



BioFuel Africa Limited

ENVIRONMENTAL ASSESSMENT AND AUDIT REPORT

JADE PROJECT



FINAL REPORT

February 2009 – AC0852 - 0041

PREPARED BY SGS ENVIRONMENT

SGS



BIOFUEL AFRICA LIMITED

ENVIRONMENTAL ASSESSMENT AND AUDIT REPORT

JADE PROJECT

GHANA

Project N°: AC0852-0041
Final Report

“This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.”

TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY	1.1
2.0	INTRODUCTION.....	2.1
2.1	BACKGROUND INFORMATION.....	2.1
2.1.1	<i>Terms of Reference for Study</i>	2.1
2.2	STATOILHYDRO'S ENVIRONMENTAL /CLIMATIC PRINCIPLES.....	2.1
2.3	OBJECTIVE OF ASSESSMENT/AUDIT.....	2.2
2.4	LEGAL REVIEW.....	2.2
2.5	METHODOLOGY.....	2.3
2.6	ASSESSMENT AREAS.....	2.4
2.7	LAYOUT OF ENVIRONMENTAL ASSESSMENT/AUDIT REPORT	2.4
3.0	PROJECT DESCRIPTION.....	3.1
3.1	INTRODUCTION.....	3.1
3.2	THE JADE PROJECT	3.1
3.2.1	<i>Test farm at Lolito - Sogakope.....</i>	3.1
3.2.2	<i>Oil mill at Sogakope.....</i>	3.2
3.2.3	<i>Plantation in the North.....</i>	3.2
4.0	BASELINE CONDITIONS	4.1
4.1	INTRODUCTION.....	4.1
4.2	DESCRIPTION OF CENTRAL GONJA AND YENDI DISTRICTS	4.1
4.2.1	<i>Climate.....</i>	4.2
4.2.2	<i>Biodiversity.....</i>	4.2
4.2.2.1	<i>Flora.....</i>	4.2
4.2.2.2	<i>Fauna.....</i>	4.2
4.2.3	<i>Land Tenure.....</i>	4.2
4.2.4	<i>Land Use.....</i>	4.3
4.2.5	<i>Soil Characteristics</i>	4.3
4.2.6	<i>Surface Water Resources and Drainage.....</i>	4.3
4.2.7	<i>Topography.....</i>	4.3
4.3	DESCRIPTION OF SOUTH TONGU DISTRICT	4.4
4.3.1	<i>Climate.....</i>	4.4
4.3.2	<i>Biodiversity.....</i>	4.4
4.3.3	<i>Land Tenure.....</i>	4.4
4.3.4	<i>Land Use.....</i>	4.4
4.3.5	<i>Soil Characteristics</i>	4.4
4.3.6	<i>Surface Water Resources and Drainage.....</i>	4.5
4.3.7	<i>Topography.....</i>	4.5
5.0	IDENTIFICATION OF ENVIRONMENTAL IMPACTS	5.1
5.1	INTRODUCTION.....	5.1
5.2	IMPACTS IDENTIFICATION/EVALUATION MATRIX.....	5.1
5.3	PLANTATION DEVELOPMENT	5.4
5.3.1	<i>Land clearing</i>	5.4
5.3.1.1	<i>Air Quality</i>	5.4
5.3.1.2	<i>Biodiversity.....</i>	5.4
5.3.1.3	<i>Land-use/Soil.....</i>	5.5
5.3.1.4	<i>Water Quality.....</i>	5.6
5.4	CROP CULTIVATION	5.6

5.4.1	Air Quality	5.6
5.4.2	Biodiversity.....	5.6
5.4.3	Land use	5.7
5.4.4	Water Quality	5.7
5.5	PROCESSING.....	5.7
5.5.1	Drying.....	5.7
5.5.2	Dehulling	5.7
5.5.3	Oil Extraction.....	5.8
5.5.4	Oil Storage	5.8
5.6	WASTE MANAGEMENT	5.8
6.0	MITIGATION.....	6.1
6.1	INTRODUCTION	6.1
6.2	LAND PREPARATION	6.1
6.2.1	Air Quality	6.1
6.2.2	Biodiversity.....	6.1
6.2.3	Land-Use	6.1
6.2.4	Soil.....	6.2
6.2.5	Water Quality	6.2
6.3	CROP CULTIVATION	6.2
6.3.1	Air Quality	6.2
6.3.2	Biodiversity.....	6.2
6.3.3	Land Use.....	6.2
6.3.4	Soil.....	6.3
6.3.5	Water Quality	6.3
6.4	PROCESSING.....	6.3
6.4.1	Air Quality	6.3
6.4.2	Biodiversity.....	6.4
6.4.3	Land Use.....	6.4
6.4.4	Water Quality	6.4
6.5	WASTE MANAGEMENT	6.4
6.5.1	Air Quality	6.5
6.5.2	Biodiversity.....	6.5
6.5.3	Land Use.....	6.5
6.5.4	Water Quality	6.5
7.0	CONSULTATIONS	7.1
7.1	INTRODUCTION	7.1
7.2	CONSULTEES	7.1
7.2.1	Environmental Protection Agency, Accra.....	7.1
7.2.2	Environmental Protection Agency, Tamale	7.2
7.2.3	Jaashie Consultative Committee Meeting.....	7.2
7.2.4	Tua Consultative Committee Meeting	7.3
7.2.5	Kpachaa Consultative Committee Meeting	7.3
7.2.6	Central Consultative Committee Members.....	7.3
8.0	CONCLUSION	8.1
	APPENDICES.....	8.1

Maps

Map 2.1: Map of Ghana showing location of Jade project (Jatropha plantation and Test farm).....	2.5
Map 3.1: Map of Test farm at Lolito showing blocks of Jatropha varieties (Source: EIS 2008).....	3.3

Tables

Table 2.1: Schedule of Activities	2.4
Table 3.1: Cultivable areas in Northern Ghana (ha).....	3.1
Table 3.2: Jatropha blocks and respective areas (ha) at the Test Farm	3.2
Table 5.1: Assessment criteria for the evaluation of impacts.....	5.1
Table 5.2: Significance ratings definitions	5.1
Table 5.3: Impact Identification and Evaluation Matrix for Potential impact of Jade Project.....	5.2

LIST OF ACRONYMS

BFA	BioFuel Africa Limited
DNA	Designated National Authority
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organisation
GSS	Ghana Statistical Service
GHG	Green House Gas
LOA	Letter of Acceptance
LOB	Letter of No Objection
LI	Legislative Instrument
LCA	Life Cycle Analysis
PHC	Population and Housing Census
PTO	Power Take Over
SARI	Savanna Agricultural Research Institute
TOR	Terms of Reference
UNFCCC	United Nation Framework Convention on Climate Change
UNCHE	United Nation Conference on Human Environment

1.0 EXECUTIVE SUMMARY

StatoilHydro ASA is one of the world's largest crude oil and gas suppliers, with operations in 40 countries worldwide. It intends to purchase Jatropha Oil from BioFuel Africa Limited, a duly registered company in Ghana, for biodiesel production. The latter has acquired about 23,000 hectare of land for cultivating Jatropha and a further 840 hectare as Jatropha Test farm and Oil mill in the Northern and Volta regions of Ghana, West Africa. The Plantation, the Test farm and Oil mill constitute the Jade Project.

As part of its business principles, StatoilHydro ASA, requires BioFuel Africa Limited to demonstrate that the Jade Project does not have significant harmful consequences on the environment, specifically, Air quality, Biodiversity, Land-use and Water quality in the areas of operation and secondly, that its operations comply with all relevant Ghanaian laws and also accords with international best practice in the industry. These are fundamental considerations by the former, prior to purchasing Jatropha oil from BioFuel Africa Limited and investing in the company.

For an independent and objective assessment of Jade Project, StatoilHydro has commissioned SGS Belgium to undertake Life Cycle Analysis of the Project, with a particular focus on Green House Gas (GHG) emissions. The Life Cycle Analysis includes an Environmental Assessment and Audit of the plantation and the Test farm, including the oil extraction process. The findings of the assessment and audit are presented in detail in the main report.

In Ghana, projects of magnitude as the Jade project are regulated by the Environmental Protection Agency Act, 1994, Act 490; Environmental Assessment Regulations, 1999, LI 1652 and the Environmental Assessment Regulation (Amendment), 2006, LI 703. These laws mandate the Agency to require an Environmental Impact Assessment (EIA) for any project that the Agency considers will have a potentially significant impact on the environment. Biofuel production also falls under the Energy Sector and therefore is regulated by the Energy Sector Policy. In Ghana, the specific policy target is to accelerate the development of biofuels, as an alternative transport fuel to substitute for;

- 10% of national petrol consumption by 2015,
- 20% of national gas oil consumption by 2015, and
- 30% of national kerosene consumption by 2015.

Realizing the targets will require a cross-sectoral approach that accommodates the inputs of other relevant government institutions. These relevant institutions include;

- Central Gonja, Yendi and South Tongu District Assemblies,
- Forestry Commission,
- Ghana Investment Promotion Centre,
- Land Commission,
- Ministry of Environment, Science and Technology,
- Ministry of Food and Agriculture, and
- National Petroleum Authority.

As at the time of the study, the Jade project had been duly permitted by the Environmental Protection Agency (EPA), after BioFuel Africa Limited had complied with the relevant environmental and planning legislations in Ghana. This study therefore identified the impacts that could potentially arise from future expansion activities within the licensed areas in both regions. The audit was on the existing operations, which comprise of actual plantation cover of about 500 hectare.

The Project Areas in the North and Volta fall within Guinea Savannah and Dry Equatorial climatic zones respectively. The Guinea savannah zone experiences its wet season, from May to October followed by a long dry spell. The latter has a double maxima rainfall pattern comprising a major wet season from April to June and a minor season from September to October and followed by a dry spell when the areas comes under the North East Trade winds, locally referred to as 'harmattan'.

Four important phases of the Jade project development have been considered in respect of their potential impacts on the environment. These are Land Preparation, Crop Cultivation, Processing/Extraction and Waste Management.

Potential impacts that could arise during land preparation are increase in airborne particulate matter and emissions from fleet of machinery. The impact could be significant in the North, where perennial bush fires are major contributors to low air quality. The mitigation measures recommended include regular servicing of farm machinery, operating the machinery in accordance with manufacturers' specification and avoiding land preparation activities during inclement weather. Similar mitigation measures are applicable at the Test farm, and should be enforced when commercial processing of Jatropha oil begins.

Biodiversity within the Project Areas has been impacted to some extent. Clearing of large tracts of land to accommodate the Plantation, Test farm and support infrastructure has led to the loss of habitat of some animal species. Plants including trees had to be removed for the project to be implemented. These trees provide food and fuel wood for some of the neighbouring communities. As a mitigation measure, Biofuel Africa Limited has complied with a directive from the Environmental Protection Agency, to leave a 500 m buffer around the plots and also leave some important economic trees within the Project Areas.

The land-use of the Project Areas in the North is mainly agriculture. The uses include subsistence crop production and livestock rearing. Construction for housing is also common. The Jade project has converted the land-use from subsistence to commercial, large scale agriculture. Management has therefore allowed the landowners to cultivate food crops in the plantations, to mitigate the potential loss of land resulting from the conversion. BioFuel Africa Limited also assists in preparing farmlands for affected farmers in crop production. In the Volta region the land was fallow, prior to the Project. As practiced in the north, the farmers in communities nearby are allowed to take advantage of the Plantation to cultivate staple crops. This measure ensures that the impact of land-use change is minimized on the affected farmers.

Water resources in the Project Areas could potentially be impacted from operations of Land preparation and Waste generation. Erosion accompanying such large land clearance could increase silt and debris deposition in nearby surface streams. Chemicals and fuels used to power and lubricate machines could also spill and be washed as run-off into streams. As a mitigation measure, vegetation buffer will be maintained between the farmlands and water resources. Land preparation activities will be avoided during inclement weather conditions.

Crop cultivation phase of the project is not expected to have any significant adverse impact on Air quality, Biodiversity, Land-use (as already determined at the preparatory phase), and Water quality. A positive impact is expected as the plantations will likely sequester carbon dioxide from the atmosphere and become a secondary habitat to some animal species. Details of the carbon sequestration potential are discussed in '*Life Cycle of a Jatropha Biofuel Production in Northern Ghana; Green House Gas Balance*' report.

