Sectoral Environmental Impact Assessment
Past, Present And Future Sand and Loam Mining
In The Soesdyke – Linden Highway Area, Guyana

March 30, 2001

SECTORAL ENVIRONMENTAL IMPACT ASSESSMENT

PAST, PRESENT AND FUTURE SAND AND LOAM MINING

IN THE SOESDYKE – LINDEN HIGHWAY AREA, GUYANA

PREPARED BY

PATICIPANTS IN THE GENCAPD MINING PROJECT
ADVANCED PRATICAL EIA TRAINING PROGRAM

March 30, 2001

EXECUTIVE SUMMARY

Introduction

This report provides an Environmental Impact Assessment (EIA) of past, present and future sand and loam mining in the Soesdyke-Linden Highway/Timehri area near Georgetown. As such, the EIA is a strategic environmental assessment, specifically a "sectoral assessment", as described by the World Bank Group. By evaluating the effects of past and present sand and loam mining, the EIA has developed a future regulatory regime and mining practices that will promote sustainable development in the industry. This report has been prepared by participants in an Advanced Practical EIA Training Program as part of the Guyana Environmental Capacity Development (GENCAPD)—Mining Program. Although this EIA is the result of a substantive effort and professional analysis, a number of shortcuts and liberties were taken in light of the training context, experience of the participants, and time and resources available. Notwithstanding that, care was taken to acknowledge the limitations of the analysis and it is the view of the trainer, an experienced EIA practitioner, that the conclusions of the environmental assessment are well reasoned and largely supportable.

Project Description—Past and Present Sand and Loam Mining

The EIA describes past and present sand and loam mining in considerable detail, including the regulatory framework in place, as applicable. Nine past mines were identified and eleven active mines were described in some detail based on field reconnaissance and available data. The transportation to market was characterized noting that an average of about 500 truck loads per day follow the East Bank Demerara Highway into the Georgetown area, with as many as 900 in peak times.

An economic evaluation of sand and loam mining indicates that it is of considerable importance to the economy of the Greater Georgetown area and is an important employer. The sand and loam resource is of vital importance for the construction industry given that the closest reserves to Georgetown are at least 43 km away. It is estimated that 88 percent of the cost of sand and loam delivered in Georgetown is attributable to the cost of transportation alone, with 12 percent only being attributable to the cost of mining and royalties.

It has been concluded that past and present sand and loam mines have a number of environmental emissions, discharges, reclamation, monitoring, erosion and other environmental issues. Generally, both current and past activities have involved mining with little regard for protection of the environment, worker and public safety, or on traffic and the transportation network.

Impact Assessment—Past and Present Sand and Loam Mining

The analysis of impacts was facilitated through scoping of the interaction of the project (both mining and potential accidents, malfunctions and unplanned events) with the environment and identifying the potential environmental effects. A rigorous environmental assessment method was employed including the consideration of the cumulative impacts of sand and loam mining in combination with other land uses in the mining area. Thresholds of significance are carefully developed and defined to characterize levels of impacts that are considered unacceptable to society in Guyana. The potential environmental effects identified are:

- Change in water quantity;
- Change in water quality;
- Habitat loss;
- Habitat avoidance;
- Change in bio-diversity;
- Habitat fragmentation;
- Direct mortality (fauna);
- Change in traffic;
- Injury, illness, and loss of life;
- Deterioration of infrastructure;
- Payment of royalties;
- Employment;
- Business revenue;
- Foreign trade/export;
- Alienation of adjacent land use;
- Limitation of future land use (mine site); and
- Loss of sand/loam resources.

A number of other projects and activities were identified to have overlapping cumulative environmental impacts with those of the project on the environment. This includes:

- Residential land use;
- Transportation network;
- Recreational land use;
- Tourism land use;
- Commercial land use;
- Forest resources harvesting; and
- Agriculture.

It was determined that the above impacts, including cumulative impacts, were in a substantive way manifested on six Valued Environmental Components. The environmental impact assessment has been focussed on these Valued Environmental Components:

- Water resources;
- Transportation;
- Flora and fauna;
- Economy;
- Land use; and
- Public health and safety.

It has been concluded that mining activities result in significant environmental impacts on all of the above Valued Environmental Components, with the exception of Economy, for which a positive environmental impact is predicted, notwithstanding significant impacts attributable to accidents that lessen the magnitude of those positive impacts. As a result overall, sand and loam mining are not being undertaken in a manner consistent with the principles of sustainable development.

Water Resources

The white sand area in which sand and loam resources are found is the recharge area of and, has hydraulic connection to, the aquifers that feed the Georgetown municipal water supply. Groundwater recharge and stream flow in the mining areas is important to the regional hydrology. Mining activities such as clearing, excavation, and hazardous materials use, and accidents such as hazardous materials spills and illegal dumping act cumulatively in combination with other land uses to cause significant adverse impacts on water resources. Little or no mitigation of these impacts is occurring and the impacts are largely unchecked.

Transportation

Transportation of sand and loam to market is resulting in increased traffic, deterioration of infrastructure and unacceptable levels of accidents. Trucking exacerbates an already stressed transportation network. Sand and loam trucking, in combination with other transportation, is resulting in significant adverse environmental impacts on transportation. These impacts are mitigated somewhat by scheduling of trucking to avoid off-peak traffic hours, but this does not greatly mitigate the overall impact.

Flora and Fauna

Mining and related accidents, in combination with other land uses in the area are resulting in substantial loss, avoidance and fragmentation of habitat, decline in bio-diversity, and direct mortality on the flora and fauna of the area. These impacts are largely un-mitigated. Particularly notable are the absence of mine planning, progressive mining and reclamation, and safe practices. It is concluded that sand and loam mining, in combination with other adjacent land uses, are resulting in significant adverse cumulative environmental impacts on flora and fauna.

Economy

The activity of mining and related revenue and employment are all resulting in positive impacts on economy. However vehicle, worker and public accidents tend to lessen the potential magnitude of the positive impact of mining. Overall, the environmental impact of sand and loam mining is considered positive.

Land Use

A combination of sand and loam mining activities are negatively impinging upon adjacent land uses due to their incompatibility. Poor or non-existent reclamation practices are precluding or limiting some potential future land uses at exhausted mine sites. The location of certain land uses in the white sand area (e.g., residential, eco-tourism, recreational) are alienating valuable sand and loam resources either by their presence or due to regulatory restrictions prohibiting mining in certain areas in the interest of protection of those other land uses. Overall, due to the lack of a coordinated land use planning effort and poor mining practices, sand and loam mining and other land uses are resulting in significant adverse cumulative environmental impacts.

Public Health and Safety

A combination of un-safe mining practices including the lack of protective equipment, high mining faces, lack of training, for example, in combination with illegal dumping, forest fires and standing water (mining below water table), are resulting in significant adverse cumulative environmental impacts on public health and safety. Little or no mitigation is in place.

Project Description—Future Sand and Loam Mining

Based on the obvious and wide ranging significant adverse environmental impacts, the authors developed an ideal future mining scenario that factors in a wide range of mitigation strategies to lessen those impacts to non-significant or acceptable levels.

Reflecting the importance of the sand and loam resources and to assure a long-term supply, a demand and reserve analysis and scenario was developed to meet the needs of the Greater Georgetown area for the next 50 years. It was determined that although reserves are greater than the long term need, current land uses and the lack of protected sand and loam reserves indicate that there is a need to protect areas for future mining. As well, other land uses are impinging upon access to these important reserves. It was estimated that over 188 million tons of sand and some 15 million cubic yards of loam are needed in the next 50 years. It was estimated that 2,620 hectares (26 km^2) would be needed for sand mining and 385 hectares for loam mining in the next 50 years. Based on available mapping, the report identifies 1,680 hectares of sand mining area and 154 hectares of loam mining area as a potential area for future reserve. While this would not meet the predicted needs of the 50-year scenario, it is certainly a positive indication of at least accessible reserves in the immediate and mid-term future. However, if other land uses impinge on that reserve, shortfalls in affordable sand reserves may become problematic well before the end of the 50-year planning horizon.

In future the ideal sand or loam pit will implement a number of important practices and procedures. Included in this would be the adoption of mining plans. Integral to these would be progressive mining and reclamation. The regulatory regime would be devised to support these practices. Regulations would require mitigation measures and Environmental Codes of Practice and/or Environmental Management Plans and Mining Plans will be needed. Future mines will be operated in an environmentally sound manner that includes preservation and re-use of topsoil, safe mining practices and efficient production. Hazardous material use and storage would be well controlled. The report outlines detailed suggestions for improving mining practices to mitigate current significant adverse environmental impacts and also to maximize positive impacts on the economy. Together, these measures would result in sustainable development in the sand and loam mining industry of the future.

Impact Assessment—Future Sand and Loam Mining

Applying the mitigation in the future mining scenario, it is predicted that all current significant environmental impacts will be reduced to non-significant levels. Positive impacts on economy will be maximized and significant impacts attributable to accidents will be mitigated through various improvements in public health and safety, and through the elimination of costly environmental accidents, malfunctions and unplanned events, and improved mining efficiency.

These conclusions assume a wide range of changes in mining practices, regulatory change, and regional land use planning. Without these, the security of sand and loam supplies is in question in the longer term and the significant adverse environmental impacts of current and past mining will persist.

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PREFACE

This report was prepared under the joint efforts of the participants in the Advanced Practical Environmental Impact Assessment Training course. This work was facilitated by the trainer, Mr. Jeffrey L. Barnes of Jacques Whitford Environment Limited. The participants contributed by participation in group activities, planning, fieldwork, research, and writing. The level of participation varied but all of the participants contributed substantially to the environmental assessment. The participants were:

Environmental Protection Agency
Fianna Holder Khalid Alladin
Guyana Geology and Mines Commission
Karen Livan Eulene Watson Carlos Todd Zaeran Ramotar Wendell Alleyne Dianne McDonald Derek Babb Rickford Vieira Ronald Glasgow Peter Hutson Aubrey Sargeant Anthony Paul Gordon Nestor Balwant K. Arjune Martin Leich Kerion Husbands Aretha Crawford
University of Guyana
John V. Loncke

1.0 INTRODUCTION

This report provides an Environmental Impact Assessment of past, present and future sand and loam mining in the Soesdyke-Linden Highway/Timehri area near Georgetown. This report has been prepared by participants in an Advanced Practical EIA Training Program as part of the Guyana Environmental Capacity Development (GENCAPD)—Mining Program. The training program was held between February 26 and March 30, 2001 in Georgetown, Guyana.

The purposes of the Advanced Practical EIA Training was to provide an opportunity for participants to build on the skills learned in the Introductory and Advanced EIA Training Programs held in March 2000 and re-offered in February 2001 (Introductory only). The objective of the training included to:

- Provide advanced practical training in EIA through preparation of a Strategic Environmental Assessment ("SEA") on sand and loam mining in Timehri/Soesdyke-Linden Highway area;
- Build practical skills in EIA;
- Build practical skills in Strategic Environmental Assessment;
- Evaluate the environmental impacts of past, present and future sand and loam mining; and
- Develop technical and regulatory strategy for the management of sand and loam mining.

1.1 Training Approach

This Advanced Practical EIA Training Program involved participants applying their previous GENCAPD Mining EIA and other training in the preparation of an actual environmental impact assessment study. The study is a "sectoral assessment" that investigates the environmental impacts of past, present, and future sand and loam mining in the vicinity of Timehri/Soesdyke. Unlike previous EIA training, there was no training manual per se. Using the previous training materials, available resources, interviews with knowledgeable persons and stakeholders, and field reconnaissance, the participants prepared this EIA Study Report. This was a group exercise in which the participants worked as a large team, and also in small groups and independently to conduct various aspects of the environmental assessment, including writing of the final report. The trainer, Mr. Jeffrey Barnes of Jacques Whitford Environment Limited, facilitated the work and provided technical support and advice to the participants. Mr. Barnes edited the report and wrote Section 1.0 and the summaries of Sections 4.0 and 6.0. He also provided some review of critical aspects of previous training, during the course of the work.

1.2 Participation

Participants were expected to be involved every day of scheduled training in Phase 1 and 3 as per the schedule provided in Table 1.1. The phases involved meetings, classroom work, field reconnaissance, writing, research, and interview of other knowledgeable persons. During Phase 2, individuals and small teams were expected to conduct certain research and writing assignments as assigned by the group. Participants were offered the opportunity to co-author a portion of the project description and assisted in the preparation of the impact assessment of at least one of the six Valued Environmental Components selected as the focus of the study.

Table 1.1 outlines the work schedule followed. There were some modifications in the schedule. In particular. Phase 3 tended to be focussed on report writing, editing, and iteration with several participants working in their offices. Training was conducted at the Oceanview International Hotel in Georgetown. Several aspects of the training involved concurrent work assignments.

