prescribe types of records and duration of recordkeeping

Incineration Process and Power Generation Units

Both the incineration process and power generation unit will require similar environmental policies as related in air quality. Providing technical standards that are applicable to air quality for such equipment or plants.

These technical standards meet or exceed the standards established by the Ghana EPA or applicable governmental agency(s). All General Standards, Variances and Alternative Procedures, Implemntation Schedules, Technical Standards and Installation Standards are applicable to both the incineration process and power generation units.

Listed are categories and topics covered in the Environmental Policy.

1. Environmental Permitting
2. Environmental Management
   - a. air quality
   - b. water quality
   - c. air emissions
   - d. hazardous waste disposal
   - e. wastewater discharge
   - f. Gulf of Guinea
   - g. Anoe Village
   - h. soil erosion
   - i. land assessment
   - j. stormwater
   - k. oil spills (land & marine)
   - l. emergency responses
   - m. malaria and eradication process
   - n. health and safety
3. Environmental Monitoring
   - a. air quality
   - b. water quality
   - c. air emissions
   - d. hazardous waste disposal
   - e. wastewater discharge
   - h. soil erosion
   - i. land assessment
   - j. stormwater
   - k. oil spills (land & marine)
   - m. malaria and eradication process

f. Gulf of Guinea
g. Anoc Village
n. health and safety

4. Training of Environmental Personnel

5. Compliance - EPA Ghana

a. air quality
b. water quality
c. air emissions
d. hazardous waste disposal
e. wastewater discharge
f. Gulf of Guinea
h. soil erosion
i. land assessment
j. stormwater
k. oil spills (land & marine)
l. malaria and eradication process
m. emergency responses
n. health and safety

6. Environmental Law

reference for determing which chemicals of each major environmental law regulate and where in the laws the chemicals are specified. Environmental laws referenced in relations to chemicals as applied to Clean Air, Clean Water, Safe Drinking Water, Resource Conservation and Recovery, and Toxic Substances.

In addition, chemicals regulated by the Occupational Safety and Health concerns of the EPA-Ghana.

7. Pesticides

include basic concerns and EPA-Ghana Regulations as related to Insecticides, Fungicides and Rodenticides. It will cover international pesticides regulations including exports,imports, and global issues,as well as pesticide regulations under other regulations such as Clean Air, Clean Water, Resource Conservation and Recovery, and OSHA.

8. Hazardous Waste

a. hazardous waste analysis
b. hazardous materials
c. hazardous properties of chemical substances

9. Audits

10. Recordkeeping

11. Pollution Control and Equipment

12. Decommission of Petrochemical-refinery Complex