Processing of Jatropha nuts to extract oil is currently exclusive to the Test farm at the Volta region. It is also on a pilot basis. Commercial production could significantly impact on air quality, should the source of power for the mills be fossil fuels. As mitigation measure Management will consider the use of electricity to power mills or steam engines backed by a generator set. The machinery should be serviced regularly and used in accordance with manufacturers' specifications.

The operations of BioFuel Africa Limited could potentially impact on the environment of the Project Areas, however, the application of mitigation measures as was the case during the initial plantation development, should be adopted for future expansion.

2.0 INTRODUCTION

2.1 BACKGROUND INFORMATION

StatoilHydro ASA is one of the world's largest crude oil and gas suppliers, with operations in 40 countries worldwide. It is currently the biggest seller of oil products in Scandinavia and a world leader in carbon capture and storage. It was established in 2007 and Headquartered in Norway.

As part of its business operations, StatoilHydro ASA, intends to invest in the operations (including Jatropha oil production and sale) from BioFuel Africa Limited (BFA), a duly registered limited liability company in Ghana, licensed under the Ghana Companies Code, 1963, (Act 179). The latter owns the Jade Project, which comprises a Jatropha plantation, a Test farm and Oil mill located in the Northern and Volta regions of Ghana. Map 2.1 provides the locations of the Plantation and Test farm in Ghana.

Currently, there are global concerns relating to potential unintended environmental and social consequences of increased biofuel production as a substitute for fossil fuels. These concerns are driven by conversion of arable farmlands to plantations that support biofuel production, and the amount of energy required to produce it. Parallel to this concern, is a campaign for its promotion due to benefits such as reduction in Green House Gas (GHG) emissions, Carbon sequestration from the plantations and their collective contribution to curb climate change.

StatoilHydro ASA recognizing the above global concern has commissioned SGS Belgium to undertake a Life Cycle Analysis (LCA) of the production chain for the Jade Project. The Assessment focuses on the Test farm at Lolito in the Volta region and the Plantation in the North, implications of processing dried Jatropha seeds into oil and transporting the oil to Tema harbour for storage and export. As part of the broad LCA, an Environmental Assessment and Audit of the components of the Jade project is considered important. The assessment/audit was undertaken in collaboration with SGS Environment, Ghana.

2.1.1 Terms of Reference for Study

The Terms of Reference (TOR) for the assessment/audit as determined in a proposal submitted to StatoilHydro ASA includes determining the impacts of the Jade project on the following;

- Air quality,
- Biodiversity,
- Land-use change,
- Water quality.

In assessing the impact of the Project on the above environmental media, the sustainability principles subscribed by StatoilHydro on environmental protection and climate change have been considered. These principles are briefly outlined below.

2.2 STATOILHYDRO'S ENVIRONMENTAL /CLIMATIC PRINCIPLES

Following the United Nations Conference on Human Environment (UNCHE), Stockholm, 1972 and subsequent conferences in Brazil, Rio 1992 and South Africa 2002, protection of the environment has become a priority for most countries. Attempts to halt environmental degradation regarding water, land and air pollution have led to several conventions and protocols, including United Nation Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol. Regular meeting of world leaders on environmental issues underscores the need for a concerted global effort for its protection. In this light

StatoilHydro recognizes its role as a major stakeholder and leader in efforts aimed at preventing global environmental degradation. This recognition has culminated in the development of a set of environmental principles that underpin all its operations, irrespective of the location on the globe. The principles are;

- Act according to the precautionary principle
- Minimize environmental impact
- Comply with applicable legislation and regulation
- Reduce Green House Gas emissions
- Seek optimal utilization of natural resources
- Make a contribution to biodiversity
- Continuously improve energy efficiency, environmental performance and products

StatoilHydro further recognizes that its presence in several countries provides it with an opportunity to lead in addressing issues specific to climate change. Significant efforts made in this regard concern the following;

- Energy efficiency
- Emissions trading
- CO₂ capture and storage, and
- Renewable energy

As part this assessment/audit study, these principles have been reviewed as a guide, in addition to relevant sections of the Environmental Impact Statement (EIS) commissioned by BioFuel Africa Limited for the plantation in the North and Test farm at the Volta region. The EIS finalized in 2008 provided the basis for the Environmental Protection Agency (EPA) in Ghana, to permit the project (Appendix 2.1).

2.3 OBJECTIVE OF ASSESSMENT/AUDIT

The objective of the study is to determine the environmental consequences of the Jade project with reference to the TOR and also conduct an audit of the existing operations. While the assessment is biased towards potential environmental impacts of future activities, the audit addresses the impacts or potential impacts that arise from the existing operation.

2.4 LEGAL REVIEW

As outlined in its environmental principles, StatoilHydro is committed to complying with all applicable statutory and regulatory frameworks of countries in which it operates or has interest. This principle also guides the company's choice of investments and business affiliates/partners, as it deems important for its trading partners to demonstrate that their operations accord with the local laws of the country in which they operate and also reflect best industry practices. To this end a review of the legal framework of Ghana was deemed necessary. The detail review was provided in the EIS and summarized below.

The laws that govern projects of the magnitude of the Jade project are the Environmental Protection Agency Act, 1994, Act 490; Environmental Assessment Regulations, 1999, LI 1652 and the Environmental Assessment Regulation (Amendment), 2006, LI 703. These laws prescribe the need for an EIA as a basis for decision by the EPA and the statutory payments for obtaining Environmental Permit. After 18 months of operations or production the law requires the preparation of an Environmental Management Plan (EMP). The Plan will detail the management of predicted impacts in

the EIS, and measures applied to minimize or eliminate impacts that were not foreseen during the EIA stage. The law requires the Plan to be renewed every 3 years.

Ghana, like most countries, relies on oil as a major source of fuel or energy to power vehicles, industrial machines and for domestic heating. The energy sector in the country falls under the ambit of the Ministry of Energy and some allied governmental institutions such as the Energy Commission. The sector is guided by the Energy Sector Policy, which also applies to the Jade Protect. The policy provides for the development of viable biofuels industry in Ghana. The specific policy target is to accelerate the development of biofuels, as an alternative transport fuel to substitute for;

- 10% of national petrol consumption by 2015,
- 20% of national gas oil consumption by 2015; and
- 30% of national kerosene consumption by 2015.

The achievement of these targets depends on other government Ministries, Departments and Agencies (MDAs), who's policies and programmes at the district or regional levels could impact on the targets. The relevant institutions were identified and incorporated in the institutional review for the EIS. They are;

- Central Gonja, Yendi and South Tongu District Assemblies,
- Forestry Commission,
- Ghana Investment Promotion Centre,
- Land Commission,
- Ministry of Environment, Science and Technology,
- Ministry of Food and Agriculture,
- National Petroleum Authority

2.5 METHODOLOGY

The methodology for the assessment/audit included field visits to the Project sites in Northern region (Yendi and Central Gonja districts) and South Tongu district, which accommodates the Test farm at Lolito in the Volta region, and Tema in the Greater Accra region, from December 9 to 13, 2008. During these visit, facilities such as the oil mill, proposed storage tanks for oil at the Tema harbour and the plantations were toured. Meetings were held with some Chiefs, Opinion leaders, member of the local Consultative committee and affected farmers in the North. A meeting was also held with officials of the Environmental Protection Agency in Accra (Head Office) and Tamale.

In addition to the field visits, relevant documents and specialist consultations were used to assess the environmental impacts of the project.

The visits involved representatives from BioFuel Africa and SGS. The Team comprised of the following;

- | | |
|-------------------------|------------------------|
| • Steinar Kolnes | BioFuel Africa Limited |
| • Ove Martin Kolnes | BioFuel Africa Limited |
| • Per Agna | BioFuel Africa Limited |
| • Adam Awal | BioFuel Africa Limited |
| • Francois Ducarme | SGS Belgium |
| • Augustine Owusu-Asare | SGS Environment, Ghana |

The itinerary during the visit is provided in Table 2.1.

Table 2:1: Schedule of Activities	
Date	Activity
December 9, 2008	<ul style="list-style-type: none"> • Site visit to Central Gonja and Yendi Jatropha fields
December 10, 2008	<ul style="list-style-type: none"> • Meeting with EPA officials in Tamale • Site visit to Yapei
December 11, 2008	<ul style="list-style-type: none"> • Site visit to Tamale irrigation dam • Meeting with Central Committee members • Meeting with Chiefs of Kpachaa, Tua and Jaashie Communities
December 12, 2008	<ul style="list-style-type: none"> • Site visit to Lolito Test farm in Volta Region
December 13, 2008	<ul style="list-style-type: none"> • Continuation of tour at Lolito & testing of oil mill in Volta region • Visit to Tema harbour to the proposed oil storage area (oil tank farm)

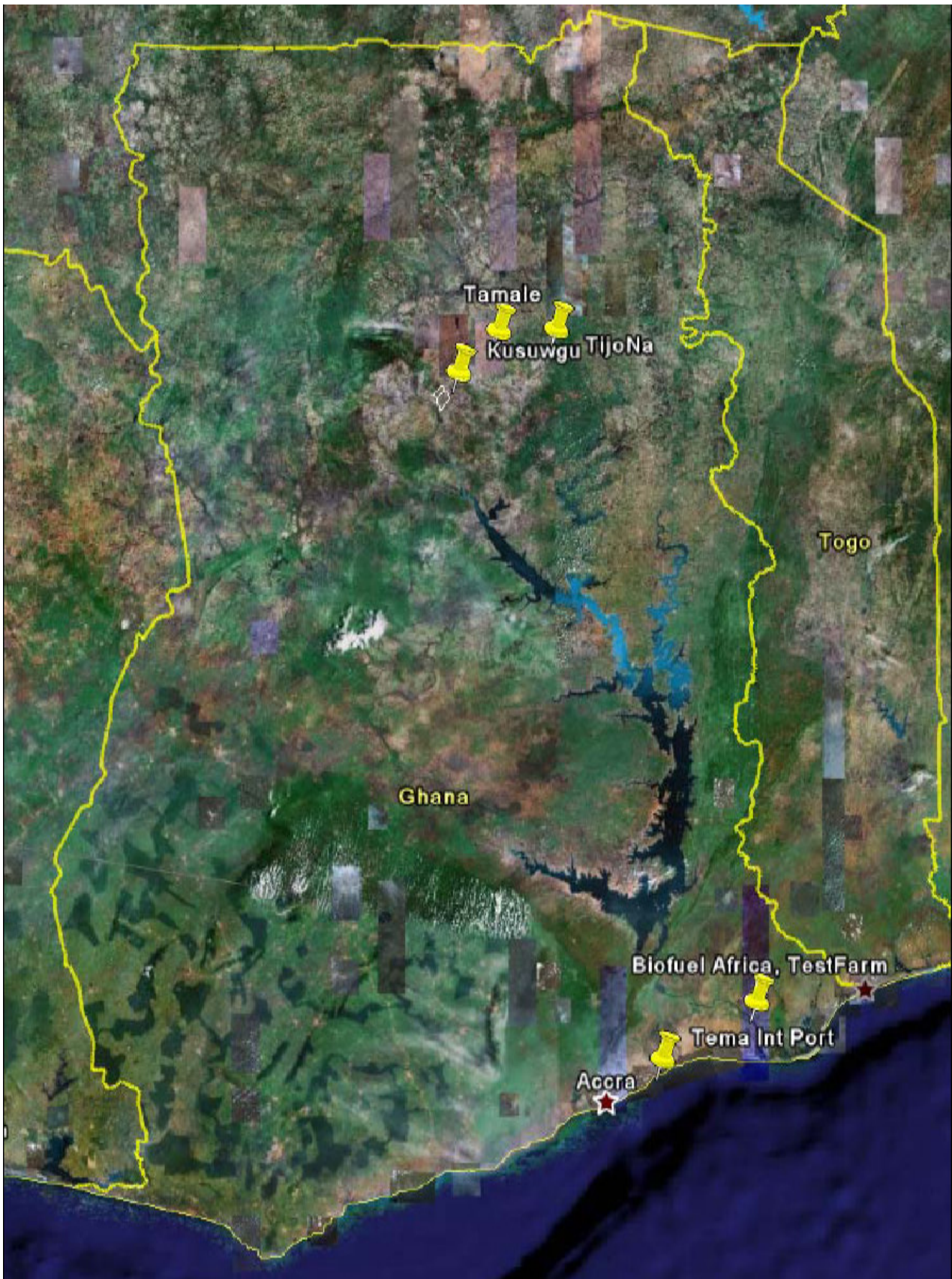
2.6 ASSESSMENT AREAS

The assessment/audit focused on areas permitted by the EPA for Jatropha cultivation, in the north and Test farm and oil mill in the Volta region. These sites were assessed for the potential impact of the Project on the local environment.