Table 1.1 Schedule of Advanced Practical EIA Training, 2001

Phase 1 **Scoping and Environmental Effects Assessment**	
February 26	• Welcome and Introduction • Develop Goals and Objective of Sectoral EIA • Preliminary Issues Scoping • Defining the Scope of the Project • Defining the Scope of the Assessment • Study Strategy
February 27	• Field Reconnaissance—Timehri/Soesdyke
February 28	• Developing Project Description
March 1	• Scoping and Developing Terms of Reference
March 2	• Preparing the Description of the Existing Environment
March 6	• Analysis of Environmental Effects
March 7	• Analysis of Environmental Effects
Phase 2 **Independent and Team Research and Writing Assignments**	
March 8-25	• Independent and Team Working Assignments
Phase 3 **Environmental Management Strategies and Reporting**	
March 26	• Developing Mitigation Strategies for Ongoing and Future Mining
March 27	• Developing Monitoring Strategies
March 28	• Preparing Final Report
March 29	• Report
March 30	• Report

1.3 Statement of Limitations

This environmental assessment was prepared as a training exercise as described in Section 1.1. The participants were learning how to apply their previous training in a “real” environmental assessment. Although this environmental assessment is the result of a substantive and valid analysis of past, present and future sand and loam mining, the report has taken a number of shortcuts and liberties due to the limited time and resources available for the exercise. In particular, the following limitations are acknowledged:

- There is a lack of proper referencing to some of the materials cited or used as reference material;
- The participants are inexperienced in environmental assessment and did not necessarily have the professional training in the assigned areas of authorship;
- Research and report production was limited by the time and resources available;
- The report has received only limited editing by the trainer in an attempt to standardize and format the document, and to correct obvious errors and omissions (the work remains the substantive effort of the participants); and
- The assessment involved only some basic field research and some reconnaissance by the team members.

Notwithstanding this, the analysis and results of this environmental assessment represent a very substantive effort by 21 professionals under the guidance of an experienced environmental assessment practitioner. It is estimated that approximately 300 person-days of effort were applied to the preparation of this report. The conclusions of the environmental assessment are, with the above limitations acknowledged, considered to be valid. As well, the technical limitations of the environmental assessment are well documented in the environmental assessment (Section 4.0).

1.4 Organization of the Report

Following this introduction, Section 2.0 provides a description of past and present sand and loam mining. Section 3.0 presents the issues scoping analysis results and the Valued Environmental Components selected to focus the environmental assessment. Section 4.0 provides the impact assessment analysis of past and present mining. Based on the conclusions of that assessment, Section 5.0 provides a description of the future mining scenario, wherein mitigation strategies are implemented. Section 6.0 provides the impact assessment of the future mining scenario.

2.0 PROJECT DESCRIPTION OF PAST AND PRESENT SAND AND LOAM MINES

This chapter provides a project description of past and present sand and loam mining in the Timehri/Soesdyke/Linden area. This project description is used as the basis for the EIA conducted in Chapter 4 of this EIA.

2.1 Past Sand and Loam Mines

This section describes past sand and loam mines within the Timehri /Soesdyke/Linden Highway and encompassing the area bounded by the Linden/Soesdyke Highway, the Yarrowkabra Road and the East Bank Highway. A “Past Mine” is considered as one that has not been in operation after the 1st of January 1998. All known abandoned sand and loam pits (mines) are considered. It is understood that there may have been additional abandoned pits that have either been converted to other uses or secondary growth has taken it over so that it is unrecognizable as an abandoned pit. From readings and research, pits have been in existence in this area since at least 1945. However this chapter will only look at the known abandoned pits as described below.

2.1.1 Description of Past Mines

“Past Mines” are those that were abandoned at least three years ago. In most cases there was no evidence of mine planning although there is on record a format for application that suggested that this was supposed to be done. The earlier pits (those mined more then ten years ago) were mined haphazardly and in a few cases randomly, leaving rugged terrain and steep slopes, that dominate the abandoned mined-out areas. The later pits (those mined less than ten years ago but more than three years) tended to be more systematically mined. Some amount of topsoil was stockpiled but this was poorly done and stored in such a manner as to contaminate the remaining reserves and render them unusable for future use. In some cases topsoil was forced into the natural vegetation, making it both difficult and expensive to reclaim. The soil is varied in colour, particle size and composition, mainly being white sand. In some areas the soil is orange-cream coloured sand with bodies of almost horizontally layered silt/clay beds that are whitish/grey in colour.

The earlier mines used hand shovels and tractors to move the sand while the later ones used trucks and front-end loaders to mine the sand. All pits were open-faced.

2.1.2 Ownership

Table 2.1 provides the ownership and a description of the past sand mines considered in this EIA. Mapping was not available and could not be provided within the context of this EIA.

Table 2.1 Past Sand Mine Ownership and Description

Name of Owner	Address of land	Size and Volume	Date of Lease	Land/Description
Bhagwin Sagar	Block A, Soesdyke.	213,000 m^2 1,278,900 m^3	Transported Land.	Transported originally belonging to Leacock presumably sold to Sagar/Walton who has subsequently sold to Astroarts – Fernandes.
Udhoo Raghoo	Lot 79, Waiakabra, Soesdyke/Linden Highway	196,725 m^2 1,491,175 m^3	Transported Land. Made application to remove and sell sand on 22nd, June 1993. Closed pit in 1996.	On a plot of land 19.03 acres as defined by Plan #16933 and surveyed by A. Mohabal and P.T. Fung. Govt. Land Surveyors on 10-4-1976.
Maurice/Viola Dos Santos	Lot 234, Soesdyke, East Bank Demerara		Transported. Started operations in 1995, have not worked for the past three years.	
Gafsons Industries Ltd - Gafoors	Swan Road Soesdyke/Linden Highway		State Land Applied for permission to remove sand on 25-11-91. Permission granted on 3-12-91. On the 16-02-99 the company wrote GGMC stating that the land was not used for the last three years and ask to give up their rights.	10 acres on the northern side of Swan Road, 500' east of Linden Highway. The sand was to be used to build a factory for the said company but the sand was instead sold to truck drivers. Removed approximately 115,610 tons of sand.
Dereck Jaundoo	Soesdyke/Linden Highway	36,570 m^2 144,220 m^3	Transported.	
Kampta Bahadur	Dakara, Timehri		State Land.	Loam pit
Sales Research and Marketing Industries Ltd.	Yarrowkabra Linden/Soesdyke Highway		State Land Granted a provisional Lease on 08-06-88 effective forms the 01-06-89.	Twenty (20) acres at Yarrowkabra on the western side of the Linden/Soesdyke Highway west of an access road called Berbice Road and being immediately north of the glass factory compound. This was issued under the State Land regulation of the State Land Act.
Civil Aviation Department /Egdeworth Prism International Company	Land aback of South Dakota Circuit		State Land. September 1988 CAD sought permission to remove sand from an area 200' X 100'.	Sand being removed for Airstrip Runaway Rehabilitation Project. The Sand was used for filler purposes 1.227 acres removing 6,000cubic yards (9,000 tons).
Denis Rambarran	North of Yarrowkabra Creek	29,700 m^2 419,958 m^3	State Land.	150 acres granted; small quantity mined by Dipcon.
NH International Limited	Timehri Back Road		State Land.	In operation during 1995/96. No permission was sought or granted for its existence the sand use to repair the East Bank Public Road.

2.1.3 Regulatory Framework

2.1.3.1 State Lands Act

Up to 1988 the Ministry of Agriculture granted permission through a provisional lease issued under Regulation 7(1), (2) and (3) of the State Lands Regulation of the State Lands Act Chapter 62:01 as follows.

Regulation Section 7

(1) *Where the Commissioner has reason to believe that the rights of any other person will not be affected by any application for a grant, lease, license or permission, he may grand leave to the applicant to take possession at once and for work to commence on the land applied for, and for the removal of any substance or thing therefrom, on his giving such security (if any) as the Commissioner may deem necessary to insure the Government against loss in the event of no grant, lease, licence, or permission being issued.*

(2) *Any lease so granted shall be at the risk of the applicant where, as a result of opposition or for any other reason, no grant, lease, or permission is issued.*

(3) *The grant, lease, licence or permission if issued, shall be deemed to have commenced from the date of the granting of the lease.*

Sections 80-82

80 *Any person desirous of obtaining sand, shell, or caddy from the state land, shall be at liberty to do so without first obtaining a licence for the tract whereon such sand, shell or caddy is lying provided that he obtains from an officer of the Department a permit stating the weight or quantity of such sand, shell, or caddy, to be removed, the place from whence it is to be taken, the mode of its removal, and its ultimate destination.*

81 *Except in the case of a permit issued to any officer of the Government for the removal of sand, shell, or caddy for the Public Service. The person obtaining a permit shall, at the time of receiving it pay royalty on the quantity of the sand, shell, or caddy mentioned in it.*

82 *A permit granted to any other person shall only be available for six (6) weeks from the date of its issue.*

The President could have refused under Regulation 90 of the States Land Act to issue a lease without giving a reason for doing so.

2.1.3.2 Mining Act

After 1988 the Legislation in place was the Mining Act, No. 20 of 1989, and its supporting Regulations.

Section 2(d) states, *"quarriable material shall be deemed to be a reference to*

(i) *rock, laterite, sand or gravel, or kaolin or other clays; or*
(ii) *any other mineral specified by notification in the Gazette by the Commission, with the approval of the Minister, as a quarriable mineral."*

Section 14(1)(b) stated that *"no person shall quarry any quarriable mineral in any land in Guyana except*

(i) *under and in accordance with a quarry permit granted under this Act; or*
(ii) *under and in accordance with a licence issued under the State Lands Act before the commencement of this Act and subsisting on such commencement: provided that a person may search or mine for minerals, or quarry any quarriable mineral in any land in Guyana, as an agent for the Commission action in discharge of its functions under section 4 of the Guyana Geology and Mines Commission Act 1979, without any licence or permit referred to above.?*

The application form is provided in Table 2.2. There were no requirements for environment related information.

Table 2.2 Application For Licence/Permission To Remove Sand, Stone, Clay, Etc.

Please print.

1. Name, in full, of Applicant
2. Nationality of Applicant
3. Registered Address
4. (a) Name of person, body of persons, partnership or Company on whose behalf application is made.
   (b) Nationality of person or Persons referred to at (a)
   (c) Particulars of registration of company, partnership etc.
   (d) Nationality of names of Directors of Company or Members of Partnerships
5. Position of appointment held by applicant in relation to or under such company, partner ship or body of persons. See “A” attached.
6. Purpose for which Licence / Permission is required.
7. Number of years for which Licence / Permission is required
8. Description of area required See “B” attached
9. Amount
   (a) of nominal capital subscribed
   (b) of cash working capital.
   (c) to be spent during the first year.
10. Bankers or other financial Guarantees.
11. Particulars of technical staff to be engaged.
12. Proposed Work Program and exploration methods See “C” attached.

Signature of Persons:

Date:

2.2 Existing Sand and Loam Mines

Most Pits are naturally reclaimed with shrubs, grasses and a few trees which varied with respect to the percentage of vegetation covered from pit to pit (fatpoke, bamboo, jamoon, hicha among several other species). Some of the side slopes of past pits have been softened due to erosion and slumping. However, vegetation remains sparse in the pits abandoned over ten years consisting of less then fifteen plant species and just about twenty percent trees, few shrubs, some mosses and fern and mainly low grasses. In the just abandoned pits there was evidence that at least one miner attempted to re-vegetate by planting coconuts and other crops. Fish farming was also practice at one mine after mining had reached the water table. It is also understood that one mine is currently being developed to be used as a housing scheme.

2.2.1 Present Regulatory Framework

The Mining Act # 20 of 1989 and Regulations govern the mining of sand and loam in Guyana. It is also governed by the Environmental Protection Act of 1996 (see also Section 2.1.3.1).

Before undertaking sand or loam mining, a license or permit is required under the Mining Act. However, under the Environmental Protection Act, an Environmental Permit is required before a mining license or permit can be granted. Operators now have to interface with the Environmental Protection Agency (EPA) and The Guyana Geology and Mines Commission (GGMC) authorities and this presents some amount of concern to them.

2.2.1.1 The Mining Act and Regulations

The Mining Act provides the umbrella framework to facilitate the various types of Mining activities in Guyana while the Regulations are intended to address specific types of operation, e.g., gold and sand mining, and stone quarrying. GGMC administers the Act and Regulations.

The focus of Mining activities in the past was on gold and to a lesser extent diamonds (with the exception of bauxite). As a result the Mining Act prior to 1989 was crafted to reflect the promotion and regulation of these activities.

The 1989 Act made provision for the promotion and development of activities such as quarrying of sand, loam and stone. However, Regulations have not yet been developed under the 1989 Act. The current situation is therefore one in which the revised Mining Act of 1989 is being administered through regulations that predate and are to some extent inconsistent or incompatible with it.