2.7 LAYOUT OF ENVIRONMENTAL ASSESSMENT/AUDIT REPORT

This assessment/audit report is presented in a format as outlined below.

- Chapter 1 – Non - Technical Summary
- Chapter 2 – Introduction
- Chapter 3 – Description of Project
- Chapter 4 – Receiving Environment
- Chapter 5 – Identification of Environmental Impacts
- Chapter 6 – Mitigation
- Chapter 7 – Consultations
- Chapter 8 – Conclusions and Recommendation
- Appendices



Map 2.1: Map of Ghana showing location of Jade project (Jatropha plantation and Test farm)

3.0 PROJECT DESCRIPTION

3.1 INTRODUCTION

This Chapter of the report describes the Jade project as implemented in the two regions. The description provides some details as per current information available to the SGS Consultants from project inception to its current state and physical observation made during the field visit to both regions. It provides information on project aspects such as land preparation for the plantation, crop maintenance including pest control, harvesting and post-harvest handling of the fruits/nuts, and the extraction process for crude *Jatropha* oil.

3.2 THE JADE PROJECT

The Project comprise of *Jatropha curcas* plantation in two districts in the Northern part of Ghana and a Test farm and oil mill in Volta region (southeastern part of Ghana – Map 2.1). The project is being implemented to produce commercial quantities of *Jatropha* seeds from which oil will be extracted to produce bio-diesel. The current cultivable area in the two northern districts, Yendi and Central Gonja is 23,762 hectare. The breakdown is provided in Table 3.1. Currently only 480 ha (2 %) of the cultivable area is under *Jatropha* cultivation. In addition to the plantation at the North is an 840 hectare Test farm at Lolito at Sogakope in the Volta region.

These areas are lands leased by BioFuel Africa, after satisfying the appropriate statutory and customary obligations to access and use the land for plantation.

District	Communities	Cultivation Area (ha)
Yendi	Kpachaa South	5,139
	Kpachaa North	1,858
	Kpalkori	3576
	Chugu	1,812
	Not survey	4,501
Central Gonja	Yapei North	2,202
	Yapei South	4,674
	Not surveyed	3,124
Total		23,762

(Source: EIS for *Jatropha* Plantation, 2008)

3.2.1 Test farm at Lolito - Sogakope

The Test farm is being developed over an area of 840 ha. The area is divided into plots with a plant density of 4,000 plants per hectare, which is realized from a plant spacing of 2.8 m by 1m. The method of propagation is by seed. The varieties are mostly exotic varieties from India, China and Sri Lanka. There are also local varieties from Tamale.

The Test farm is furnished with infrastructure that supports its operations. These include;

- Dug-out for water storage,
- Farmhouse,
- Tractor/vehicle workshop,

- Machine/equipment fleet camp,
- Nuts drying area.

In addition to these is the Oil mill.

Prior to the establishment of the Test farm an Acacia plantation had been planted to act as wind break and for aesthetics. This plantation is still viable.

The plants at the Test farm are staggered as they were planted at difference times of the year. The younger plants (seedlings) were raised in November 2008 (Appendix 3.1 - Photo 1), while the matured plants were about 8 months during the visit in December, 2008 (Appendix 3.1 - Photo 2). Currently, the Test Farm is divided into six main blocks and cultivated with various *Jatropha* varieties. Their respective names and coverage are provided in Table 3.2.

Plantation Blocks	Areas(ha)
Windmill	155
African House	150
Katanga	140
Melon	125
Test Farm	135
Amekpokope	135
Total	840

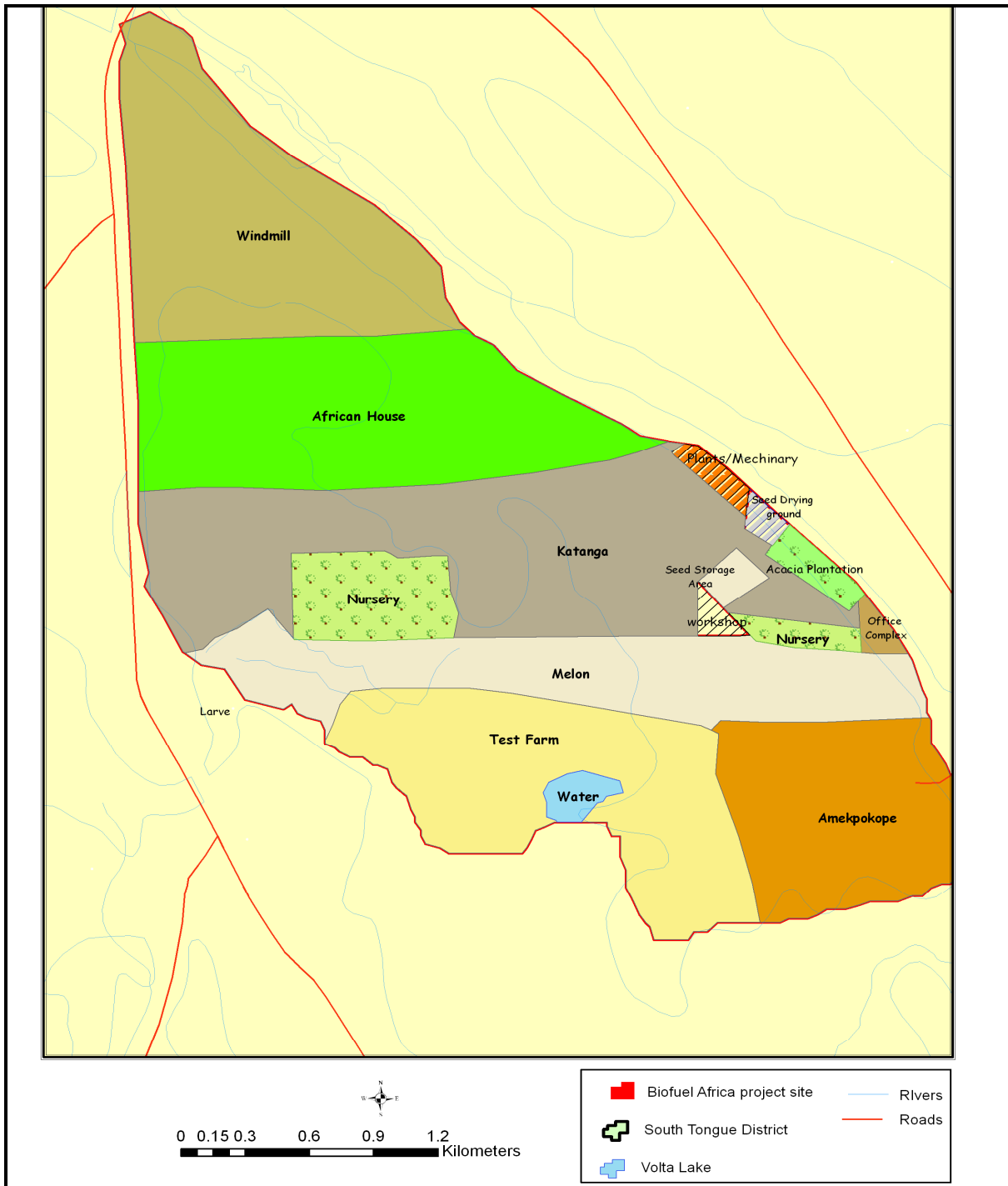
A map showing these areas (courtesy EIS, 2008) is provided in Map 3.1.

3.2.2 Oil mill at Sogakope

A key component of the Jade project is the Oil mill for extracting oil from the dried *Jatropha* seeds. Currently a single mill has been installed for this purpose. The mill is powered by a tractor via a Power Take Over (PTO) shaft connection (Appendix 3.1 Photo 3). Prior to milling the seeds, they are dried in the sun and dehulled manually. The seeds collected are put in a receiver cone, and directed into the adjustable pressing unit. The adjustment regulates the pressing process and therefore the thickness of the residue i.e. *Jatropha* cake. Adjustments that give the thinnest cake usually extract the most oil from the seed. The cake residue can be returned into the receiver for re-pressing and or deposited into a basket and transferred into jute bag for storage. The options for the stored cake include use as manure for the plantation, sale to communities for soap making or burnt under controlled condition to produce power for operating the mills when production becomes commercial.

3.2.3 Plantation in the North

The land area for the plantation at the North is provided in Table 3.1. During the visit, two established plantation sites at Jimle and Kpachaa were toured. These sites have cultivable areas of 5,000 ha and 1,800 ha respectively. The areas acquired at Yapei were visited as well as the Buipe site on the Black Volta tributary. The plantations are mechanized.



Map 3.1: Map of Test farm at Lolito showing blocks of Jatropha varieties (Source: EIS 2008)

The fleet of machinery used to support the plantations includes the following;

- 16 x 130 hp crawler tractors with dozer and front root rake.
- 4 x 130 hp 4WD tractors with front loaders and additional fork lifters.
- 12x 6 ton tractor trailers
- 10x rollover ploughs
- 10x Semi-ploughs
- 6x Rotor cultivators

- 3x Heavy duty 3.8m wide harrows. 600mm wheels
- 8x Light duty 7.2m wide harrows. 440mm wheels
- 2x Sowing machines for Jatropha nuts
- 2x Row making cultivators
- 1x Pesticide sprayer for tractor.
- 4x Automatic roll-in-water-spray guns with tubes and tractor mounted pumps
- 6x Small Massey Ferguson tractors (used)
- 6x 213 to 400hp Case and Massey Ferguson heavy duty tractors for harrowing and ploughing.
- 1x Shantui SD 22 Dozer. (Cat 7 class).
- 1x Seedling planting machine
- 1x Jatropha harvester

In addition to the above, there are a number handheld equipment kept at a machine camp on the farm. These machines are also used for weeding through the plantation and pruning the trees to maintain plant architecture and also allow for future mechanisation of activities such as harvesting and pest control.

The visit coincided with the dry season, when the north and south come under the influence of the North East trade winds locally referred to as 'harmattan'. During such times trees shed their leaves as an adaptive mechanism to conserve the little available water in its tissues. The condition is severer in the north than at the south. The Jatropha plants in the north had mostly shed off their leaves at the time of the visit to reflect the general dry atmospheric conditions. On the contrary at Lolito the plants were luxuriant for the matured plots and the seedlings. Part of the test farm area experiences perennial flooding, a condition that adversely affects Jatropha plant growth

4.0 BASELINE CONDITIONS

4.1 INTRODUCTION

Baseline information is important to determine the status of various bio-physical and socio-economic indicators, prior to project implementation at the Northern and Volta Regions. The baseline condition is a benchmark for future comparison. Prior to this assessment/audit, interventions in some parts of the Project Area had already been made. This chapter therefore relies on previous information gathered for the initial EIS for the Jade project and provides a summary.

The structure adopted is as follows:

- Description of bio-physical conditions of the two districts (Yendi and Central Gonja) that accommodate the Northern Project Area
- Description of the bio-physical conditions of South Tongu district that accommodates Lolito in the Volta region.