This has lead, in some cases, to difficulties in the regulation of mining activities such as sand and loam pit operations.

However, notwithstanding these difficulties efforts are made to address issues under the existing provisions.

Licenses—Large Scale

Licenses for sand and loam pit operations are granted under Section 10 of the Mining Act since these are deemed as quarriable minerals While this section provides the broad outline for granting a quarry license, detailed regulations for administering these operations do not exist. Licenses are granted to large-scale operations, but none have been granted to date in the project area. Currently, the GGMC considers and sand or loam pit with a proposed area of mining in excess of 60 acres to be a large scale mine.

Permits—Medium and Small Scale

While Section 10 of the Mining Act does not provide for the issuing of quarry permits which would be applicable to sand and loam, Section 7 – 8 provides for the general granting of licenses and permits.

Permits are usually granted to small and medium scale sand and loam mines such as many of those operating within the project area. Currently these operators conduct their operation under either a temporary permit or a mining permit.

Temporary Permits

Temporary Permits are normally issued at the commencement of mining under Section 14 (1) of the Mining Act on a monthly basis for the removal of specific quantities of sand or loam. The applicant has to pay the amount of royalty prior to the issuing of the permit. This was intended to be an interim measure prior to the issuing of mining permit to regulate the operation.

To date many operators still carry out their operation with a temporary permit while their mining permits are being processed.

Mining Permits

There are currently four mining permits in effect in the project area. Mining permits typically have conditions pertaining to environmental, royalties, reporting, record-keeping and related matters.

2.2.1.2 Environmental Protection Act

Under the Environmental Protection Act, sand and loam mines require an Environmental Authorization. As a part of this process, an EIA may be required before the Environmental Authorization can be granted. To date, two EIA studies have been completed for sand mines. A number of Environmental Authorizations have been issued.

On-going discussions between the EPA and GGMC are leading towards a revised policy wherein sand and loam mines less than 60 acres would not require an Environmental Authorization. However, the GGMC issues a mining permit and it is expected that the draft Code of Practice for sand and loam mining (prepared by EPA and GGMC) apply.

2.2.1.3 Enforcement

The responsibility for monitoring and enforcement activities is divided between the Mines Division and Environmental Division of GGMC and the EPA. The Mines Division derives authority to monitor and enforce under the Mining Act and Regulations, while the Environmental Division operates under a Memorandum of Understanding (MOU) with the EPA.

This MOU does not give the Environmental Division officers the authority to take action but rather only to report to the EPA.

Hence , monitoring and enforcement is the responsibility of Mines Division and the EPA.

The Mines Division conducts quarterly inspections of sand and loam pit operations.

The EPA does not conduct regular monitoring of sand and loam mining. They do however undertake inspections in response to particular issues or requests.

2.2.2 Description of Existing Sand/Loam Mines

2.2.2.1 Existing Mines

Sand and Loam Mining are currently being conducted in areas along the Soesdyke-Linden Highway and the East Bank-Timheri Public Road. There are eleven existing sand/loam mines; seven of the mines can be easily accessed via the highway, while the others are located at some distances off the East Bank-Timheri Public Road and closer to the Timehri International Airport. The mines are privately owned and operated, with the exception of one of the two loam mines, which is operated by the Government (Regional Democratic Council # 4). The sand/loam mines that were inspected and the status at the time of inspection are as follows.

Table 2.3 Operating Sand and Loam Mines

Mines	Status
Rory Walker	Active
Chindnandan Persaud	Active
Udho Raghoo	Inactive
William Dalgety/Neel Persaud	Active
Ronald Arjune	Active
Physy Rahaman	Inactive
Dennis Rambarran	Inactive
Sat Narine	Inactive
Robert Kallicharan	Inactive
Mahdodri	Active
B&B Ramsaroop	Active
Regional Democratic Council # 4	Active

The existing sand/loam mines in Table 2.3 include those mines that have a mining permit (including temporary) or have reserves remaining (from previous mining), but may not necessarily be currently active. The land used for sand and loam mining are owned by the Government, with the exception of those lands held by Mahdodri and Kallicharan, which are transported. The lands owned by the Government are leased to various individuals for specific purposes. Most of these lands were primarily leased for agricultural purposes (especially for farming). However, since the lands have proven to be very much infertile (due to lack of an abundance of topsoil material, low fertility and/or excessive drainage), applications were made for change in land use to facilitate sand/loam mining. This was done through the Lands and Surveys Department, Ministry of Agriculture. The leases are usually granted for a period of 25 years.

The area surrounding the sand/loam mines has various other land uses, some of which are relatively close and adjacent to mining activities. These land uses include, but are not limited to, eco-tourism resorts and recreational activities (e.g., firing range, motor racing), residential and agricultural activities (poultry rearing and animal husbandry), airport, fire station, and a prison.

The sand and loam belts are within the drainage area of the Madewini River which discharges directly into the Demerara River. The tributaries of this river that are located close to the mining are the Madewini, Waiakabra, Marudi, Yarrowkabra and Dakara Creeks. The loam mining area is drained via the Dakara Creek.

Due to land use conflict with recreational and tourism land use, a decision has recently been made by the National Land Use Committee to prohibit any new mining in the area between Swan Road and Smart Road to Marudi Creek.

There are two major settlements along the highway in proximity to and bordering the mines. There are the Kuru Kururu and the Yarrowkabra settlements. These settlements are designated for residential and commercial lots and for civic purposes (e.g., school, health centre, church, etc.).

All of the mines have one access road to their mining pits with a checker's booth located at a strategic point to control and monitor vehicle entry/exist to and from the mining pit. The distance of the mine haulage roads from the mining face range from 120 m to 1,770 m. The longest haulage road is that of Mahadodri (1,770 m), with the shortest being Rory Walker (120 m). In most cases the stripping and mining limits have extended within the area of the highway reserve (i.e., closer than 200 m from the road shoulders).

Table 2.4 provides information on the existing mines inspected by the study team in March 2001 that are currently licensed and in operation.

Table 2.4 Information on Existing Sand and Loam Mines

Block No.	**Operator**	**Location**	**Property Size (acres)**	**Material**
GS 23/2	Udho Raghoo	North of Madewini Creek between Smart and Swan Roads.	46	Sand
A-1/MP/000	Ronald Arjune	Waiakabra, Soesdyke	8.91	Sand
D-4/MP/000	William Dalgety	Waiakabra, Soesdyke	30.873	Sand
W-1/MP/000	Rory Walker	Waiakabra Creek	30.70	Sand
GS 23/3	Physy Rahaman	North of Yarrowkabra Creek	74	Sand
GS 23/5	Sat Narine	North of Yarrowkabra Creek	160	Sand
R-6/MP/000	Dennis Rambaran	North of Yarrowkabra Creek	150	Sand
P-4/MP/000	Wolton Perreira	Opposite Ideal Road	298	Sand
G-1/MP/000	E. Giddings	North of Madewini Creek between Smart and Swan Roads	Not known	Sand
R-3/MP/000	B &B. Ramsaroop	Ideal Road, Waiakabra	9	Loam
R-7/MP/000	R.D.C # 4	Dakaura Creek	181	Loam

Table 2.5 provides date on the size of mines, volume mined and reserves. The data are not complete.

Table 2.5 Summary Description of Existing Sand and Loam Mines (Estimated using GPS)

Owner's/ Operator's name	Size of property (acres)	Average depth of mining (m)	Area mined (m^2)	Volume mined (m^3)	Material mined ('000 tonnes)	Reserve remaining ('000 m^3)
U. Raghoo	46	5	7,778	38,890	64	1472
W. Dalgety	30.873	10	40,000	400,000	660	1401
R. Walker	30.7	3	16,397	49,191	81	534
P. Rahaman	74	10	24,035	240,351	396	4545
S. Narine	-	-	-	-	-	-
D. Rambaran	150					
Mahadodri	-	10	110,847	1.11M	1829	-
R. Kallicharran			35,379			
E. Giddings /N. Persaud	-	10	11,687	116,870	1928	-
B&B. Ramsaroop	9	3	47,250	141,750		-
R.D.C # 4	181	2	1,000	1,700		-

NB: 1 acre = 4,047 m^2 *and density of sand (in-situ) is assumed to be 1,650* kg/m^3
Density of loam is assumed to be 1.8 kg/m^3 *(in-situ).*

Table 2.6 provides information describing the conditions observed at mine sites during inspections conducted in March 2001.

Table 2.6 Summary Description of Existing Sand and Loam Mines

Owner's name	Topsoil and spoil material storage	Width of mine access road	Length of access road
U. Raghoo	On top of active mine face, inside pit and on the edge of the pit	3m for vehicle path area, plus wide clearing on both sides	Two roads leading (one- ingress and the other egress) linked by in-pit roads along the active mining face. Access road approx. 143 m.
W. Dalgety	On top of active mine face, inside pit and on the edge of the pit	3m for vehicle path area, plus wide clearing on both sides	Similar to above. However, access road is approx. 150 m long.
R. Walker	Topsoil material pushed to the edge of the pit	Topsoil material pushed to the edge of the pit	Two roads leading (one- ingress and the other egress) linked by in-pit roads along the active mining face. Access road approx. 292 m.
P. Rahaman			
S. Narine	No commencement of mining. Clearing of a section of the site is evident	-	-
D. Rambaran	Storage of topsoil on edge of pit and in pit. No sign of reclamation.	Inactive mine	-
R. Kallicharan	Storage of topsoil material on the edge of pit and 5-10 m behind active mine face.	3 m of vehicle track area, plus clearing of both sides.	1 km
Mahdodri	Storage of topsoil material on the edge of the pit and approx. 50 m behind active mine face.	3 m of vehicle track area, plus clearing of both sides.	1 km
E. Giddings	On top of active mine face, inside pit and on the edge of the pit	3 m of vehicle track area, plus clearing of both sides.	Access road approx. 158 m long
B&B. Ramsaroop	Storage of material on both sides of the mining strips	Width of access road 7-8 m	In- pit access approx. 60 m and access to primary road approx. 4 Km.
R.D.C # 4	On pit edge and in buffer zones between pits. Some in-pit stockpiling of topsoil is also evident	3m for vehicle path area, plus wide clearing on both sides	One access road for entry/exist of approx. 150 m in length. There is a wider area along this road to permit vehicles to turn.

2.2.2.2 Transportation From Mines to Market

The transportation of sand/loam from the mines to market (Georgetown and surrounding area) is currently being conducted using privately owned trucks. The capacity of these trucks ranges from 5-25 tonnes, however, most of them are of 5- and 7-tonne capacity.

The transportation analysis conducted in this EIA addresses the effects of sand/loam transport from the perimeter of the mines to the final destination, i.e., the consumers. The sand/loam extracted from these mines is used to supply consumers in areas of East Bank Demerara, Georgetown, East Coast Demerara, West Coast Demerara, and West Bank Demerara. The main transportation routes are the Soesdyke-Linden Highway and the East Bank-Timheri Public Road, with the other routes depending on the location of the consumer.

The number of sand/loam trucks that passes within a given section of the transport route depends on the consumer demand and the access route taken by the trucks. According to an officer at GGMC's checkpoint, located in the vicinity of the junction of the highway with the East Bank-Timehri Road, there can be up to a maximum of 900 loaded trucks passing this point per day; however, on an average day there are about 500.This figure will however be dependent on the consumer demand, traffic and road conditions, location of the market, and whether the material is being stockpiled.

Most of the sand/loam transported from the mines is used for landfill and for infrastructure development (e.g., roads, bridges, houses) in areas such as the newly-established housing schemes.

The sand/loam mines opening hours range from 4 hours to 16 hours, for 6 days weekly, Monday to Saturday, with the exception of holidays.

The trucking schedule depends on the periods of entry to and departure from the mines, the current traffic and road conditions, and the number of trucks and truck trips per day. Most of the trucking is done in off-peak periods (4 - 6 am and 10 am – 2 pm) to minimize further traffic increases, which can lead to a potential increase in accidents and traffic jams.

Sand and loam transportation results in increased traffic, noise, dust, and annoyance for residents and other vehicles on or along the roads. This truck traffic exacerbates traffic problems and results in numerous accidents. Slow truck traffic is incompatible with car and minibus traffic and often is the cause of accidents associated with over-taking.

2.2.2.3 Environmental Emissions, Discharges and Waste Practices

Emissions

The main source of aerial emissions at the mine sites is from the burning of diesel fuel by the loading and haulage equipment. The quantity of these emissions depends on the number of equipment at the mining sites and the specifications of this equipment. The quality of aerial emissions will depend on the above and also on the type of fuel (primarily diesel and the condition of the vehicles.