For the above Districts, the bio-physical information provided covers the following;

- Climate
- Biodiversity
- Land Tenure
- Land Use
- Soil Characteristics
- Surface Water Resources and Drainage and
- Topography

4.2 DESCRIPTION OF CENTRAL GONJA AND YENDI DISTRICTS

Central Gonja District is located at the South-western part of the Northern Region. It has an estimated population of 85,621 with a projected population growth rate of 2.9% (2000 PHC). The District has a surface area of 8,353 km², and a population density of 10 persons per sq km. The District Capital, Buipe is located 78 km away from the Regional Capital, Tamale. The primary occupation of the people in the district is farming. The crops include maize, sorghum, millet, and rice, roots and tubers (cassava and yam) and legumes (cowpea, soyabean, groundnuts). There are a few fishers along the streams in districts and along the major tributaries of the Volta River at Yapei and Buipe. The dominant ethnic group is Gonja. There are also minority groups like Ewes, Dagombas, Dagartis, Chinburus and Fulanis.

The Yendi District is bordered by 8 other districts. These are Saboba/Chereponi and Zabzugu/Tatale, the South by Nanumba, North and East Gonja, Tamale Metropolitan and Savelugu-Nanton, North-Gushiegu and Karaga. The district has an area of approximately 5,350 km². The population of the Yendi District is 142,504 and has a growth rate of 2.9% per annum (2000 PHC). Dagombas are the major ethnic group and the minority ethnic groups include Kokomba, Akan, Ewe, Basare, Moshie, Chokosi and Hausa.

4.2.1 Climate

Yendi and Central Gonja districts fall within the Guinea Savannah eco-climatic zone which characterizes the northern part of the country. The area experiences two major seasons as the rest of the country. These are the wet season, which affects the area from the months of May to October. The peak of the rain season is August and September. Available data on rainfall collected over 44 years is provided in Appendix 4.1.

4.2.2 Biodiversity

4.2.2.1 Flora

The plant cover in the North is diversity and comprise of important economic trees, medicinal plants and grasses. The important trees include the following;

- Dawadawa (*Parkia biglobosa*)
- Shea (*Vitellaria paradoxa*)
- Neem (*Azadirachta indica*),
- Baobab (*Adansonia digitata*),
- Silk cotton (*Ceiba pentandra*) and
- *Kayak senegalensis* (Mahogany).

The others are *Mitrygyna imermis*, *Nuclea latifolia*, *Diospyros mespiliformis*, *Ximania americana*, *Tamarindus indica*, *Balanites aegyptica*, *Ficus sp.* and *Acacia sp.* The grass species include *Pennisetum sp.*, *Sporobolus pyramidalis*, *Tridax procumbens*, and *Themida triandra*.

The vegetation cover is sparse and interspersed with economic trees. At areas with dams or streams, the indigenes have cultivated staple crops such as cassava, yam, millet, soyabeans, groundnut, pepper and maize.

4.2.2.2 Fauna

The wildlife species identified include birds such as horn bill (*Bucomus sp.*), Senegal Coucal (*Centropus senegalensis*), francolin (*Francolinus sp.*), and owl (*Typo sp.*). Other animals such as monitor lizard (*Veranus sp.*), grass cutters (*Thryonormys swinderianus*), Togo hare (*Lepus Capensis*), giant rat (*Cricetomys gambianus*), Trohse (*Kinixys sp.*), monkey (*Columbus sp.*), rabbits and squirrel (*Xenus sp.*), are found.

4.2.3 Land Tenure

The lands in the Project Areas, Yendi and Central Gonja Districts, are vested in the YaaNaa and Yagbonwura respectively. The sub-chiefs of Nanton and Kusawgu oversee the administration of the land in Kpachaa (Yendi District) and (Central Gonja District) respectively. The chiefs have influence on the use of the lands under their jurisdiction.

4.2.4 Land Use

The main land uses in the Project Area are as follows;

- Subsistence agriculture,
- Human settlements,
- Mechanized agriculture (crops),
- Grazing grounds for livestock,
- Fuel wood collection and charcoal burning,
- Savannah grasslands and woodlands, and
- Unprotected wildlife.

4.2.5 Soil Characteristics

The soils are of voltaic origin. According to the FAO soil map of Ghana most of the soils fall into the broad category of “moderately well drained concretionary soils developed on Voltain shales.” Specifically it falls under the Sambu-Pasga association which is light brown light textured concretionary soils underlain by medium textured concretionary soil matrix with iron pan boulders. The soils are low in organic matter content and are deficient in mineral at the root zone. They are well drained and have lateritic concretions. Soil test done by the Savanna Agricultural Research Institute (SARI) shows that the soils in the Project Areas are acidic with pH, between 4 and 6. Results of chemical properties of soils collected from Kpakore, Kpachaa, Jimle and Chegu are provided in Appendix 4.2.

4.2.6 Surface Water Resources and Drainage

The main rivers in the area are the White Volta and the Oti Rivers. The White Volta flows from east to west. It maintains flow all through the year and serves as the major source of water to the communities along its banks. Some of the tributaries of the White Volta in the area are Gou, Kito, Gbarni, Wawaa and Juni. All the streams flow from almost north to south into the White Volta. The Yapei project area (Central Gonja) is located in this drainage basin.

In the Jimle Project area (Yendi District), the Oti River is the main river which also flows into the White Volta. In this area, the Oti River flows almost from the north to the south. The small tributaries of the Oti which include Toloni, Sulumbene and Mosenam flow from the west to the east into the Oti. The area is served by a number of small streams, many of which dry up during the long dry season. A few of the streams have been dammed to provide portable water for communities as well as livestock.

The Yapei project area falls within the White Volta catchment area being the closest to the White Volta at about 200m. The Jimle project area falls within the Oti River catchment. The closest part of this area to the Oti River is about 9 km. Other smaller tributaries of the two main rivers maintain flow only during the rainy season. Surface water resources in the area are scarce in the dry season and all communities depend on constructed dams for water. The flat nature of the area also leads to high run-off into the White Volta and sometimes flooding.

4.2.7 Topography

The northern part of Ghana has a generally flat landform, interrupted by gently undulating plateaus. The altitude of the area is approximately 100 - 200m above mean and slopes gently towards the White Volta.

The sites in the Yendi and Central Gonja Districts are generally plain with gradient between 2 – 3 % in a south-eastward direction. Elevations are between 32.4 m (102ft) and 45m (150ft) above sea level.

4.3 DESCRIPTION OF SOUTH TONGU DISTRICT

The South Tongu District is one of the fifteen districts in the Volta Region with Sogakope as the district capital. It has an area of about 594.75 Km² and a population of about 64,852. The area has a growth rate of 1.22% per annum (2000 PHC, GSS). Urban settlers constitute 11.3% of the population and the remainder (88.7%) live in the rural areas. It is bordered on the east by the Akatsi and Ketu Districts, and north by North Tongu District. West is the Dangme East District of the Greater Accra Region and to the south is the Gulf of Guinea. The district is generally low lying.

4.3.1 Climate

The Project area at Lolito falls in the Dry Equatorial Climatic region of Ghana which is considered one of the driest parts in the country. The area comes under the influence of the North East Trade winds from November to February and followed by the wet seasons, from mid April to June (major season) and the minor season from September to October, when the area comes under the Southwest Monsoon winds from the Gulf of Guinea. The hottest month for the area is in March and the coolest temperatures are recorded in July and August. Climatic data collected for the area for about 17 years is provided in Appendix 4.1.

4.3.2 Biodiversity

Information provided on biodiversity as part of the EIA indicates that the dominant tree species are Neem, *Azadirachta indica* and few strands of oil palm trees (*Elaies guineensis*), *Mitragyna inermis*, *Borassus akeassii* and frangipani (*Plumeria obtusa*). Some areas are waterlogged, and have *Typha domingensis* and *Ipomoea aquatica*.

Few animal species including birds, rabbits (*Oryctolagus cuniculus*), grasscutters (*Thryonomys swinderianus*), squirrels, snakes and insects are reported in the area.

4.3.3 Land Tenure

Land in the district is vested in individuals, family and clan heads. Any arrangement for land is between the clan head or the individual owners and the interested parties.

4.3.4 Land Use

Prior to the development of the Test farm the land was fallow and covered with grasses and scattered strands of trees.

4.3.5 Soil Characteristics

Detailed study on characteristics of the soils in the district was commissioned to test the suitability and fertility status of the soils in the Project. The soils are classified according to FAO Soil Classification as Sodic Solonchaks with some areas having patches of Haplic Cambisols (FAO, 1990). These soils have generally very deep, dark grey to grey clay loam. The subsoil is alluvial and has greyish brown clay and sand often strongly mottled red or reddish brown. Results of the study showed that the soils fall in the Ada-Oyibi soil association. They are deep alluvial clays which are periodically flooded with saline water. The detailed report from the Soil Research of the CSIR is provided in Appendix 4.2.

4.3.6 Surface Water Resources and Drainage

The Lolito area fall with the catchment of the Volta River. The area is drained by Kpen and Bele, which are accessed by the nearby communities. The Test farm is drained by main streams which are perennial. As part of the EIA for the Test farm, details water quality analysis was undertaken as part of baseline. The results are provided in Appendix 4.3 – Table 4.1.

4.3.7 Topography

The topography of the South Tongu District is gentle with gradient less than 5 %. The landform rises from near sea level to about 18 meters (60 feet). The project area itself is located in an area below sea level and is therefore liable to flooding.

5.0 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

5.1 INTRODUCTION

The environmental impacts associated with project implementation could be several depending on the scope of the study. This study focuses on the impacts with respect to Air Quality, Water Quality, Biodiversity and Land Use. The specific impacts that relate to Green House Gases (GHG) are considered in detail in the Life Cycle Analysis report, titled '*Life Cycle of a Jatropha Biofuel Production in Northern Ghana; Green House Gas Balance*'.

5.2 IMPACTS IDENTIFICATION/EVALUATION MATRIX

An impact matrix is used to identify the impacts from project implementation. The impacts are evaluated based on score to determine the overall extent of the impact on the environment. The identification process relied on observations made in the field during the visit, discussions with local residents in the affected communities, discussions with Unit and Central Consultative Committee members, and SGS's previous experience in impact assessment for large scale project in Ghana.

The score criteria used is provided in Table 5.1 below.

Table 5:1: Assessment criteria for the evaluation of impacts			
Criteria	Category	Score	Description
Severity	Low	1	The impact will not cause noticeable or measurable change
	Moderate	2	The impact will cause noticeable change but reversible
	High	3	The impact will cause permanent change
Geographical scale	Low	1	The impact is likely to be contained on site
	Moderate	2	The impact is likely to be local but have off-site impacts
	High	3	The impact will have widespread off-site impacts
Duration	Low	1	Within a day
	Moderate	2	More than a day, but less than a week
	High	3	Greater than a week
Probability	Low	1/0	Expect one or no occurrence in six months
	Moderate	2	Expect one occurrence or more every month
	High	3	Expect one or more occurrences every week

Table 5:2: Significance ratings definitions	
Significance ratings	Total score range
High	9- 12
Moderate	5 – 8
Low	≤4

Table 5:3: Impact Identification and Evaluation Matrix for Potential impact of Jade Project										
Processes	Impact	Impact Details	Receptor	Scoring of Impacts				Total Score	Significance	Significance with mitigative measures
				Severity	Scale	Duration	Probability			
Land preparation										
<ul style="list-style-type: none"> • Clearing • Ploughing • Ridging • Pegging and staking 	Air quality	Dust generation, gaseous emissions from machinery and equipment	Close communities, Workers Ambient air	2	1	1	2	6	Moderate	Low
	Biodiversity	Habitat disturbance Loss of flora Loss of fauna	Flora and Fauna	3	2	3	1	9	High	Moderate
	Land use	Change in Land use	Local Communities	2	1	1	3	7	Moderate	Low
	Water Quality	Pollution of nearby water resources	Streams/Rivers	2	3	2	1/0	8	Moderate	Low
		Erosion from cleared surfaces	Streams/Rivers	2	2	2	1	7	Moderate	Moderate
Crop cultivation										
<ul style="list-style-type: none"> • Sowing • Irrigation • Pest control • Ploughing (post planting) • Harvesting 	Air quality	Emissions of NOx and SOx from tractors and other motorised equipment	Ambient air Local communities	1	1	1	1	4	Moderate	Low
	Biodiversity	Destruction of insects, e.g. butterflies, ants, grasshoppers from spraying of insecticides	Fauna	2	1	1	2	7	Moderate	Low
	Land Use	Destruction of arable crops	Local communities	2	1	1	1/0	5	Moderate	Low
	Water Quality	Abstraction of water	Streams Local communities	1/2	2	3	2	8	Moderate	low
Processing										
<ul style="list-style-type: none"> • Fruiting drying • De-husking of nuts • Milling/Extraction • Oil storage 	Air quality	Emissions from Fuel	Air	1	1	1	3	6	Moderate	Low
	Biodiversity	Attraction of vermin	Local community	1	1	1	2	5	Moderate	Low
	Land-use	Soil contamination from spills	Soil	2	1	3	3	9	High	low
	Water Quality	Accidental spill in run-off	Streams/ rivers	2	3	2	2	9	High	Moderate
Waste										
<ul style="list-style-type: none"> • Vegetation/wood waste • Service and maintenance 	Air quality	Odours from waste dumps	Workers Local communities	1	1	1	1	4	Low	Low
	Biodiversity	Attract vermin to site	Local communities	1	1	2	1	5	Moderate	Low
	Land-use/ Soil quality	Loss of land-use to waste disposal	Soil	1	1	3	1	5	Moderate	Low

Table 5:3: Impact Identification and Evaluation Matrix for Potential impact of Jade Project										
Processes	Impact	Impact Details	Receptor	Scoring of Impacts				Total Score	Significance	Significance with mitigative measures
				Severity	Scale	Duration	Probability			
<ul style="list-style-type: none"> • Hydrocarbons facilities and uses • Sewage and garbage 		Soil contamination from fuels and oils from equipment serviced at workshop	Soil	2	2	3	1	5	Moderate	Low
	Water quality	Water contamination of fuels and oils from equipment serviced at workshop	Stream/rivers Underground water	2	2	1	1	5	Moderate	Low

As in Table 5.3 above, the Potential impacts are listed according to activities involved in the Project's implementation from Plantation development or expansion, through oil processing and management of waste resulting from the activities. The discussion is as follows.

5.3 PLANTATION DEVELOPMENT

5.3.1 Land clearing

Land preparation for the Jade project requires significant effort and resources, given the area involved to accommodate plantation and the supporting infrastructure. The land preparation process includes removal of selected trees, trees stump and roots and rocks, ploughing, harrowing, creation of ridges and furrows.

5.3.1.1 Air Quality

Clearing has been completed for the existing plantation, however, additional lands will be cleared to expand the farms and enhance BioFuel Africa's capacity to produce *Jatropha* nuts in commercial quantities to meet both domestic and export demands. The clearing process is mechanised and requires the use of tractors, graders and allied implements as listed in Section 3.3.2. The activities and the machines involved could impact on the environment as stated in Table 5.3 above.

The potential impacts are increase airborne particulate matter (dust) from the fields and gaseous emissions from farm machinery. These could impact the local air quality. In the north, where drought related bush fires are a common occurrence, the quality of ambient air can be significantly affected by any activity that increase in airborne particulate. The potential recipients are local communities close to the farms, workers on the farms and road users at areas where the access or public roads are close to the plantations.

Gaseous emission result from combustion in heavy duty farm machinery and equipment. The gases include Carbon Dioxide (CO₂), Nitrous Oxides (NO_x) and Carbon Monoxide (CO), which are Green House Gases, and Sulphur Oxides (SO_x). These gases will have moderate impact on the local environment. However, given the landscape (open space) at the plantation sites, gaseous emission will be dispersed rapidly. The recipients could include workers and local communities close to the plantations.

In this study the impact of dust and gaseous emission from land clearing activities is considered moderate (Table 5.3). However, when mitigation measures as discussed in Chapter 6 are implemented, air quality impacts could be low.

5.3.1.2 Biodiversity

Impact of land clearing on biodiversity could potentially be significant. In the process of clearing to prepare the land for the plantation, all or most of the original vegetation cover on the fields are removed. The plants and trees are part of the food chain of animals within the project area and beyond, therefore any loss of vegetation or plant could commence a chain of losses involving some indigenous animal species. Clearing activities could also disturb the habitat of some animals including birds, insects and reptiles which form part of the existing ecosystem.

The baseline studies conducted at the Project areas as part of the EIA show the following as the natural vegetation cover and animal species present. Among the vegetation cover are economic trees such as Dawadawa (*Parkia biglobosa*) and Shea (*Vitellaria paradoxa*) trees. In addition to these are Neem (*Azadirachta indica*), Baobab (*Adansonia digitata*), Silk cotton (*Ceiba pentandra*) and Mahogany (*Khaya senegalensis*). Others are *Mitrygyna imermis*, *Nuclea latifolia*, *Diospyros mespiliformis*, *Ximania*

americana, *Tamarindus indica*, *Balanites aegyptica*, *Ficus sp.* and *Acacia sp.* The grass species are few and include *Pennisetum sp.* and *Sporobolus pyramidalis*. The cover is generally sparse especially in the north at the time of the visit.

The wildlife species reported in the area include birds such as horn bill (*Bucornis sp.*), Senegal Coucal (*Centropus senegalensis*), francolin (*francolinus sp.*), and owl (Typo sp.). Other animals such as monitor lizard (*Veranus sp.*), grasscutters (*Thryonomys swinderianus*), Togo hare (*Lepus Capensis*), giant rat (*Cricetomys gambianus*), monkey (*Columbus sp.*), rabbits and squirrel (*Xenus sp.*) are also reported.

It is possible that some of the economic trees especially those at their seedling or young stage could be destroyed in the process of land preparation. The animals which depend on these plants for shelter/habitat could also be affected.

The impacts that will arise from clearing to expand the existing cultivated area are regarded as high. Impact on biodiversity loss within the project areas could be minimised, however the interconnectivity between all actors in the ecosystem is such that mitigation measure would make the impact on biodiversity moderate.

5.3.1.3 Land-use/Soil

Prior to cultivation of the existing plantation, lands in the Project Area were subject to uses that reflected the culture and norms of the indigenes. These included nomadic practices, where Fulanis would graze their cattle from one location to another throughout the year. This practice is common in Northern region. Crop production for local market and for subsistence is also common in the North. The crops cultivated are staples such as cereals: - maize, sorghum and millet. Other crops grown include cowpea, soybeans, groundnuts and yams.

Introduction of *Jatropha* plantation has modified the land-use of the area to some extent, though it remains predominantly agricultural. The shift is from small scale annual crops production and livestock rearing to perennial crop production on a commercial scale. The impact is the conversion from food crop production to *Jatropha*, which is for bio diesel. The impact could affect mostly the communities that are close to the plantation and whose lands have been converted into plantation. Their animals would also have to travel long distances for grazing, when fodder in their immediate surroundings has been consumed.

In some cases the land is allowed to lie fallow, and remains undeveloped until such time that some use such as construction, farming or any profitable activity is considered. This study evaluates the impact on land-use as moderate and becomes low after mitigation measures are applied.

For areas in the North, where the lands were covered with bushes and lay fallow, introducing *Jatropha* has a significant positive impact. The bushes were a source of fuel for perennial bush fires. Cultivation of *Jatropha*, in addition to the care and maintenance given to the land prevent bush fire in the cultivated areas. *Jatropha* is resistant to fires, therefore its cultivation around the communities also serve as fire-belt to protect life and property.

Soils in the Project Area in the north are lateritic and have low organic matter content (Appendix 4.2). Their humus layer is also thin. Humus binds soil particles and helps to maintain its structure, therefore any activity that contributes directly or indirectly to deplete organic matter could impact on the soil fertility and structure. Activities such as clearing on a large scale expose the surface of the soil to the vagaries of the weather.

The exposed surface becomes prone to water (rain) or wind erosion, which further aggravates the soil condition. The top soil is washed along with run-off or blown off when the area comes under the

influence strong winds. Apart from the impact of erosion on soil fertility and structure, the soils are underlain by plinthite. This material is rich in iron and becomes very competent, when exposed to air. Breaking the earth's crust with bottom breakers and ploughs during land preparation could expose plinthite to air and moisture. The plinthite reacts to form a solid concrete-like layer referred to as hard-pan. Hard-pan is impermeable and its presence in any field adversely affects land preparation and promotes water logging after torrential rains. When mitigation measures are applied the impact could be low.

In Volta region, the impact of land clearing on soils is variable. Portion of the land area are clayey while some areas are loamy. As indicated earlier, land preparation for the Jade project is mechanised. The soils structure could be destroyed as the layers/horizons become compacted under the weight of heavy machinery. The compacted soil could have adverse impact on future agricultural production.

5.3.1.4 Water Quality

Impact of land preparation on water quality could be significant; given that the Project Areas have parcels of land near the Volta Lake or its tributaries. Land preparation as described earlier would break the earth's crust and loosen the soil. The loose soil could form part of run-off from the fields which report to the Volta Lake.

Sediment deposition impacts water resources by increasing load (siltation), turbidity, colour and nutrients level. When deposition is prolonged channels capacity is reduced, a condition that could easily lead to flooding. The impact of land clearing on water quality is rated as moderate and could be low when mitigation measures are applied.

5.4 CROP CULTIVATION

Crop cultivation follows after land preparation and comprises the following; sowing, irrigation, pest control, ploughing in between crop rows at various stages of plant growth, and Harvesting. These activities have varied significance in terms of impact on quality of air, biodiversity, land-use/soil and water quality.

5.4.1 Air Quality

Crop cultivation activities may have little impact on air quality. The growing plants sequester carbon dioxide from the atmosphere, which compensates the initial release of CO₂ when the land has been cleared. However, mechanised activities including ploughing, spraying to control pest, etc., that currently use fossil fuel release CO, CO₂ and SO_x and NO_x into the atmosphere from the combustion process. The ploughing process also loosens the soil and generates dust. Ploughing in between rows of plants and spraying to control pests are activities undertaken not more than a couple of times in a week and does not involve entire fleet of support machines. The emissions are dispersed immediately. Thus impact on air quality is rated low.

5.4.2 Biodiversity

Biodiversity in the Project Area, have been displaced by the initial clearing to establish the plantations, support infrastructure. The remaining wildlife includes birds, squirrels, lizards, snakes and insects. Some of these organisms had made their holes, webs or anthills in the plantation. Though their original habitat had been destroyed, the plantation has become a suitable abode for these species. The plants that were originally at the Project Areas, are common species, which are common in areas outside the boundaries of the plantations, thus there is no threat in terms of loss or extinction. The impact on biodiversity is the loss in plant density, destruction of bio-habitat, displacement of animal and their food sources. Mitigation interventions are expected to make impact on biodiversity low.

5.4.3 Land use

Jatropha plant under good management practices could be economically productive for about 20-25 years. The areas acquired by BioFuel Africa are dedicated to Jatropha, except in cases where an agreement has been reached with the communities or farmers to allow intercropping with staple crops such as maize and pepper. As indicated earlier, the opportunity cost of the plantation is food crops, cattle grazing grounds and potential site for construction. The land use until such time that productivity declines and the Project managers decide to decommission the project remains under Jatropha cultivation. The impact is loss of land for alternative agricultural use and construction. This impact is rated moderate.

5.4.4 Water Quality

Jatropha plant does not require much water to thrive and would not have adverse impact on water resources within the Project Area. However, the seedling stage is critical and requires sufficient quantities of water. At Lolito, water is abstracted (reference EIS, 2008) for irrigation. This could reduce the volume of water in the streams and may affect the drawdown areas. The impact is rated moderate.

5.5 PROCESSING

The ultimate for the Jatropha plantation is crushing of the Jatropha nut to extract oil for fuel. The processing comprises activities as listed;

- Drying
- Dehulling
- Pressing/milling
- Oil collection and storage

The impacts of processing on the environment (where applicable) are discussed from Section 5.5.1 forward.

5.5.1 Drying

Drying of Jatropha nut is based on solar technology. The technology involves spreading the fruits on a mat, raised to about a meter high on wooden stakes. The fruit are exposed to solar radiation until such time that the shells become dehydrated and blacken. The dried fruit are collected in a jute sack for storage. No other external heat source is applied to the fruits. The drying process has no impact on air, biodiversity, land use and water.