The main sources of fugitive dust or particulate emission are from land clearing, and burning, stripping of topsoil, mining and sand/loam transport. Land clearing causes a minor increase in wind speed at or near ground level, which was evident at the time of inspection. The increase in wind speed causes particulate matter to become airborne. This environmental effect from all evidence would appear to be limited to the mining property and adjacent areas. The void created by mining and surrounding vegetation however, help to buffer this effect. A recommendation put forward by the National Land Use Committee requires a vegetation strip to remain in front of the mines (parallel to the highway) (200 m) and along the sides (perpendicular to the highway). In most cases, this recommendation is not being followed.

Discharges

The discharges at the mines are from poorly constructed workshops, fuel storage/transfer areas and from domestic waste generated at or brought to the mines. Oil, grease waste and grease rags coming out of the onsite workshop are disposed of in pits dug for this purpose outside of the mining limits. Some of these materials are scattered around the workshop or maintenance area.

There is no major fuel storage facility at the mine sites, however, fuel for the loading equipment is brought to the sites in small quantities (45 gallon drums), enough for a few days supply. The transferring of fuel to equipment has resulted in several hydrocarbon spills, some of which were evident at the time of the inspection.

The servicing of vehicles in poorly constructed facilities is of obvious concern, due to high permeability of the sand layer and the potential threat to ground water resources. There are several patches of areas contaminated with oil/fuel, most of these are located around the vehicle maintenance area and fuel transfer points.

Several of the active mines have resident quarters for some workers. Human waste, such as garbage and sewage that is generated on site, is disposed of in pits and screened latrine, respectively.

Reclamation, Monitoring and Erosion

There is no sign of adequate and intentional reclamation practices. Reclamation involves the re-contouring and stabilizing of slopes and the re-spreading of topsoil (previously stockpiled) onto mined out lands. The goal of reclamation should be to return the mined out land to a state where it can be beneficially used for future land uses at the minimum cost possible, and that the reclaimed land is aesthetically compatible with contiguous areas.

The apparent lack of a properly designed and/or properly implemented mining and reclamation plan has not only left the lands in a poor state for the enhancement of re-vegetation, but also wasted a portion of the sand/loam resource. This was evident particularly in the loam mines, where topsoil was stockpiled on mineable reserve, which is not being mined. The stockpiling of topsoil on mineable resource would increase the cost of future mining of this reserve, since the material would need to be re-handled. Stockpiling topsoil against standing forest and close to the mining face is evident at the mines. This limits the access of vehicles for re-spreading of topsoil and causes dilution or spoilage of the sand/loam due to sloughing pit walls and topsoil into the mining pit.

Some attempts have been made to use the mined out lands for alternative land use. These include the rearing of fish (hassar, tialapia, etc.) and farming (bora, coconuts, etc.). The exposure of the water table at two of the sand mines (Raghoo and Rambarran) would suggest that mining has taken place below the water table level, probably during the dry season when the level would be at its lowest point.

There are no monitoring wells at any of the mines for periodic assessment of the water table level and monitoring of the quality of water for on-site contaminants, such as petroleum, oils and lubricants (POL).

Erosion of the pit walls and the mining face is evident in all mines, but more pronounced in the sand mines as loam deposits seem to be shallower. The erosion and sloughing of the mining pit is not only a safety hazard for mines personnel and equipment in the pit wall, but also affects the quality of sand/loam that is being mined. Inadequate land clearing and stripping of topsoil has caused topsoil to be eroded into the mining pit and in some cases rendered portions of the sand/loam reserve unsuitable for commercial use.

2.2.2.4 Other Environmental Issues

A source of major concern expressed by some of the mine operators is the problem of illegal dumping at the site and into the mined out pits. This act is perpetrated by truck drivers, especially in the early hours of the morning, when the garbage is transported to the site to be disposed of into the mining pits, after which the trucks are loaded with sand/loam. There was evidence of this act at almost all of the sand/loam mines inspected. However, owing to routine inspection of the truck trays, the problem has reduced and now shifted to the dumping of the garbage along the transportation routes. Piles of garbage that may have been dumped by these sand trucks were seen in various sections along the highway.

The main source of noise emanating from the mines is from the operation of mining and transport equipment. The equipment used at the mines includes bulldozers, front-end loaders, backhoe, and dragline. The backhoe and the dragline are used for loam mining. Land clearing, and stripping of topsoil are done primarily by the bulldozer; however, in some cases where the vegetation is less dense the front-end loader is used instead. The main use of the front-end loader is for excavation from the active mine face.

The noise generated by the mining and transport equipment is dependent on the equipment specifications and the number of machines operating within a given period, the vehicle conditions (efficient mufflers, loose parts, etc.) and the gradients and condition of the mine road. Some of the mine haulage roads have steep gradient, sharp curves and poor traction; as such, vehicles need to operate in low gear, thus creating a greater noise level. The use of vegetation (bamboo, tree branches, etc.) on the mine road helps to improve vehicle's traction.

2.2.2.5 Occupational Safety and Health

This section describes issues of Workers Safety, First Aid and Evacuation, Occupation Health with emphasis on dust control, Protective Equipment and Public Safety Related issues.

Within the study area of the present sand and loam Mines, Occupational Safety and Health are acknowledged by all operators (owner), but there is little evidence of appropriate health and safety practices and enforcement of any rules they may have in place.

Information for this section was acquired from field visits using the methods observation and discussion using a checklist.

From the current (existing) list of ten (10) sand and two (2) loam Mines. Four (4) of the listed Sand Mines were in operation along with the two (2) loam mines.

At all the operational Sand and Loam Mines, evidence of hazardous materials are used, these are mainly in the form of Diesel fuel and Lubricants and Waste fuel/oil.

Spills of fuel and oil can be seen at areas where repair works are done, at points where trucks constantly stop, e.g., at checking points and to some extent it occurs while fueling excavators, bulldozers and draglines.

Safety training to Manager, Supervisors and Employees in the area of Sand and Loam Mining were greatly lacking, as none of them that were interviewed has had such training. No rules or posters were written up or posted up with respect to safety while operating on site.

Communication links between excavation operators at the pit and others in office is limited. Standby vehicles were observed at two (2) Sand Mining sites during operation in case of accident occurring, to evacuate injured persons. Evidence of a cell phone was on site at one of the Loam Mines.

Injuries and illnesses experienced by workers at these sites are basically sand hitches. However, there was a report of a fatal accident which had resulted in death due to a worker being run over by a loaded sand truck after slipping and falling while trying to mount on the moving truck. The amount of trucks observed at any one time in the pit awaiting their turn to be loaded were ranging between 2 to 12.

First Aid Kits were not available at any of the sand or loam Mine sites visited, while protective gear used were mainly disposable respirators. Operators are expected to supply their own health and safety gear.

Side slopes of all the operational Sand and Loam Mines were almost vertical and ranging from a height of between 25 – 30 feet. While the Loam pits slopes height were between 5 – 8 feet.

Topsoil and overburden are pushed back to existing vegetation of no more than 10 to 15 feet from the working edge of a Sand Pit. At Loam Pits the topsoil and overburden are piled up along narrow strips of land on both sides of an excavation. The manner in which these topsoil and overburden are banked up poses great risk to life and may deemed an occupational hazard since it can suddenly breakaway due to vibrations, and undermining, among other factors.

Standing water in the Pit or Sand or Loam areas were not seen, however, in all cases there was evidence of patches of dried out pools, leaving the area somewhat moist in compared to other areas. This suggested that excavation was done below the seasonal water table at those points.

Standing water presents a number of issues including the potential for contamination of aquifers and the potential for biting fly breeding habitat.

Dust from moving vehicles (trucks) in and out of the Mine site and by natural occurrences (wind) was a big problem to us at the time of visit and to workers and even the flora and fauna around the immediate environment. This was mainly due to the dry weather being experienced at this time which rendered the situation problematic. No control measures like watering were in effect.

While there are no reported Public Related issues in the area of the site visited, this cannot totally be ruled out, since time did not permit us to speak with residents in the area or owners of adjacent and other land uses (e.g., a chicken farm, an agriculture farm, two (2) recreational and one (1) residential area farms). There is potential for persons to inadvertently fall into a pit, be buried by a collapsing mine face, or be run over accidentally by mining equipment and trucks. Occupational diseases such as typhoid, a water borne disease and silicosis from the constant breathing in of dust from silica sand were not able to be ascertained or addressed.

In all cases except one of the excavators, the cabin which houses the operators were enclosed by metal frame and fitted with glass windows for clear vision, the exceptional one was enclosed by metal frame and metal mesh. The safe distance between loader and trucks were observed at two Mine sites while the other were lacking in this area. More so, the absence of an assistant to the excavator operator was prevalent at all Mining sites.

The average number of trucks traversing in and out of the Mining site per day, ranges from 60 – 150 ranging in size from 5 – 17 tons.

In all of the present Sand and Loam Mining sites visited, garbage disposal is seen. Dumping of the garbage occurred early in the morning and comprises of old stoves, old guttering, bed springs, tires among other things. The trucks that are transporting the sand are the one who are involved in this illegal activities. The result of this illegal dumping of garbage can have adverse effect on the health of workers.

2.2.3 Economic Evaluation

2.2.3.1 Production and Income

GGMC records, sand and loam production over the period 1996 to 1998 was calculated at 1,289,353 and 33,741 tons respectively. These figures represent the tonnage which royalty was actually paid on. However, this tonnage only accounts for 38% of the actual production (from survey figures). Tentative comparison between the small, medium and large scale operators revealed that production from the large scale operator, most of which was recorded as export, accounts for 20% of the total sand production. Loam was not exported.

Over the 1996 to 2000 period, direct income from the sand and loam sector is estimated to be approximately G$222 million with the large scale operators contributing G$169 million and the small and medium scale operators G$53.4 million. Income from the large scale operators whose earnings is mainly based on export is taken at approximately US$4.00/ton. They contributed to direct income of approximately G$26 million in 2000. Export earnings from sand within the project area totaled G$6,588,000 for the period 1996 – 2000. This was in 2000 when export began.

On the other hand, income for small and medium scale operators which is variable, was estimated during 2000 to be approximately G$120 per ton. The small operators contributed approximately G$6,543,550 in 2000.

2.2.3.2 Export Earnings

Export earnings is derived only from sand. During 1996 – 2000, large scale operators accounted for approximately US$ 1,030,820 (RMC), while small to medium scale exports accounted for US$ 36,000.

2.2.3.3 Cost Analysis

The cost of mining sand as at 2000 was estimated to be G$100/ton (based on actual costs of operators) while for the trucker, the cost of purchase at the pit is approximately G$120/ton. Consumer cost for sand in and around Georgetown is approximately G$1,000/ton. This 88% increase is accounted for by the high transportation cost compared with the low tonnage transport capacity (5 tons/truck).

2.2.3.4 Spin Off

The sand and loam sector is critical to the civil works and building sectors of the economy. Its application as a landfill, in concrete and as an asphalt base, and in other industrial processes makes it a starting point, without which development could be seriously curtailed. The small and medium scale operators within the project area share a segmented market with the producers, supplying to the distributors who are normally private businessmen operating trucks. The private truck operators satisfy the final demand of the consumers.

The above gives an indication of the large extent of the spin off from sand and loam mining. However, given the time constraint, the extent of this spin off was not assessed.

2.2.3.5 Employment

Employment in the sand and loam sector is varied from time to time, depending on the level of activity. There are currently eight (8) sand pits and two (2) loam pits operating within the project area and typical number of persons directly employed per operation is approximately three (3) giving a total direct employment of thirty persons. Employment for equipment operators account for one third, while Labourers account for two thirds of the total employment. Approximately 80% of the persons employed are from within the local community.

The indirect employment embraces a wider spectrum, e.g., truck drivers, truck porters, mechanics, spare parts industry, construction industry, etc., the extent of indirect employment was not assessed given the time constraint. However it is worthy of note that there are hundreds of truckers employed in the industry and most truckers have an assistant.

2.2.3.6 Revenue to Government—Royalties

Government collects direct revenue from sand and loam mining in the form of royalty. Royalty is payable by small and medium scale operators, within the project area, at a rate of G$25/ton. During 1996 – 2000, royalty paid by the operators within the project area totaled G$25,791,200.

There are no systematic records of the amount of taxes paid by the sector or the duties collected for imports by the sector.

3.0 ISSUES SCOPING

3.1 Issues Scoping and Selection of Valued Environmental Components

As a part of the training, the study team undertook extensive discussions regarding the issues associated with sand and loam mining. Then based on that discussion, the scope of the project (as described in sections 2.0 and 5.0) were determined. Then the scope of the environmental assessment was set and Valued Environmental Components ("VECs") were selected on which to focus the environmental assessment. As well the potential project-VEC interactions were determined and the potential environmental effects identified.

3.2 Selection of Valued Environmental Components

The following provides an annotated list of the VECs selected for analysis and the associated issues.