5.5.2 Dehulling

After drying, the seeds are dehulled. The process involves manually rubbing the nuts on a metal wired mesh to separate the seed from the husk (Photo 4). The fragments of the seed and husks are then separated by winnowing. The seeds collected are stored in a jute sack for pressing.

The process has no impact on air, water and biodiversity. However, the disposal of the husk may pose an environmental challenge. Currently, the husks are heaped at a designated waste site on the Test farm. Proposed measures to manage the husks are provided in Section 6.5.3.

5.5.3 Oil Extraction

The extraction process involves a mill powered by a tractor. The mill has a receptacle (receiving cone) where dried seeds are placed to feed into the pressing chamber. The seeds are drawn into the chamber by gravity, or pressed in, using a wooden spatula. As the crushing process begins, oil is extracted from the seeds into container (Photo 3) leaving behind cake as residue. The crude extract is collected into a collection tray and discharged into metal drums for storage. The extraction process requires an external energy source.

At Lolito, the mill is powered by a tractor, which operates on fossil fuel (diesel). The emissions include CO, CO₂, NO_x and SO_x which result from the combustion. These emissions are minimal, due in part to the scale of operation. However, it is expected that expanding the extraction facilities would require a corresponding increase in power, which could result in significant emissions, in the event that fossil fuel remains the source of energy. Mitigation measures proposed to manage emissions, when oil extraction becomes large scale, is provided in Section 6.4.1.

The process of collecting and decanting oil into storage containers could result in spills. Oil spill in the project area could contaminate the soils and could have a long term significant impact.

5.5.4 Oil Storage

The crude *Jatropha* oil is stored in a large barrel, and allowed to stand for a few days, to allow sediments to settle. The clear oil is decanted into dedicated containers for testing. This operation is manual and does not require any external energy input. The potential impact of storage could include fire hazards and accidental oil spills. The impact of fire outbreak could be significant, and could affect lives and property. Accidental oil spill as mentioned earlier could contaminate the soils within the project environs

5.6 WASTE MANAGEMENT

The entire production operations from land preparation, through crop production to oil extraction will generate wastes. The waste will include solids, liquids and gases. The waste from land preparation activities includes trees, rocks and soil excavated for construction and gases from exhausts and combustion equipment. Liquid waste will include waste water from construction sites and waste oils from vehicle service camps.

During crop cultivation, the common wastes generated will include empty metal cans, sacks and other packaging materials for seeds and additives. At the processing stage, waste sources will include husks (Appendix 3.1 – Photo 5), seed cake and sediment from the oil processing operation. Redundant materials from machinery and equipment could also be a source of waste at the Project Areas.

Crop cultivation on such large scale will require a significant and regular supply of fuel and lubricants. The fuels and lubricant may spill accidentally and become waste. The empty containers for storing these lubricants would also require final disposal. In addition to the above, domestic waste and sewerage from the farm house and workers camp would add to the waste stream. All these waste materials will have to be suitably managed in accordance with the waste management system of the respective districts.

The impact of waste generated from the operations may be moderate to low depending on the rate of expansion in infrastructure and processing facilities and management of the various streams of waste. Expansion of the farm land will increase trees and rock waste and atmospheric emission from the fleet of heavy duty machinery involved, while processing activities will result in large volumes of seed cake, and dried husks. The different waste will impact on the air, biodiversity, land-use and water. The impact is moderate and will become low, when mitigation measures are applied.

6.0 MITIGATION

6.1 INTRODUCTION

Mitigation measures are implemented to ensure that predicted project impacts are reduced as much as practicable and where feasible they are eliminated during Project implementation. These measures are required to be practical and economically feasible such that all the component activities would contribute to the overall sustainability of the project.

Prior to project inception the EIS had identified potential impacts and proposed mitigation measures at the instance of BioFuel Africa. This chapter therefore considers the mitigation measures that need to be put in place based on conditions on the ground at the time of the visit.

6.2 LAND PREPARATION

At the time of the visit, land preparation activities were on hold, however at areas where the plantation has been established, the following are proposed for the various environmental media;

6.2.1 Air Quality

Construction work involving heavy machinery should be avoided during inclement weather conditions. These conditions include periods of strong wind and periods when the area comes under the influence of the North East Trade winds locally referred to as harmattan. The harmattan is dust laden, so that any activity that generates dust on a large scale will worsen the visibility and increase dust nuisance

The fleet of machines are currently powered by fossil fuels, which emits gases from their exhausts. It is imperative that all machines are maintained regularly and operated in a manner that accord with manufacturer's specification. The exhausts should be fitted with mufflers and should point upward. Machine which have exhaust pointing upwards reduce the incidence of dust generation during operations and when their engines are idling.

6.2.2 Biodiversity

As a directive from the EPA, some economic trees e.g. Shea nut trees, are preserved in areas where the plantation is established in the North. This practice should be maintained for areas that will be expanded and should remain undisturbed throughout the Project's Life cycle.

6.2.3 Land-Use

The Land-use is defined by the plantations, and will remain so for the entire economic life of the trees. Currently, beehives are placed at some locations to promote the continued existence of bees in the plantation, while they produce honey as an additional benefit and support pollination among the plants. As identified in Chapter 5, the impact of Jade project on Land use is the loss of alternative agricultural production. BioFuel has therefore come to some agreement with the locals, to allow them to cultivate staple crops within the plantation. This measure ensures that, while BioFuel Africa prepares the land by ploughing and harrowing to input *Jatropha* seeds, the local will input their staples and will be responsible for controlling weeds at those parts of the field. This measure ensures a win-win situation for both parties, a practice that should be continued as long it remains practicable.

Further to the above, wetland areas that support tall grass e.g. *Typha spp* used for roofing houses will be preserved. Sacred groves and other sites of religious significance identified in the Project Areas will be avoided. As much as practicable a buffer zone will be left in all cultivable areas as refuge for wildlife or biodiversity.

Some area within the acquired sites in the North will reserved for use as burial grounds or cemetery for the indigenes. The specific sites will be agreed with the chiefs and local representatives.

6.2.4 Soil

Soils in the Project Areas in the North have concretionary sub-soils and are underlain with iron pans in some areas. A detailed pedological investigation is recommended, to guide tillage practices. However, tillage should be carefully managed to reduce top soil erosion, and exposure of the concretionary subsoil layer. These soils are marginal for mechanized farming. Deep plough should be avoided at areas with iron pans. Burning of grass should be avoided under all conditions.

6.2.5 Water Quality

Clearing of lands close to surface water, should be avoided as much as possible. Clearing vegetation along most river banks in Ghana accounts for the drying up of these rivers to the extent that the throughput of some has considerably reduced and in some cases they have become extinct. Vegetation along streams provides protection and reduces evaporation. They also maintain a balance between surface and ground water. In the event that clearing is done at close range, a buffer of vegetation cover should remain between the plots and the stream. As much as practicable silt traps should be installed to prevent siltation of nearby water, as silt reduces channel capacity and enhance flooding. In areas where the plots slope toward the stream, due to the depression they run through, ploughing should be done across the field and parallel to the direction of flow.

When it becomes necessary for soil and other waste materials to be stockpiled on the field, the piles should be sited away from the water courses to avoid a possible washing of soils into the streams.

6.3 CROP CULTIVATION

Jatropha plantations are in themselves an environmental enhancement measure as it contributes to ameliorating the problem of climate change by sequestering CO₂ and from the atmosphere. Until such time that fuel supply for powering the fleet is obtained from bio fuels, fossil fuels remain the main source fuel for powering the machines. This requires mitigation measures to reduce impact on aspects of the environment addressed by this report.

6.3.1 Air Quality

Mitigation measures proposed for land clearing for air quality applies during crop cultivation.

6.3.2 Biodiversity

Mitigation measures for biodiversity discussed for land clearing also apply.

6.3.3 Land Use

The Project Areas will remain mainly under Jatropha plantation, and may be expanded in future. The expansion will also accommodate support infrastructure, oil processing mills and on-site storage facilities. As part of efforts to mitigate the loss of land use as a result of the plantation, intercropping is permitted and encouraged. The Management of BioFuel Africa is also promoting a Jatropha out growers' scheme for all interested farmers. Under this scheme, seeds are supplied to the farmers to plants on their lands and intercropped with food crops. The benefits of this arrangement include increased CO₂ capture in the area, economic gains from both staple crops when they mature and Jatropha when the nuts are also due for harvest.

Management of BioFuel Africa are also involved in a process to promote the use of Jatropha as fire belt and for avenue planting. When all the nuts are harvested BioFuel Africa will purchase them and process for oil. These measures are expected to reduce the impact of loss of land use to the farmers due to Jatropha cultivation on a large scale

In addition to the above mitigation measures, BioFuel Africa has constructed dug-outs which serves a dual purpose of trapping water in the dry season for irrigating the plantation and for watering livestock almost the year round. Until then, livestock had to travel long distances in search of water in the dry season as most streams in the North are ephemeral and dry up during the dry season.

The management of BioFuel Africa is considering constructing additional dug outs which will be dedicated to livestock watering to prevent interference or competition for water by crops and animals, and some local in the adjacent communities

The implementation of these mitigation measures and their careful management makes the Jade project impact positively on the local environment.

6.3.4 Soil

The lands will be cultivated in such a way that the organic matter in soils is maintained and, as far as possible, increased. The following measures will be adopted;

- Burning of grass on the fields will be avoided
- Suitable cover plants and intercropping will be incorporate soon after plantation establishment
- product from pruning operations will be ploughed back into the soil, if no pathogen are found in them
- Composting of husks and garbage on site should be adopted to replenish soil organic matter and for mulching

The improvement of organic matter will improve physical structure/stability of the soil and hence avoid erosion, improve cationic exchange capacity and hence slow down the loss of nutrients and cationic fertilizers. Such improvements also improve carbon storage (increase carbon pool in soil) with a beneficial effect on GHG balance.

6.3.5 Water Quality

Jatropha plants are able to grow on marginal soils and withstand harsh conditions including limited supply of water. The plantation will be rain fed. However, Management has constructed some dug outs in Lolito and Kpachaa to provide water for the indigenes and their livestock. These dug outs are not expected to impact on water quality in the Project Area.

6.4 PROCESSING

The activities involved in processing include dehulling of nuts, milling and storage of the oil. These aspects of the Jade project also require mitigation as they have varied impact on environment al media.

6.4.1 Air Quality

Mitigation measures to address air quality in the Project Areas include measures recommended for the mitigating air quality for land preparation activities. The impacts from processing is currently minimal

however, BioFuel Africa should ensure the following are implemented to forestall deterioration as processing capacity increases;

- Replace fossil fuels with bio fuels as main fuel source for power generators and mills for oil extraction
- Fit filters to all exhaust points of machinery used in processing
- Regularly service and maintain machine parts
- Use machines in accordance with manufacturers specifications
- Avoid any form of incineration or burning waste on site
- Periodically spray water over unsealed areas in the processing yards to control the generation of particulate matter

Further to these, Management is considering the possibility of using steam turbine (working with press cakes firing) to produce electricity to power the mills or connect to the national power grid for electricity supply. The option could be supported with by generator plants as back up power facility.

It is expected that these measures would keep the ambient air quality within acceptable local and international limits for oil processing facilities.

6.4.2 Biodiversity

Processing will not impact on biodiversity. No mitigation measures are therefore recommended.

6.4.3 Land Use

The areas to be used for processing and storing crude Jatropha oil forms part of the acquisition area for the Jade Project. When the extraction capacity is increased it will not require any addition change in land use. Therefore no mitigation measures are required apart from those discussed for mitigating impact of the project on land use.

6.4.4 Water Quality

Processing will not impact on water quality. No mitigation measures are therefore recommended.

6.5 WASTE MANAGEMENT

Waste is generated at the various stages of the project; from land preparation to processing and storage and requires mitigation. In order to reduce the impact of poor waste management, the following is recommended:

- Staff should be educated on the importance of proper waste management
- Suitable rubbish bins and waste disposal facilities should be provided for all staff on site
- All domestic waste should be disposed of at a recognized disposal facility
- If no suitable final waste disposal facility is available, management should liaise with the Waste Management Department of the respective districts for regular collection
- Management should consider the option of composting biodegradable waste for use as mulch or replenish organic matter in the soils

6.5.1 Air Quality

Gaseous wastes are mainly gases from equipment in the operational areas. The impacts of gases as waste could be mitigated by measures discussed above for gaseous emission during the various stages of the project development. No further mitigation is proposed for mitigating waste.