Transportation (From Mine Site to Market)

- Dust from trucks and sand on roads
- Integrity of infrastructure
- Traffic
- Accidents

Public Health and Safety (Limited to Mine Site and Surrounding Communities)

- Malaria
- Worker Safety
- Worker Health
- Public Health and Safety

Land Use (Within Mining Area and immediately Adjacent)

- Agriculture (including pigs and poultry)
- Tourism
- Forestry
- Residential
- Airport
- Recreation (including motor racing)

- Military Facilities and Activities
- Commercial
- Electrical Power Transmission
- Cemeteries
- Other Land Use

Water Resources

- Groundwater (Quality and Quantity)
- Surface Water (Quality and Quantity)

Flora and Fauna (including species of special conservation status within mining area)

Economy (Within Market Place, e.g., greater Georgetown area)

- Employment
- Revenue (land owner, contractors, miner, trucker, government)
- Spin-off

3.3 Project-Environment Interactions

Table 3.1 outlines the potential interactions of past and present sand and loam mining. For the future project, please refer to Section 6.0

Table 3.1. Potential Interaction of Past and Present Mining and Other Land Uses with the Environment

Project Activities and Physical Works	**Potential Environmental Impacts**																
	Change in Water Quantity	Change in Water Quality	Habitat Loss	Habitat Avoidance	Change in Bio-diversity	Habitat Fragmentation	Direct Mortality (fauna)	Change in Traffic	Injury, Illness, and Loss of Life	Deterioration of Infrastructure	Payment of Royalties	Employment	Business Revenue	Foreign Trade/Export	Alienation of Adjacent Land Use	Limitation of Future Land Use (mine site)	Loss of Sand/Loam Resources
Mining																	
Clearing	√	√	√	√	√	√	√								√		
Site Access Roads			√	√	√	√	√								√		√
Mine Buildings				√		√									√		√
Stripping/Stockpiling of Topsoil	√	√	√	√	√	√	√								√		√
Mining Sand and Loam	√			√		√									√		√
Transportation to Market								√		√							
Employment and Business											+	+	+	+			
Hazardous Material Use		√							√								
Mine Reclamation	√	√	+	√	√	+	√									√	
Solid and Liquid Waste Disposal		√		+					√								√
Accidents, Malfunctions and Unplanned Events																	
Hazardous Material Spills		√		√					√						√	√	
Vehicle Accidents							√	√	√				√				
Worker Accidents									√				√				
Public Accidents									√				√				
Forest/Brush Fires	√	√	√	√	√	√	√		√						√		
Illegal Dumping		√		+					√							√	
Illegal Settlement	√	√	√	√	√	√	√								√	√	
Standing Water	√	√	√	+	√				√								
Past, Present and Future Projects																	
Residential Land Use	√	√	√	√	√	√	√	√		√		√	√		√	√	√
Transportation Network		√	√	√	√	√	√	√	√			√	√	√	√	√	√
Recreational Land Use	√	√	√	√	√	√	√	√		√		√	√		√	√	√
Tourism Land Use	√	√	√	√	√	√	√	√		√		√	√	√	√	√	√
Commercial Land Use	√	√	√	√	√	√	√	√		√		√	√		√	√	√
Forest Resources Harvesting	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√
Agriculture	√	√	√	√	√	√	√	√		√		√	√		√	√	√

“+” indicates positive interaction

“Ö” indicates interaction

4.0 ENVIRONMENTAL IMPACT ASSESSMENT OF PAST AND PRESENT SAND AND LOAM MINING

This section provides the environmental impact assessment of past and present sand mining as described in Section 2.0.

4.1 Water Resources

4.1.1 Basis For VEC Selection

Most of Guyana's population is concentrated in a strip along the Atlantic coast. Consequently, most of the active water wells are located in a close vicinity to the coastline.

The whole aquifer system is apparently replenished by percolating rainfall over the White Sand outcrops that are hydraulically connected with the sand layers that provide the Georgetown water supply. Average recharge depth over the entire White Sand area (15,700 km^2) was estimated at some 4 mm/yr. Besides serving as the major area of natural recharge, the White Sand serve also as one of the two major storage reservoirs of the whole aquifer system.

The surface water in the White Sand area is also important for domestic, recreation and other uses for the communities that exist within those areas. It is therefore important to conduct environmental assessment on the ground and surface water resources with respect to sand/loam mining since any damage will have a deleterious effect on the future use of water resources.

4.1.2 Boundaries and Residual Environmental Impact Rating Criteria

4.1.2.1 Assessment Boundaries

The boundaries for this assessment are the aquifer systems that provide the Georgetown area with its water supply. This includes the important recharge areas in the white sands of the mining area.

Another boundary for this assessment was the technical limitations imposed by the lack of data, lack of resources (small study team that was busy with other assignments) and limited specialist expertise (the team did not include a hydrogeologist).

4.1.2.2 Residual Environmental Impact Criteria

For this environmental assessment a significant environmental effect on water resources is one that results in a long term change in water resources quantity or quality, affecting a group of people more than 10 individuals. The impact may be irreversible.

4.1.3 Existing Conditions

The groundwater resources of the sand and loam mining area are very important, since apart from being the main area for the artesian coastal aquifer, Guyana Water Authority (GUYWA) is considering developing, at some undetermined point in the future, new well fields near or within the White Sands area in the future, and conveying it to the coast. In addition, their consultant recommended a fairly comprehensive monitoring system for the coastal wells, and sinking new test wells in or near the White Sands area. Importantly, there are little data on the water resources of the White Sands area. An extensive study on the groundwater resources of the area was done in 1997 by Dr. Abraham Mercado for the Guyana Water Authority (GUYWA).

Dr. Mercado’s report is cited here almost verbatim without reference. This liberty is taken in the context of this training exercise.

The relationship of Land use, surface water, groundwater and the coastal aquifers are not understood. However, detailed preliminary study suggest that the hydrogeology of the White Sands area is of a nationally strategic nature.

4.1.3.1 Preliminary Study of Guyana Artesian Coastal Aquifers

Most of Guyana's population s concentrated in a narrow strip along the Atlantic coast. Consequently, most of active water supply wells are located in a close vicinity to the coastline. Considering the proximity of the sea, and the risks of the salinization of coastal wells, the management of GUYWA considers the present information concerning the dynamics of the Artesian Aquifer along Guyana Coast as insufficient, and modern groundwater monitoring and management tools have to be introduced over a relatively short period of time.

Dr. Abraham Mercado, was contracted by GUYWA as a short-term consultant for that purposed. The remainder of this section is drawn verbatim from his report. Some of the objectives of his short-term assignment were to assess the present and future state of the Artesian Coastal Aquifer System, to analyze sea-water intrusion risks, and to formulate practical measures to improve the groundwater management. One of the major goals of Dr. Mercado's study was to examine alternative groundwater management strategies in order to ensure the safe and long-term operation of coastal wells tapping the Guyana Artesian coastal Aquifer. This information is taken from Dr. Mercado's report dated August 1997.

The formulation of the Aquifer System Model, at least on a conceptual level, is a prerequisite for deriving alternative management strategies. In spite of the complexity of the lithological sequence, the aquifer system can be sub-divided into three Leaky-Coupled aquifer units-Upper Sands, "A" Sand, and the "B" Sand formations, within which water can flow vertically form one sub-aquifer to the other by leakage.

The whole aquifer system is replenished by percolating rainfall over the White Sands outcrops, where clay layers separating the various aquifers seem to disappear there. Natural Replenishment rates were re-estimated at some 66 Million Cubic Metres (MCM) of which almost 2/3 are contributed to the "A" aquifer, about 30% to the Upper Sands, and only 5 MCM/yr. are recharged to the lower "B" sub-aquifer. Average recharge depth over the whole white sands area (=15,700 sq. km) is estimated at some 4 mm/yr.

Besides serving as the major area of natural recharge, the White Sands outcrops, extending over an area of 15,700 sq. km., serve also as one of the 2 major storage reservoirs of the whole aquifer system. Considering a conservative phreatic storativity of 1-3%, the phreatic storage capacity is estimated at 157-471 MCM per m drawdown of the phreatic water table. Considering further, that water levels in this area can be lowered in the future by some 15-25 meters at least, the available phreatic One time Reserve (OTR) is estimated at the range of 2.4-11.8 Billion Cubic Metres (BCM).

Fresh water, released most likely by the inland invasion of the sea water-fresh water interface, is another source of regulating storage, estimated roughly at the same order of magnitude. This enormous regulating capacity of the aquifer system explains the observed stability of the groundwater levels within the Georgetown area, where groundwater exploitation considerably exceeds natural recharge.

The obvious natural outlet of the aquifer system is to the Atlantic Ocean; somewhere northward of the present shore line. Apparently, one can determine theoretical location of aquifer distances as those required to pinch-out from the continental shelf, yielding a distance of 60 km for the Upper Sand, and more than 100 km for sub-aquifers "A" and "B".

Although the above presented classical model is quite attractive, as it might ensure almost a complete isolation of the artesian aquifer from the ocean, the real-life model is possibly much more complex, since the clay percentage of the lithological cross-section increases gradually northward. Exploration oil drilling, about 100 km offshore, has shown indeed a significant facies change to predominantly marine clays and tight limestones, suggesting that aquifer outlets, change to predominantly marine clays and tight limestones, suggesting that aquifer outlets, possibly due to deeply covered faults, are located at much shorter distances, say, a few kilometres only from the shore. This assumption was confirmed rather clearly by model simulations, carried out by the short-term consultant, using the USGS MODFLOW groundwater flow model reported here.

Two alternative Sea-Outlet Models were considered. The first one is based on the classical assumption that all 3 sub-aquifers are connected directly to the sea (e.g., via some fault). The second model is based on the alternative assumption that only the Upper Sands aquifer has a direct connection to the sea, whereas aquifer units "A" and "B" are connected indirectly to the sea, via leakage through the overlying Upper Sands aquifer. There is no evidence to prefer one model over the other, except the extremely low salinity of the "A" aquifer, suggesting that the second-indirect outlet model might be closer to reality.

Sea water intrusion is a common phenomenon in coastal aquifers. Although the Guyanese coastal aquifer is characterized by some favourable conditions, the risks of its salinization due to sea-water invasion cannot be ignored. Over exploitation of the "A" sands results in the decline of their piezometric head, as exemplified within the Georgetown area. This results in a leakage from the upper sand into aquifer "A", causing further sea-water intrusion into the already saline water bodies of the upper sands. Saline water migrates then downward into aquifer "A" creating there the conditions of an inland moving interface. Similar process might take place between the "A" and "B" aquifer units.

The above scenario, based on Model II of the sea-outlet, can be described as consisting of three successive stages, whose timing is of paramount importance for making proper management decisions: (i) Sea-water intrusion into the Upper Sands Aquifer, (ii) Downward movement of saline water into the "A" sands aquifer and the gradual creation of an interface there; (iii) Interface movement of the newly created interface towards the pumping centers along the coast. Each one of these stages would take a considerable time. The transit-time from the Upper Sands to the "A" sands is estimated as an example, at the range of 20-100 years.

Water quality data, although scarce, can be used as a useful tool to understand the hydrogeochemistry of the aquifer system, as well as to trace the pre-cursors for sea-water component. The same possibly applies to the "B" sands. The "A" sands water is obviously of different origin, reflecting the rapid percolation of recharge water through the White Sands outcrops, resulting in extremely low chloride salinity within the range of 7-14 ppm. They remained about constant in the Georgetown wells, in spite of their exploitation for over 40 years.

The Upper Sands relatively high salinity is explained most likely as the result of past surface invasions of sea-water before the defense wall was constructed. Since its construction, about 200 years ago, the soil profile of the Demerara clays is gradually flushed. The relatively high salinity of the "B" formation, although much lower in comparison to recorded Upper Sand salinity, is related to the possible existence of saline water above the basement. Solute transport to the "B" wells is either by molecular diffusion or by the upcoming of the underlying saline water.

In spite of the above presented evidence, the paucity of data should be always considered. Detailed recommendations regarding the initiation of a long-term water quality monitoring program, as an early warning system for sea-water intrusion, are given further in Dr. Mercado’s report.

Present exploitation is estimated at 65 MCM/yr., of which 60 MCM/yr. are abstracted from the "A" aquifer, and the remaining 5 MCM/yr. from aquifer "B". The respective exploitation of the Georgetown wells is approximately 15 and 5 MCM/yr., increasing only slightly during the last 20 years. Most Upper Sand wells were abandoned, and its exploitation is presumed to be negligible.

Groundwater abstraction resulted in considerable water levels depletion. Recorded drawdowns of Georgetown wells are some 15-20 m for the "A" wells and 25-30 m for wells penetrating the "B" aquifer. No records are available for other well fields, although their respective drawdowns are considered lower because of their well spread.