6.5.2 Biodiversity

Waste generation at the Project Areas will not have direct impact on biodiversity, however, vermin e.g. rodents could be attracted to garbage if the wastes are not well managed. Mitigation measures prescribed in Section 6.5 therefore apply.

6.5.3 Land Use

Prescribed measures in Section 6.5 above apply for mitigating impact of waste on soils. The waste generated should be managed in a manner that does not interfere with the Land-use of the project areas. During commercial production, management of dry husks will become important. Rather than considering the husk as waste for disposal, the husk could be composted with shrub and other vegetable materials and domestic biodegradable waste to produce compost for the plantation. This measure will ensure the area acquired for the plantation is maximised. The final compost could be used as a soil conditioner, to nourish the soil in addition to benefits outlined in Section 6.3.4. Redundant materials should be cleared from open spaces and appropriately housed for final disposal.

6.5.4 Water Quality

Waste oils from processing and hydrocarbon receptacles should be handled with care. In order to avoid contamination of surface and ground water resources within the Project Area, especially from hydrocarbons, the following are recommended;

- Hydrocarbon and other chemical use should be reduced and kept to a minimum
- Bio-degradable chemicals should be used where possible
- All large machinery should be appropriately maintained to prevent leakage and waste
- Vehicle and machinery maintenance should not be done in the field
- All hydrocarbon containers should be stored above ground and in appropriate containers
- All large machinery should be monitored on site for hydrocarbon leakage
- If a leakage is detected, metal drip trays should be used immediately to prevent further contamination. Contaminated soil should be removed from site immediately
- Material Safety Data Sheets should be available for all chemicals on site. The Farm Managers should be aware of actions to take should spillages occur.
- A supply of oil-absorbent material and appropriate clean up equipment should be available at all times
- Used hydrocarbons and chemicals contaminated soils should be disposed of at a recognized disposal facility, and protected from rain water
- Used hydrocarbon and chemical containers should be disposed of appropriately

7.0 CONSULTATIONS

7.1 INTRODUCTION

Consultation with project affected persons is paramount to the sustainability of Jade project. It provides feedback and allows the project managers to address impacts (both positive and negative), resulting from project implementation. For the Jade project, consultations with some communities close to the project sites were undertaken to ascertain the acceptance of the project by the local communities, government agencies and to obtain feedback and concerns that need to be addressed.

7.2 CONSULTEES

The consultees are provided in Table 7.1.

Table 7.1: List of Consultees			
Institution/Community	District	Persons	Designation
Environmental Protection Agency	Accra	<ul style="list-style-type: none"> • William Agyeman Bonsu • Opong Boadi Kyekyeku 	<ul style="list-style-type: none"> • National Climate Change Focal Point /CDM – DNA • Principal Programme Officer
Environmental Protection Agency,	Tamale	<ul style="list-style-type: none"> • Adu Iddrisu 	<ul style="list-style-type: none"> • Programme Officer
Jaashie Consultative Committee members	Gonja	<ul style="list-style-type: none"> • Chief Issa Adam • Alhassan Haruna • Haruna Haruna • Abraham Issa 	<ul style="list-style-type: none"> • Chief of Jaashie • Linguist • Elder • Elder
Tua Community	Gonja	<ul style="list-style-type: none"> • Chief and Community Consultative Members 	
Kpachaa Community	Gonja	<ul style="list-style-type: none"> • Community Consultative members 	
Central Consultative Committee members	Gonja	<ul style="list-style-type: none"> • Iddrisu Yussif • Iddrisu Hussein • Central Committee members 	<ul style="list-style-type: none"> • Executive member • Executive member
Lolito/Sogakope	South Tongu	<ul style="list-style-type: none"> • Ove Martin Kolnes 	Farming Consultant

The outcomes of the meetings are provided from Section 7.2.1 forward.

7.2.1 Environmental Protection Agency, Accra

The EPA officials responsible for Climate Change and Clean Development Mechanism (CDM) had no objection to the project development. They proceeded to outline Ghana's procedures relating to CDM projects as a guide to the Project Managers, should they wish to consider the plantation as a CDM project in future.

The process commences by notifying of the EPA with a Project Idea Note, which would attract a Letter of No Objection once the ideas have satisfied a sustainability criteria. The criteria are based on environmental benefit of the project, which comprises the following;

- Level of emission reduction

- Social benefit of the project
- Economic viability
- Cultural implication

When the criteria have been met, the project is validated by an international certification organization after which a Letter of Acceptance (LOA) is issued by a Designated National Authority (DNA), which is the EPA in the case of Ghana. The license makes the project proponent eligible to trade in Carbon credits.

7.2.2 Environmental Protection Agency, Tamale

EPA Tamale has been involved in the Project development from inception and has provided the needed guidance to ensure that all the local laws and customs are duly adhered to. The Tamale office has also played a pivotal role in ensuring that a broad base community consultative approach is adopted to unearth the concerns of the citizenry and also address them in a manner that ensures a win-win scenario for all the stakeholders.

There were recommendations to the effect that BioFuel Africa Ltd should encourage the citizenry to go into cultivation of Jatropha as fire belt around the peripherals of their property, as the belt offers dual benefits of protecting property from fire and strong winds and also generate economic returns from the sale of nuts to the BioFuel Africa Ltd. The official recommended that BioFuel Africa integrate more farmers into the out grower scheme, given that it had the potential to curb north-south migration of young people who are the human resource base of the region.

The siting of a processing plant for extracting crude Jatropha oil was a prior to the Agency. It was recommended that since Tamale metropolis had better infrastructure in terms of roads, water and power supply that the districts, BioFuel Africa should consider siting a processing plant in Tamale in the future as part of the efforts to revitalize the local economy and create jobs for the youth.

Other recommendations during the meeting were;

- Develop community based woodlot to serve as windbreak and sequester carbon
- Allow planting of economic trees in Jatropha plantation blocks
- Incorporate beehives to facilitate pollination and generate extra income from sale of honey
- Train local citizen to produce quality Jatropha seeds for out growers in the region
- Promote cultivation of Jatropha at boundaries of rice farms
- Promote Jatropha cultivation in schools and use as avenue plants

7.2.3 Jaashie Consultative Committee Meeting

At Jaashie the chief and opinion leaders (Photo 6) reiterated some challenges faced in the community. These included perennial water shortages and difficulties encountered in intercropping the dominant crop which is maize with Jatropha. The source of domestic fuel is wood, which are harvested from the immediate environs. There is the likelihood that these fuel woods will be exhausted detriment of the community. Some requests raised at the meeting included the need for a mosque, groundnut-mill and grading of access roads in the community and restocking the health post with drugs.

7.2.4 Tua Consultative Committee Meeting

The participants at the meeting recounted the benefits derived from implementation of the Jade project. These benefits included employment, access to water from dam constructed by BioFuel Africa, provision of groundnut mill, free ploughing of alternative lands for farmers whose lands were taken for plantation development and the construction of a health post to address their health needs.

The concerns raised included the unexpected laying off at work as employees at BioFuel Africa. During such times their economic activities are interrupted and their security becomes affected. They also raised the issue of a school block that was promised them and has still not been constructed.

Representative of BioFuel Africa addresses these issues as follows;

- Laying off of employees

Operations of BioFuel Africa are capital intensive and require regular capital inflow, which should be matched with productive activities at the farm level. However, the seasonality of production makes it necessary to lay off workers especially casual workers during the period of lean or no production and to re-engaged them in the major productive season. This measure ensures that the finances of the company are not unduly stretched given the already huge capital injection into various aspects of the plantation development. BioFuel Africa will therefore ensure that alternative livelihood skills and training is given to casual staff, which will provide an alternative means of income during lean production periods.

- School block

On the subject of the school block, the citizens were expected to locate a land and relay the site details to BioFuel Africa. As at the time of the meeting no details had been presented to the Management of BioFuel Africa for consideration and action. The citizens were encouraged to expedite action on locating a plot for this purpose.

7.2.5 Kpachaa Consultative Committee Meeting

The consultative committee members indicated they had full knowledge of the operations of BioFuel Africa and for that matter the Jade project. They had concerns about the implications of replacing their Shea nut, Neem and Dawadawa trees with Jatropha, especially as the former trees provide food, medicine and fuel wood or charcoal. Potential loss of biodiversity was also a concern.

The representatives of BioFuel Africa responded that as per an agreement with the EPA, some commercial trees will be left undisturbed within the plantations. Secondly, a buffer will be left around the plantations that will provide refuge for the displaced biodiversity.

7.2.6 Central Consultative Committee Members

The Central Consultative Committee is the highest decision making body with 5 member representation from all the communities that are affected by implementation of the Jade project. The membership has 2 females and 3 males from the affected communities. The following concerns were recorded concerns;

- Preservation of water resources
- Loss of economic trees and medicinal plants
- Impact of bush fires

- Potential employment creation
- Relocation of affected farmers to sites further from their residences

These issues are addressed by BioFuel Africa in a number of ways.

Regarding preservation of water quality, BioFuel Africa is committed to ensuring that water resources within the Project Areas are not affected by any activity, from land preparation through pest control by chemicals to harvesting and processing for oil. The commitment is evident in the use of dug-outs for harvesting rain water and underground water resources for irrigation, rather than draw water from surface streams. Farm plots are located further from streams and in addition buffer of undisturbed is maintained to ensure that silt and debris do not get washed into streams.

Some economic trees and medicinal plants within the project area had to be removed to make room for the Jade project. The replacement of these trees/plants then becomes imperative in order to sustain their source of livelihood and traditional medicine. As a principle BioFuel Africa does not fell economic trees or destroy medicinal plants unless all alternatives considered require their removal. Where the trees are felled or medicinal plants are removed, replacement is done by planting similar trees and medicinal plants on plots designated by the communities, who are made responsible to nurture the trees or plants to maturity. This measure ensures that communities continue to derive benefits from trees and medicinal plants of similar species that were felled for project implementation.

The generally long dry spell in the North promotes bush fires. The fires are a threat to agricultural and economic development as they could destroy plantations and property. The fires are usually started by Fulanis, to allow fresh luxuriant grasses to germinate in place of old grasses, as fodder for their cattle. They could also be started by hunters in search of rodents and other wildlife. As part of efforts to curb incidents of bush fires and its attendant destruction, BioFuel Africa, is promoting the cultivation of *Jatropha* as fire belt in the communities. Further to this, the affected communities have provided members who have been trained in fire fighting and positioned to manage any fire condition within the Project Areas. The hunters and Fulanis are also educated on the implications of bush fires to deter them from starting such fires.

Recruitment into the work force of BioFuel Africa is considered important by the citizenry, as it provides income for their upkeep and access to basic needs. BioFuel Africa recognizes this and has therefore employed several workers from the communities, who have been trained in various crafts. The selection criterion does not discriminate. The trained members are both males and females and are trained in machinery operation. This includes tractors and allied farm machinery for land preparation, harvesting and the maintenance of these machines. It is expected that when processing commences the staff shall be trained in mill operation. Out grower schemes in the affected communities is also intended to create jobs. Ultimately, these efforts are expected to collectively address the concerns of unemployment created by the displacement of farmers within the Project Area.

Some farmers have been relocated from their farmlands to make way for the *Jatropha* plantation. The affected farmers have to journey several kilometers to their new plots, a condition some consider unsuitable for their work. In addressing this concern, BioFuel Africa representatives indicated that the affected farmers will be allowed to cultivate staple crops within the *Jatropha* plantation, which has been planted on their previous lands. They will be responsible for controlling the weeds and will be involved in harvesting the nuts for income, when the crops mature. This arrangement is expected to minimize the impacts of the Jade project on restriction of access to lands by the affected farmers in the communities.