The projected increase of groundwater exploitation would result in, undoubtedly a significant decline of water levels, resulting possibly the intrusion of sea-water. Quantitative assessment of these trends calls for the use of models. The USGS groundwater flow model MODFLOW was chosen as one of the possible tools for that purpose. MODFLOW was used here, primarily as a demonstration of its well known capabilities, as well as to assess possible hydrological impacts of present and projected production patterns. Simulated water levels, in both steady-state and transient runs, are reasonably close to observed patterns, supporting to large extent the validity of the conceptual model used in this work. The simulation exercise described here, demonstrates the importance of utilizing models, even at this preliminary stage when available data is scarce to nearly non-existent, for the purpose of "filtering" alternative models. It showed on the other hand, the inability of the model to distinguish at this stage between the two alternative models of the sea-outlet. Closing this information gap, which is quite important in assessing the future behavior of the aquifer, can be achieved only by monitoring campaigns, advocated in Dr. Mercado’s report.

Dr. Mercado opines that although his report summarizes the findings of his short-term assignment, the project can not be considered as completed by any means. Some of the possible avenues to complete and continue this project are described below:

- Complementary studies, to be executed at further stages of the project. They are divided into short-term and mid-term activities. Short-term activities may start right now, although they require some organizational modifications. The execution of long-term assignments would be undertaken I cooperation with the team of the Long-Term Consultant.

- Development of computerized data management system. Preliminary version of this system was programmed by the short-term consultant, enabling the coding of available data by a technician of the Water Resources Unit. This system will be completed by the team of the Long-Term Consultant.

- Introduction of simulation models as a routine aquifer management tools by GUYWA personnel. The use of the MODFLOW model was demonstrated here as a typical example.

- Recommendations regarding possible reorganization of the Water Resources Unit, and the training of its personnel.

- Detailed monitoring recommendations, including also recommendations with regard to the procurement of the necessary equipment.

The establishment of a monitoring grid and a data management system, and their continuous operation are considered essential. Until further field data becomes available, the following guidelines are recommended for the management of water resources along the coast.

- Coastal wells tapping the "A" aquifer should be considered as the main groundwater source until their unavoidable salinization, whose timing is still unknown. It is recommended however to increase the spacing between adjacent wells in order to prolong their salt-free operation. This applies especially to Georgetown wells.

- After the salinization of "A" wells two alternative courses can be considered: (i) Conveying and treating surface waters, and (ii) Conveying groundwater from new well fields, to be developed further to the south, near or within the White-Sands area. It is proposed to undertake the necessary steps to examine the economic and engineering feasibility of these alternatives.

- If the development of new well fields in the White Sands area appears to be attractive, it is proposed to drill and test several exploration/exploitation wells in this area. They are necessary in any case, to complete hydrogeological models and update present natural recharge estimates.

- The exploitation of the Upper Sands aquifer might have been abandoned too early, without examining the feasibility of skimming fresh groundwater bodies. Specific recommendations regarding the planning and execution of complementary studies are listed in this report.

Following these recommendations would lead hopefully to a broader and more comprehensive view of the Guyanese water resources along the coast, enabling finally their optimal and long-term utilization.

Dr. Mercado met with Ms. J. Jafferally with the Hydrometeorological Services. The major goal of this meeting was to collect available data; namely-gauging stations within the White Sand area, and evaporation records from this area. We found out that such stations do not exist. It seems therefore that quantitative assessments with regard to streams gain or losses is not possible with the recharge area of the artesian aquifer.

Proposed Mid-term activities by GUYWA

Monitoring Wells near the White Sands: On the basis of fifth information gained, proposed, locate and estimate the cost of new production/monitoring wells, to be drilled along the northern boundary of the White Sands. Cost estimates should include also pumping tests and equipment. Findings of these wells would be used among others, to quantify better the order of magnitude of deep groundwater recharge within the Water Sands, applying the, so called, indirect method. New wells would be used also to assess better the possible utilization of groundwater reserves stored in the White Sands.

Hydrometeorological Models: Develop and run a hydrometeorological model, based on daily rainfall and low data of selected basins, to assess the order of magnitude of deep percolation into the underlying aquifer, using the so called direct method.

Delineation of Effective Recharge Areas: Use available information, field trips included, to delineate areas of high and low natural recharge over the entire White Sands area. Special attention should be paid to the possible outcropping of clay layers, and the overlying vegetation. Assess and quantify the role of streams crossing the White Sands as a determining factor of deep groundwater recharge.

GUYWA accepted the following guidelines in order to optimize the exploitation of the coastal aquifer, while minimizing the possible negative impacts of sea-water intrusion:

- The control of sea-water intrusion has to be considered as the dictating factor in the hydrological planning of the Guyana Artesian Coastal Aquifer
- The ultimate sea-water intrusion along the coast, would be accepted by GUYWA as an hydrological constraint, on the basis of combined hydrological and economic considerations. Minimum water level profiles should then be defined and maintained accordingly, to prevent sea-water intrusion beyond a pre-defined distance from the coast.

- Maintaining the above-mentioned Minimum Water Level Profiles, might require among others different distribution of groundwater exploitation.

- In moving the interface between present and ultimate positions, large quantities of fresh water are released. They are considered as One-Time Reserve (OTR). Unless properly managed, most of the OTR volume might be wasted to the sea.

- Proper execution of above goals requires primarily the availability and accessibility to hydrogeological information and related data. Collection and compilation of available data, including possible organizational changes, are considered therefore as a major issue by GUYWA.

Another major issue is the introduction of simulation models as a groundwater management tool. The use of simulation models would assist among others in: (1) Verifying the validity of alternative conceptual models, (2) Examining the significance of planned sea-water intrusion on the safe groundwater exploitation and its aerial distribution, (3) Simulation of alternative scenarios for the possible decline of groundwater levels and the consequent sea-water intrusion, (4) Forecasting the possible salinization of coastal wells, (5) Identification of information gaps and their effect on the decision making process.

4.1.3.2 Physiography and Stratigraphy

The principal physiographic features that relate to the artesian coastal aquifer are the coastal plain, adjacent uplands, major rivers and the continental shelf.

The width of the coastal plain, between the Pomeroon and Corentyne rivers, ranges between 5 miles near the Essequibo river, to about 50 miles near the Berbice river. The width in Georgetown area is about 30 km. The coastal plain extends along 150 miles of shore line, and covers an area of approximately 2,000 sq. miles.

The coastal plain is underlain by a 50 m sequence of clays-occasionally silty and sandy. From a geological point of view they can be divided about equally between the esaward Demerara clay and the Coropina clay formation; they are referred to oftenly as the Young and Old Coastal Plain respectively.

Typical ground-levels along Georgetown coast are approximately (Halcrow, 1993) 1 m below mean sea-level (msl). According to Worts (1958) they are about 1 ft above msl. An extensive system of sea-walls, or sea-defenses, extending along parts of the coast and banks of major rivers, prevents the inland flooding during high-tides, reaching some 3-5 ft. above msl. In some areas sea-defenses are lacking, and hence they are flooded during high tides. Manual gates, called kokers, along the sea-walls were installed to provide the discharge of accumulated drainage water to the sea during low-tide.

Ground-levels rise gradually inland to approximately 35-50 ft (11-15 m) above msl, along the northern boundary of the upland White Sand Hills, where a well defined terrace level is evident. Further to the south the altitude of the upland increases up some 400 ft (122 m).

The white sands cover an extensive part of Guyana, up to some 160 km from the coastal plain. They are characterized by gently undulating topography, shaped most likely by stream erosion. The more sizable rivers, such as the Essequibo and Demerara rivers have dissected the white sand formation down to the underlying Pre-Cambrian basement.

The Continental Shelf extends to some 120 km offshore, where the sea-bed is about 100 m below msl. Further offshore the sea-bed steepens rapidly to a depth of 180 m at a distance of 136 km from the shore, and 900 m at a distance of 144 km.

The sub-surface geology of the study area is characterized by a sequence of unconsolidated sediments of Tertiary to recent age, overlying a Pre-Cambrian basement of granite and gneiss rocks. Seismic surveys and deep drillings indicate that the sediments were deposited in a basin whose thickness thickens coastwards and eastwards. According to a structural contour map, the basement is at a depth of 100m near the mouth of the Essequibo river, and reaches a maximum of some 2,000 m near the mouth of the Berbice River. Offshore oil drillings have shown the sediments to be up to 3,800 m thick at the edge of the continental shelf.

Structurally, the basin may be considered geosynclinal with an axis along the Berbice River. The cycle of accumulation of river borne sediments and subsidence results in alternate deposition of sands and clays in a fluvio-deltaic environment.

The sediments are of Pliocene (Tertiary) to Quaternary and recent ages. The White Sands are considered as the oldest sediments of late Pliocene to early Pleistocene age. The sediments consist of a variable sequence of sands, silts and clays. At the outcrop White Sands area, sands dominate the sequence. Clay percentage increases gradually northward. Exploration oil drilling, about 100 km offshore, has shown a significant facies change to predominantly marine clays and tight limestones.

At the latter stageas of the White Sands deposition, tectonic uplift occurred and the sediments were moderately tilted with a shallow dip seaward. Subsequent marine transgressions, combined with post-glacial deposition, resulted in the deposition of the upper Coropina and Demerara Clays covering most of the coastal plain. It is presumed that these clays are continuing also offshore to an undefined distance from the present coastline. Although the sand, silt and clay deposits of the White Sand Series might be considered by some as patchy **lenses** rather than continuous beds, they were subdivided into several sub-units.

Table 4.1: Geological Sequence at Georgetown
(Taken from Table 2.1 in Harlcrow, 1993)

FORMATION	AVG. DEPTH BELOW GROUND-SURFACE (m)	AVERAGE THICKNESS (m)
Demerara and Coropina Clays	0-50	50
Upper Sands	50-80	30
Intermediate Clays	80-200	120
"A" Sands	200-240	40
Lower Alternating Clays	240-380	140
"B" Sands	380-400	20

Conceptual Model of the Aquifer System

Division into Sub-Aquifers

In spite of the above described complexity of the lithological sequence, it might be divided possibly, at least for the sake of modeling and groundwater management, into six sub-units at least, of which 3 can be classified as aquitard to aquiclude formations (The Demerara and Coropina Clays, the Intermediate Clays and the Lower Clays), and the remaining 3 as aquifer formations (Upper Sands, and the "A" and "B" sand formations).

The depth of the lowermost aquifer formation (B sands) in the Georgetown area is about 400 m. Below this unit, and down to the impervious bedrock at a depth of some 600 m, there is a sequence of clays, silts and sands. Other aquifer formations might exist theoretically at the lower interval of 400-600 m. They are considered however, as impractical for groundwater development in view of their salinity and drilling depth (Worts, 1958), and were not considered further in Dr. Mercado's report

In spite of the relative thickness of the confining clay layers, this sequence would be considered further as a Leaky Coupled System, in which water can flow vertically from one sub aquifer to the other by leakage.

Recharge and Storage Areas

There is no doubt that the natural replenishment of the whole aquifer system is by percolation rainfall over the White Sands outcrops, although opinions might differ with respect to its order of magnitude. Another source of debate might be the mode of recharge. It is presumed further that the confining clay layers almost disappear here. Rainfall is percolating therefore to the Upper Sand formation, and leaks partly down into the "A" and "B" aquifer units.

Table 4.2: Outflow Model I-Direct Hydraulic Connection with the Ocean

FORMATION	AVG. TOP DEPTH BELOW GROUND-SURFACE (m)	THEORETICAL OUTLET DISTANCE FORM THE COAST (km)	THEORETICAL PIEZOMETRIC HEAD AT THE OUTLET (m ASL)	INITIAL WATER LEVELS OF COASTAL WELLS (m ASL)
Upper Sands	50	60	+1.25	+(1-2)
"A" Sands	200	137	+5	+(3-4)
"B" Sands	380	140	+9.5	+(10-11)

Apparently, the presumed high infiltration capacity of the White Sands should result in groundwater recharge in the order of magnitude of the surplus rainfall (rainfall-evaporation), and minimal surface runoff. According to Halcrow (1993), this is not exactly the case. In spite of the high infiltration capacity, deep percolation into the aquifer is relatively low, as significant portion of the percolating rain water are seeping out into creeks and rivers crossing the White Sands. This topic is discussed further in this chapter.

Besides serving as the major area of natural recharge, the White Sands outcrops serve also as the major storage reservoir of the whole aquifer system. The White Sands outcrops extends over an area of 15,700 sq. km (Harley, 1996). Considering a minimum phreatic storativity of 1%, the Specific Storage Capacity might be estimated at the amazing value of 160 MCM per metre of regional drawdown. Even if only 10% of the White Sands area are contributing to the phreatic storage of the aquifer system, it is still a significant factor in understanding the dynamic behaviour of the aquifer system.