The Central Consultative Committees are in agreement with these proposals from BioFuel Africa and are also monitoring its implementation. They also channel grievances from the communities to the Management of the BioFuel Africa. This ensures that concerns of affected communities are known in a

timely manner and practical steps are taken to ensure they are addressed for a mutual beneficial co-existence of all stakeholders in the Jade project.

8.0 CONCLUSION

The Jade project is a large scale Jatropha plantation cultivated by BioFuel Africa Limited, in the Northern and Volta regions of Ghana. The land take in the north for plantation and support infrastructure (farm house, machines and equipment camp) is 23, 762.45 ha. The component in Volta occupies an area of 840 ha, which comprise of a test farm and an oil mill for extracting crude Jatropha oil and support infrastructure.

Clearing such large tracts of land in the North and Volta regions to accommodate the plantation and support infrastructure has potential impacts on the environment. The impacts include loss of vegetation cover and for that matter biodiversity; air quality impacts from increased airborne particulate matter and emissions from engines and fuel powered equipment; water quality impacts from potential accidental discharge of chemicals on land that run-off into water resources and sediments in run-off that may end up in surface water resources. The plantations have altered to a moderate extent, the land use of the area, from mainly food crop production and livestock rearing to a mixed crop of staple and Jatropha. Eventually, the latter may be a mono crop for the areas under cultivation.

The findings from the assessment and audit indicate that BioFuel Africa Limited has complied with the local laws that govern the establishment of plantations of such magnitude. Essentially, the company has satisfied requirements for obtaining the requisite licenses/environmental permits that authorize their operations. Furthermore, the various land planning and customary obligations for leasing lands and operating in the districts have been observed to ensure a mutual co-existence of the project operations and its stakeholders. Proposals and specific arrangements are in place to address impacts on the environment and the affected stakeholders. They include the following;

- Preserving as much as practicable economic trees in areas earmarked for the plantation
- Planting of similar species at designated plots for trees and medicinal plants whose removal were imperative for plantation establishment
- Installing beehives in plantations to promote pollination and provide alternative source of income for the community
- Avoid establishing plantation close to streams
- Avoid land preparation activities during inclement weather conditions
- Ensure the proper management of hydrocarbons and waste generated on site
- Establishment of Community Consultative committees to act as channel of information and feedback for all the stakeholders
- Develop out growers for the plantation who will grow Jatropha on their own plot and sell the nuts on agreed terms to BioFuel Africa
- Use of Jatropha as fire belt to protect live and property and other crop plantations
- Train and provide alternative livelihood skills for affected stakeholders
- Provide some educational infrastructure as part of BioFuel's social responsibility contributions to the communities
- Regularly maintain machinery and operate same in accordance with manufacturers specifications
- Proper management of soils by maintaining top organic layer, careful tillage to control erosion and avoidance of deep ploughing of Project Areas in the North

As these measures are implemented, a feedback mechanism allows the BioFuel Africa to monitor the impact of mitigation measures to ascertain their effectiveness in remedying or reducing impacts and the

necessary modification to address unforeseen impacts. The assessment which also considered impacts for future expansion concludes that previous mitigation measures adopted during the initial plantation establishment should be maintained and where possible improved..

APPENDICES

Appendix 2.1
Environmental Permit for BioFuel Africa Ltd
for the Jade Project

Tel: (021) 664697 / 664698,
662465 / 667524

Fax: 233 (021) 662690

Email: support@epaghana.org



Environmental Protection Agency

P.O. Box M 326
Ministries Post Office
Accra, Ghana

Permit No. CA002080104

ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL PERMIT

ENVIRONMENTAL ASSESSMENT REGULATION, 1999 LI 1652

This is to authorize

BIO-FUEL AFRICA LIMITED

Located in Central Gonja and Yendi Districts (Northern Region)

To commence and pursue operations as per attached schedule

Date Issued: 28th February, 2008



J. A. ALLOTEY
EXECUTIVE DIRECTOR

NB: This Permit is only valid with the Seal of the Environmental Protection Agency

Appendix 3.1

Photos



Photo 1: Jatropa seedlings at Lolito (Test farm)



Photo 2: Matured Jatropa plant at Test farm



Photo 3: Tractor-Mill connection for Oil extraction



Photo 4: Manual dehulling of dried Jatropa nuts



Photo 5: Heap of dried husk (waste) at Lolito



Photo 6: Meeting with Chief, Elders and members at Jaashie

Appendix 4.1 Climatic Data

Table 4.1: Monthly rainfall data for Yendi (1961 - 2005)

Station 08010YDI Yendi (Met)		Monthly Summary of Observations										
Year	Monthly Rainfall Total (mm)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1961	0.0	0.0	15.0	108.5	94.0	216.7	283.5	70.4	264.4	47.5	0.0	0.0
1962	0.0	0.0	53.8	68.1	177.5	226.8	157.0	322.3	272.5	141.7	43.7	6.9
1963	0.0	55.1	41.1	127.3	209.8	156.5	229.6	216.9	274.3	268.7	1.8	0.0
1964	0.0	0.0	78.2	110.7	158.5	78.2	94.2	85.6	274.6	26.9	10.4	4.8
1965	43.7	4.6	55.9	93.2	239.0	331.5	136.9	175.0	186.4	148.8	0.0	0.0
1966	0.0	0.0	40.1	120.9	73.1	167.9	117.6	300.7	292.9	137.4	0.0	0.0
1967	0.0	7.6	61.2	131.3	141.2	147.1	192.8	269.5	219.5	109.0	3.5	23.1
1968	0.0	15.5	91.9	38.3	64.8	235.7	205.5	267.7	218.2	138.7	18.3	0.0
1969	0.0	0.5	119.6	64.5	144.3	152.4	323.6	291.6	349.7	143.8	68.3	0.0
1970	1.0	0.0	2.8	38.1	242.1	129.5	209.0	223.3	566.2	37.3	0.0	0.0
1971	0.0	28.7	212.6	32.0	178.3	172.7	147.8	453.4	232.4	7.9	0.0	51.3
1972	0.0	0.3	80.5	87.4	273.6	152.9	253.5	203.2	128.0	159.8	0.0	7.1
1973	0.0	0.0	49.5	64.0	68.6	104.1	157.0	216.7	275.1	59.7	1.3	0.0
1974	0.0	0.0	62.2	65.8	151.4	239.3	205.7	294.9	257.3	142.2	0.0	0.0
1975	0.0	12.5	83.6	119.9	74.7	100.8	348.2	38.9	297.2	41.7	2.3	0.0
1976	5.6	34.5	1.8	61.7	81.4	270.5	180.3	182.6	193.8	270.3	28.7	0.0
1977	0.0	0.0	1.5	83.6	192.7	119.9	105.4	256.0	289.1	89.9	0.0	106.7
1978	0.0	9.9	70.8	115.1	180.3	148.7	229.8	240.6	215.8	118.3	0.0	1.0
1979	0.0	0.0	65.8	115.4	125.8	233.4	204.1	237.1	221.0	51.8	15.3	0.0
1980	6.8	0.0	38.6	48.9	110.9	83.7	178.2	187.4	187.3	144.6	5.8	0.0
1981	0.0	0.0	36.5	104.7	148.9	153.2	304.0	262.0	228.4	81.8	0.0	0.0
1982	0.0	36.8	79.6	131.8	103.8	61.5	111.3	181.5	260.2	73.8	0.0	0.0
1983	0.0	0.0	2.8	72.6	134.1	159.4	134.6	74.4	139.1	3.1	0.0	46.0
1984	0.0	0.0	40.6	72.7	145.7	181.6	180.9	235.6	176.3	78.6	7.8	0.0
1985	0.0	0.0	97.5	64.9	85.6	161.3	232.5	271.4	198.5	90.2	28.4	0.0
1986	0.0	0.4	26.1	68.5	50.0	196.6	220.2	177.2	235.5	147.3	15.5	0.0
1987	1.2	0.0	48.4	8.1	101.5	126.3	234.4	216.8	181.8	96.1	0.0	0.2
1988	0.0	9.1	7.0	53.3	120.8	162.8	145.6	247.6	192.9	107.6	3.9	0.2
1989	0.0	0.0	201.4	13.9	85.0	229.2	240.8	303.0	518.3	120.4	0.0	0.0
1990	0.0	0.7	0.0	40.9	47.3	179.5	197.1	174.8	183.6	91.6	0.0	23.8
1991	0.0	0.3	162.5	87.6	194.3	196.4	187.6	299.7	202.0	157.2	0.0	0.0
1992	0.0	0.0	36.7	61.1	103.2	120.8	206.3	67.5	227.6	74.6	19.8	0.0
1993	0.0	TR	23.9	104.3	142.2	139.0	152.2	346.7	184.5	74.1	5.1	0.0
1994	0.0	0.0	10.2	45.2	135.4	185.9	124.1	195.2	345.3	135.5	0.5	0.0
1995	0.0	0.0	67.8	53.6	151.6	101.8	183.5	394.2	190.4	131.5	5.6	TR
1996	0.0	3.3	1.5	60.8	87.6	287.6	124.1	227.0	251.7	72.1	0.0	0.0
1997	23.4	0.0	13.8	134.4	156.3	201.4	157.8	151.1	313.9	104.9	45.6	0.0
1998	0.0	1.2	0.1	86.4	177.1	238.2	62.7	212.8	355.0	38.9	0.0	1.4
1999	45.6	16.8	10.0	62.8	83.2	157.7	116.1	174.7	205.5	196.8	0.0	0.0
2000	5.6	0.0	14.5	105.2	101.2	139.4	125.2	376.3	299.6	95.4	0.0	0.0
2001	0.0	0.0	tr	59.2	144.7	151.4	130.2	254.6	276.6	35.9	0.0	0.0
2002	0.0	0.0	53.8	90.9	105.8	156.2	222.8	212.2	160.7	62.4	2.6	0.0
2003	0.0	15.6	30.9	62.3	20.3	76.4	67.8	59.1	71.3	98.3	2.4	0.0
2004	30.0	0.2	49.8	134.6	116.1	193.9	245.3	395.4	284.2	32.3	51.5	0.0
2005	5.7	28.1	19.4	142.0	129.4	219.6	246.1	114.7	300.0	120.0	0.0	0.0
2006												
Mean	3.7	6.0	52.7	77.7	130.4	168.2	181.9	224.4	246.8	103.6	7.8	6.5

Source: EIS 2008

Table 4.2: Monthly rainfall data for Sogakope (1990-2007)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1990	30.1	37.8	27.1	231.9	–	172.0	76.2	0.0	65.5	39.3	40.2	132.5
1991	–	14.2	–	261.5	–	53.5	294.9	0.0	–	–	–	–
1992	0.0	0.0	59.7	–	196.9	25.8	–	0.0	53.3	52.2	60.2	10.6
1993	0.0	0.0	28.4	78.0	55.7	141.1	38.8	29.8	98.	63.5	41.4	14.8
1994	22.5	8.5	77.0	12.4	142.3	51.4	16.9	0.0	82.3	94.5	132.2	0.0
1995	0.0	0.0	–	–	–	145.6	73.5	–	–	–	–	0.0
1996	–	–	–	–	–	–	84.0	–	–	–	–	–
1997	–	–	–	–	–	320.9	56.6	6.5	18.2	167.4	80.1	15.5
1999	–	–	38.7	37.3	172.8	250.9	39.7	17.4	106.4	30.2	51.9	40.5
2000	0.0	0.0	24.2	134.2	121.7	68.2	26.2	16.5	37.4	93.5	64.9	9.1
2001	0.0	0.0	44.6	113.6	203.9	272.4	21.6	0.0	65.6	59.1	87.5	2.2
2002	24.1	22.6	46.5	111.5	73.8	297.4	22.2	2.5	43.1	132.0	127.9	0.0
2003	72.0	0.0	52.8	237.4	58.1	250.6	13.9	0.0	36.3	208.0	160.2	10.5
2006	0.0	26.9	77.7	21.5	183.4	175.8	16.8	1.8	165.9	83.5	32.2	0.0
2007	0.0	0.0	37.4	113.8	110.6	218.6	74.8	16.8	96.7	82.4	4.6	20.0

Source: EIS, 2008

Appendix 4.2

Soil Characteristics of Project Areas

Appendix 4.3
Water Quality Results at Project Areas