There is a pronounced water level difference between the Kuru-Kuru well (>+15m ASL) in the White Sands and the initial water levels of coastal wells (+3-+4m ASL). This observation indicate the existence groundwater flow from the recharge area towards the sea. If there is no hydraulic connection to the sea, initial water levels of coastal wells should have been about equal to that of the Kuru-Kuru well.

Pumped water from "A" wells along the coast are extremely fresh (chloride salinity around 10 ppm), indicating a continuous flushing by fresh dune water. Harclow's suggestion (1993) that the low salinity of the "A" sands is explainable by their deposition under more fresh-water fluvial conditions seems to Dr. Mercadoo as a bit shaky, in view of the higher salinities of the Upper and "B" sand-units. Molecular diffusion, although relatively slow process, should have been sufficient to equilibrate groundwater salinities on a geological time scale. A partially based assumption that the coastal wells are hydraulically isolated form the ocean might lead to erroneous management decisions.

Alternatively, we might suggest that only the Upper Sand aquifer has a direct outlet to the ocean; possibly at the above estimated distance of about 60 km from the coast, whereas the "A" and "B" sand formations are connected indirectly with the ocean, via al leakage to the Upper Sand formation. The implications of this alternative model, named Outlet Model II, are examined further in Dr. Mercado's report.

One-Time Reserves (OTR's)

The present assessment that groundwater exploitation exceeds the limited natural recharge rates, requires extensive use and management of the available groundwater reserves, defined here as One-Time Reserves (OTR's)

At this stage we can visualize two complementary OTR's: (i) Phreatic storage within the White Sands outcrop area, and fresh water volumes releasable by the invading interface.

- **Phreatic Storage of the White Sands Outcrops** : The White Sands extends over an area of 15,700 sq. km. Considering a conservative phreatic storativity of 1-3% the phreatic storage capacity is estimated at 160-480 MCM/m water level depletion. Considering further, that water levels in this area can be lowered by at least 15-25 meters. The available phreatic OTR is estimated at the range of 2.4-12 billion cu.m.

  Utilizing those enormous quantities would require to move future well fields into this area. In fact we consider it as the only feasible hydrological solution, when present well fields would be invaded possibly by sea-water.

- **Fresh Water Volumes Released by the Moving Interface**: The present position of the interface in aquifer units "A" and "B" is estimated according to the 1st outlet model at a distance (L?) of some 130 km northward from the coast, although model simulations, presented further in this report indicates that this distance might be in the order of few km's only.

  According to the 2nd model this distance might be shorter, some 50-60 km only. Again, model simulations, presented further in Dr. Mercado's report indicates that this distance might be in the order of few km's only.

Regardless of the actual outlet distance, the 2nd model dictates that sea-water would intrude in a rather tortuous path, starting by a direct intrusion into the Upper Sands aquifer, and than by a consequent downward migration through the intermediate clays.

4.1.4 Impact Analysis

In the absence of data on the surface and groundwater resources beyond that described in Section 4.1.3, it is difficult to predict with confidence, the extent of impact of mining on water resources. Table 4.3 provides the Environmental Effects Matrix, characterizing the environmental effects of past and present mining, including cumulative environmental effects. It is evident that various mining activities will result in changes to rates of evapotranspiration, interception, runoff and groundwater recharge. There is potential for contamination of the aquifer through hazardous materials use and spillage. As such, there is no question that mining and the various other land uses that are acting cumulatively with mining are adversely affecting the water resources. As the area is the principal area of recharge for the coastal aquifer, it is expected that the cumulative environmental effects are far-reaching. There is little or no mitigation being applied to the protection of the aquifer or nearby streams. As a consequence, it is concluded that the cumulative environmental effects of sand and loam mining, in combination with other past, present and likely future projects, are resulting in significant adverse environmental effects on water resources (Table 4.4). The level of confidence with which these predictions are made is low, only due to the paucity of data about the hydrologic system of the area. Accidents, malfunctions, and unplanned events could potentially be resulting in significant adverse environmental impacts. The likelihood of there occurrence is low, but the potential magnitude is high.

Table 4.3. Environmental Effects Assessment Matrix, Past and Present Mining

Valued Environmental Component: Water Resources

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Cultural and Economic Context**
Mining							
Clearing	Change in Water Quantity (A)	None	3	6	5/6	R	2
	Change in Water Quality (A)	None	1	6	5/6	R	2
Stripping and Stockpiling of Topsoil	Change in Water Quantity (A)	None	3	6	5/6	R	2
	Change in Water Quality (A)	None	1	6	5/6	R	2
Mining Sand and Loam	Change in Water Quantity (A)	None	1	3	5/6	I	2
Hazardous Material Use (Routine)	Change in Water Quality (A)	None	1	2	5/5	R	2
Mine Reclamation	Change in Water Quantity (A)	None	3	6	5/6	R	2
	Change in Water Quality (A)	None	1	6	5/6	R	2
Solid and Liquid Waste Disposal	Change in Water Quality (A)	None	1	3	5/6	R	2
Accidents, Malfunctions and Unplanned Events							
Hazardous Materials Spills	Change in Water Quality (A)	None	1	3	5/1	R	2
Forest/Brush Fires	Change in Water Quantity (A)	None	3	6	5/1	R	2
	Change in Water Quality (A)	None	3	6	5/1	R	2

Table 4.3. Environmental Effects Assessment Matrix, Past and Present Mining

Valued Environmental Component: Water Resources

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Cultural and Economic Context
Illegal Dumping	Change in Water Quality (A)	Some operators check trucks to ensure they are not bringing waste to mine site for illegal dumping	1	3	5/1	R	2
Illegal Settlement	Changes in Water Quantity (A)	None	1	3	5/6	R	2
	Changes in Water Quality (A)	None	1	3	5/6	R	2
Standing Water	Changes in Water Quantity (A)	Draft Codes of Practice limit mining to within 3 m of water table; this is observed by some operators	1	3	3/1	I	2
	Changes in Water Quality (A)	Draft Codes of Practice limit mining to within 3 m of water table; this is observed by some operators	1	3	3/1	I	2

KEY

Magnitude:

1 = Low: *e.g.,* the water resources of a few persons adversely affected
2 = Medium: *e.g.,* the water resources of 1,000-10,000 persons adversely affected
3 = High: *e.g.,* the water resources of greater than 10,000 persons adversely affected

Geographic Extent:

1 = <1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1000 km^2
5 = 1001-10,000 km^2
6 = >10,000 km^2

Duration:

1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = 72 months

Frequency:

1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = >200 events/year
6 = continuous

Reversibility:

R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:

1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

Table 4.4. Residual Environmental Effects Summary Matrix

Valued Environmental Component: Water Resources

Phase: Past and Present Mining	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	S	1	3	1
Accidents, Malfunctions and Unplanned Events	S	1	2	2

Key:

Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analy or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

*As determined in consideration of established residual environmental effects rating criteria.

4.1.5 Monitoring

At present, there is no monitoring of groundwater resources or surface water resources in the sand and loam mining area.

4.2 Transportation

4.2.1 Basis for VEC Selection

In preparing an EIA report different components need to be looked at to obtain a broad based overall picture. In many cases these components overlap to varying degree so it was decided at the scoping stage to allocate particular sections a given component and thereby eliminate overlapping. For transportation three potential impacts were looked at, namely, (i) change in traffic, (ii) injury, illness, and loss of life due to vehicle accidents, and (iii) deterioration of infrastructure. These three impacts were chosen based on the number of vehicles (trucks and tractors) using the road, and the great distances these vehicles need to travel to deliver the sand/loam to the consumer. The basis for choosing the second impact is many and varied depending drivers' fatigue, poor vehicle maintenance and the tendency to speed. The passage of trucks along populated areas can result in increased traffic and potential for accidents, increase noise and dust, and reduction in the overall quality of life of residents. The integrity of the transportation network is influenced by the size and number of vehicles that use it.

4.2.2 Boundaries and Residual Environmental Impact Rating Criteria

4.2.2.1 Project and Assessment Boundaries

The two boundaries set for this EIA study are based on time and location of consumer. The time is taken to be from 0200 hours to 1600 hours Monday to Saturday when sand transport is primarily undertaken. This occurs year-round although it is interrupted by holidays. Typically, sand is not hauled on Sundays. The zone of influence or spatial boundary of the sand/loam transport was taken to be from the perimeter of the mining property, and along the highway and East Bank Public Road to Georgetown and its environs.

4.2.2.2 Technical and Administrative Boundaries

To properly assess the effects of sand/loam mining on the transportation system the relevant data on the traffic patterns and the transport routes is needed. Attempts were made to acquire such information from GGMC, the Police Traffic Department and the Ministry of Public Works. Some information was received from GGMC and this was considered in this report. Due to the short time of this exercise no traffic survey was conducted. Checks with the other two agencies revealed that while they may have the information, the bureaucratic process was an impediment to timely acquisition of this information for this assessment.

4.2.2.3 Residual Environmental Impact Rating Criteria

A significant environmental impact will be considered to be one where sand and loam transportation will, in combination with other transportation, result in frequent traffic conditions where traffic is halted, jammed or unreasonably slow (i.e., traffic jams). The rate of accidents is unacceptably high and the loss of life and injury in accidents is frequent. The road infrastructure is damaged by the level of traffic and weight of vehicles to the point where the infrastructure deteriorates and is in need of frequent repair. The incompatibility of various vehicle types and local versus through traffic is frequently evident (e.g., frequent overtaking and risk taking, obscured vision, frequent turning, etc.).

4.2.3 Description of Existing Conditions

This sand and loam transportation system involves the use of tractors, dump trucks and in the future tandem trucks to transport the material to the market place or consumer. The capacity of the trucks ranges from 5 to 25 tonnes. These vehicles were/are/will be owned and operated by individuals and contractors, and are primarily of five and seven tonne capacity. Trucking of sand and loam to Georgetown is done via the Soesdyke-Linden Highway and the East Bank-Timehri Public Road, which is the only available haulage route. Presently a GGMC checkpoint is located along the Public Road to monitor the numbers of trucks and sand/loam production extracted from each pit. The assessment is supported by routine quantity surveys of the various mines. The trucks are covered to reduce sand/loam spillage (on to the road) and the emission of fugitive dust.

The road is mainly a dual carriageway with some four-lane bridges close to Georgetown. It has extensive unlimited access by residences, businesses, institutions and roadways. There are several artery roads that join the main road. Traffic stoplights are presently non-existent and traffic signs, while there are some near Georgetown, are inadequate and poorly maintained. During the peak periods the addition of these vehicles exacerbate an already chaotic situation resulting in a number of accidents. Sand truck through traffic is frequently incompatible with local traffic and the frequently stopping and starting of numerous minibuses. There is also incompatibility with other through traffic, e.g., vehicles and taxis heading to and from the international airport at Timehri and businesses along the highway. Traffic jams and slowdowns are a frequent occurrence, especially during the morning and afternoon “rush hours”. However, excessive traffic is a problem through most of the working day and well into the evening.

Although data were not readily available to the study team, it is common knowledge that the rate of accidents along the highway is very high and there is frequent loss of life and personal injury as a result of accidents. Often, accidents involve sand trucks or are a result of risk-taking and overtaking of slower traffic (e.g., sand trucks) by minibuses and other vehicles.

4.2.3.1 Project-VEC Interactions

The transportation of sand to market and related accidents are the two principal activities that result in impacts. The types of impacts anticipated are changes in traffic, injury, illness and loss of life and the deterioration of infrastructure. These interactions occur in the past, present and future.

The effects of sand and loam transport on the existing transportation network would involve increased traffic, deterioration of infrastructure and the potential for and increase in accidents (which can led to injury, illness and loss of life). The effect on traffic is more pronounced at certain sections of the transportation route (in populous areas) and during specific time period (peak hours). The effect of sand/loam transport on existing traffic is dependent on the material and location of the consumer, the size of haulage trucks, and whether the material is being stockpiled. The size of the truck use in sand/loam transport sometimes depends on quantity of material required by the consumer. If the material is being supplied to small and individual consumers then often the trucks are of smaller capacity (5 or 7 tonne). Smaller trucks may have lesser effects on the deterioration of infrastructure. This may however lead to more truck trips (loaded); thus the effects on traffic may be more extensive for smaller trucks. Larger trucks, on the other hand travel slower and require less truck trips (loaded) to achieve similar quantities.

4.2.3.2 Impact Analysis

Table 4.5 presents the impact analysis results in table format.

This aspect of impact analysis addresses the interactions of sand/loam transport on the existing transportation network to determine the nature and extent of residual environmental impacts. The nature of residual environmental impacts emanating from the transportation of sand and loam to the market include an increase in traffic, deterioration of infrastructure, and the potential for injury and loss of life. The extent of these impacts depends on the traffic patterns, the trucking period, the location and population of communities contiguous to the transport routes, and the conditions of the infrastructure (roads, bridges, culvert, signs, etc.).

Table 4.5: Environmental Effects Assessment Matrix
Valued Environmental Component: Transportation (to market)
Phase: Past and Present

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Transportation	Increased Traffic (A)	Trucking during off-peak hours is more widely practised in the present. Some increased size of trucks in present. Stockpiling in areas close to market is occurring for certain projects.	2-3	4	1/2	R	2
	Deterioration of infrastructure (A)	Some repairs done as necessary	2-3	4	2/2	R	2
Accidents, Malfunction and unplanned events	Injury , Illness and loss of life (A)	None	2-3	4	2/1	I	2

KEY

Magnitude:
1 = Low: *e.g.*, < 8 trucks per hour,
2 = Medium: *e.g.*, 9-36 trucks per hour,
3 = High: *e.g.*, >37 trucks per hour

Geographic Extent:
1 = <5 km
2 = 5-40 km
3 = 41-60 km
4 = >60 km

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Frequency:
1 = < 50 trips / day
2 = 50-500 trips/day
3 = >500 trips/day

Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

The extent of the environmental effects addresses the magnitude, geographic extent, duration /frequency, reversibility, and cultural and economic context. The level of these environmental effects is based on evaluation of the above criteria, which are documented in Table 4.5. The magnitude of the environmental effects is determined on the number of sand or loam trucks that pass along a section of the transport route within a given period. The magnitude is categorised as low, medium and high. A low magnitude occurs when there is less than 8 sand or loam trucks in an hour. A medium magnitude is when there are between 9-36 sand or loam trucks in an hour; and a high magnitude is where there are more than 36 sand or loam trucks pass a given section along the transport route every hour. The geographic extent of the transportation route is categorised into 4 sections. Section 1 covers the areas along the highway and the East Bank-Timeheri Public Road up to the junction with the highway (approx. 5 km). Section 2 covers the area along the East Bank Public Road up to the junction with the Demerara Habour Bridge (approx. 40 km). Section 3 covers the area from the bridge to any part of the City of Georgetown. The last section covers areas from Georgetown to along the East Coast of Demerara (approx. 60 km).

The frequency addresses the number of truck trips (loaded) per day. On a normal day, there is an average of 500 loaded truck trips. The number of truck trips will however, be dependant on the market demand and location, traffic and infrastructure conditions, size (tonnage) of haulage trucks and whether the material is being stockpiled.

Transportation of sand/loam has adverse effects on existing traffic condition and infrastructure. However, there are no data available to quantify or qualify the level of these effects on the transportation network. Trucks travelling in a convoy are difficult to overtake as such vehicles travelling behind the convoy may be forced to follow it for a long period (and distance). The traffic build-up behind the convoy would depend on the speed of the trucks and trailing vehicles, and the density and speed of opposing traffic. If the latter is low, trailing vehicles can easily overtake the trucks or convoy, thus minimizing the back up of traffic behind the convoy.

Currently there is little mitigation associated with the impacts of sand and loam transportation.

42.3.3 Determining Significance

Table 4.6 summarizes the conclusions of the impact analysis.

Table 4.6. Residual Environmental Effects Summary Matrix
Valued Environmental Component: Transportation

Phase: Past and Present	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	S	2	3	1
Accidents, Malfunctions and Unplanned Events	S	2	1	1

Key:

Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

*As determined in consideration of established residual environmental effects rating criteria.

The transportation associated with routine mining activities has significant environmental effects, that arise as a result of increased traffic and deterioration of infrastructure. The environmental effects are rated significant based on the magnitude, duration, frequency, geographic extent, and/or reversibility of the existing transportation network. The assessment of the level of effect is based on visual observation and on information received from mine operators and vehicle drivers. A combination of substantive impacts cause us to conclude that the threshold of significance (Section 4.2.2.3) is exceeded by project related transportation, in combination with other transportation on the roads.

The level of confidence of the environmental effects is evaluated based on field reconnaissance, literature review and in consultation with experts. The lack of relevant data, inadequate time and money, and the difficulty of acquiring expert opinion have to some extent compromised the level of confidence. However, that environmental impacts are occurring is self-evident to anyone who is a resident of the greater Georgetown area.

The likelihood of significant adverse environmental effects is determined by the probability of occurrence and scientific certainty on which these effects may occur. Due to factors mentioned in Section 4.2.2.2, scientific and/or statistical methods were not applied; instead, this assessment was based on visual observation and on information received from mine operators and truck drivers. Since there is limited information and data available for the assessment, then the apparent likelihood of the environmental effects on existing transportation network cannot be substantiated with scientific certainty.

4.2.3.4 Monitoring

By collecting and analyzing traffic data at strategic sections along the transport routes, it would be possible for one to demarcate routes and set periods to reduce the effects of sand/loam transport on the existing transportation network. The measures implemented should be reviewed periodically and modified where necessary in order to ensure that the adverse effects on the transportation network are not exacerbated. However, little or no formal monitoring is undertaken.

4.3 Flora and Fauna

The terms floral and faunal refer to the biological communities, which would be studied in this assessment. The **Flora** is the plant population as a group that colonises a specified location, country, region or time, while the **Fauna** relates to the animal groups which exist within a certain locality, country, region or period in time. Information on the terrestrial and aquatic organisms in the Linden Soesdyke area will be represented; these include relative abundance, distribution, sensitive habitats, endangered and endemic species and other ecological interactions within the ecosystems.

4.3.1 Basis for Selection

Flora and fauna were selected as a VEC, because they represent a very significant factor within the biophysical environment, upon which mining of this nature will create some adverse impacts. Sand and loam mining is conducted by first stripping the land of vegetation, followed by the removal of topsoil and overburden and finally the excavation of large amounts of soil (sand/loam). Hence, inevitably there would be some loss/reduction in the floral population (plants, trees, grasses, herbs, shrubs, ferns, fungi, etc.) during and after mining, and until some re-vegetation occurs. Additionally arboreal organisms, such as birds and snakes, monkeys, would be affected, ground dwellers including those which burrow in the soil may be killed, injured or otherwise disturbed, their habitats may be destroyed, food source depleted, nutrient cycle lost and barriers of migration to breeding and feeding grounds. High sediment loads in water resource, fuel spills and other forms of pollution can have negative impacts on the aquatic environment. While high noise levels and dust emissions may affect faunal species. When these and other potential adverse impacts of sand/loam mining in the biological environment were considered in scoping it was decided that flora and fauna should be studied as a VEC in this EIA. The VEC includes rare and endangered species including those of special conservation status. The study team chose to include biota in this broadly defined VEC owing to the paucity of data on specific species and community groups.

4.3.2 Boundaries and Residual Environmental Impact Rating Criteria

4.3.2.1 Project and Assessment Boundaries

For flora and fauna, the assessment boundaries extend beyond the limits of the project boundaries. This is because the life cycle of various biotas involve species and community groups or populations that may extend well beyond the project boundaries. As this will vary from species to species and from community to community, it suffices to say that project impacts must be assessed in the context of these broader biological boundaries. However, practically speaking, for the purposes of this assessment and to be very conservative, the population boundaries of species are assumed to be consistent with those of the project boundaries, i.e., within the direct zone of influence of the project. This has been done despite the fact that the ecosystem of the project area is well represented in the sand belt of the Guianas.

4.3.2.2 Technical Boundaries

There were several technical boundaries that affected the study of the Valued Environmental Component Flora and Fauna in the project area. These are as follows:

- *Lack of existing data.*

Data and information regarding flora and fauna in the project area were often lacking. This included simple baseline data. Also there weren't much documented information in relation to the flora and fauna in the area. For the purpose of this assessment whatever data was available had to be used. Another problem that also contributed to the lack of baseline data was that previously no records were kept of mining activity in the area by the regulatory bodies.

- *Time allocation.*

Based on the nature of this assessment, conducted as a training exercise under the GENCAPD Mining project, there wasn't enough time to gather existing data or conduct additional field studies that may have been helpful to the assessment. These data had to be gathered and analyzed within two weeks. This didn't allow for any detailed survey to collect information that might have been helpful and existing data that was available had to be used.

- *Budget.*

Also, again, based on the nature of the project in which this assessment was done there wasn't any provision financially for the execution of any detailed baseline data survey.

- *Lack of time available for participants.*

The participants of this project all had full time jobs. Also, they had to be away from their job for the first phase of the project. During the second phase they had to find the balance between their job and their respective research. Therefore, much time wasn't dedicated towards this aspect of the training.

4.3.2.3 Residual Environmental Impact Rating Criteria

In establishing residual environmental impact rating criteria the study team focused consideration on those animal communities that are dominant in the area, such as, mammals (labbas, agouties, savannahs foxes, deer, opossums, etc.) and various species of birds. These are the two most prevalent animal groups in the Linden Soesdyke area. A few reptiles, amphibian and fishes are also representative groups of the site, but since these are very rare they would have a low degree of interaction with the project. The dominant plant communities in the area that would be more seriously affected include, dukama, duka, congo pump, various palms and wild ferns. The area also encompasses a number of creeks, the Madewini, Marudi, Dakarra, Yarrowkabra and Awabisi, which serve as habitats for aquatic organisms. These areas also provide for a greater diversity of flora, due to the presence of moisture.

Six scales were chosen to evaluate impacts:

1. *Magnitude* - relates to the enormity or degree of adverse impacts on groups of species, habitats and ecosystems. Using rating of 1-3, with 1 being of lowest magnitude and 3 highest magnitudes.

2. *Geographical extent* – these values were determine after considering the physical boundaries of the project, together with the range in migratory patterns of the animals and their interactions or relationships with a particular specie or ecosystem in that area and other location countrywide or regionally. Scales of 1-7 were chosen, 1 being less than a hectare, while 7 was an effect which is >800 hectares or may even be felt regionally or further afield.

3. *Duration* – Encompasses the time frame within which a particular effect may adversely affect the organisms, habitats or ecosystem. From a 1-5 range, 1 represented an effect lasting less than a month, while 5 would be an effect that would last more than 120 months.

4. *Frequency*- this parameter addresses the regularity of an occurrence or effect within a year. These can range from an extremely low or rare incidence which would be given a value of less than 5 to one which is continuous throughout the life of the mine.

5. *Reversibility*- describes the whether or not an impact can be changed or reversed. Where if an effect were long term or permanent it would be irreversible.

6. *Ecological/socio-cultural and Economic Context* – this refers to the extent of environmental degradation of the area either by natural or human intervention. Values of 1 and 2 are used. In this study all the effects would be given a rating of 2- that indicates that the area is not unspoilt but has undergone some adverse changes, caused by the human interference in the area.

In developing a threshold for the evaluation of impact significance, several criteria will be used. Those impacts which are of high magnitude, covering a geographic area greater than 100 hectares, occuring over a period greater than 60 months and that have a frequency of more than 50 occurrences per year, will be important in evaluating significance. Additionally impacts that are irreversible and those when the cumulative effects of other developments in the area are measured would have the potential to drastically affect the environment will be also be considered in determining significance.

A significant environmental impact would be one that is of enough magnitude, or of such great geographic extent, duration and frequency that a reduction in the abundance and distribution/migration rate of species and species groups or communities results within the assessment boundaries. This criterion would be used especially in cases where even after mitigation has been applied can still have undesirable effects on large portions of the flora and fauna communities, making them unable to regain the original population status within natural variation. The impact may be irreversible.

4.3.3 Description of existing environment

Guyana is divided into four (4) geological regions. The area where sand mining is conducted on the Soesdyke Linden Highway falls into the lowland region or sandy rolling hills. White sands and undulating forest usually below 15 metres asl dominate this area. The soils are composed of over 80% quartz sand, some clay at lower depths and minute portions of other minerals. Loam soils (saprolite) also exist in some regions of the highway, having marked colour variation in the soil horizons, where after some 15 metres or more a mixture of white and red sand may be encountered.

Some regions tend to be of a swampy nature, where pegasse soils are common, followed by layers of sand clay loam and sand. The topsoil tends to be very thin ranging between 80-100cm. The water table usually fluctuates between 12 - 14 m below ground level and seldom goes below this value.

Sand by definition is a very porous coarse grain soil particle, being very permeable, percolating rate tends to be extremely high and as such nutrient retention is poor and erosion potential high. Hence, the soil series in this area has been classified as “tiwiwid sand” by some researchers, since the organic matter load is very low and as such the area tend not to be suitable for agricultural purposes, consequently they have been classes also as “Capability Class IV”. On the contrary however, these lands were designated since the 1950’s as agricultural lands and were leased to a number of persons for this purpose. However, because of low fertility rate, very few persons were able to succeed with this venture and subsequently turned to mining, as the first alternative, tourist resorts are also common in this area. As such the region stretching from Yarrowkabra to Madewini Creek/Emerald Towers have recently been reserved for tourism.

The primary vegetation types on such soils are dry evergreen forests with a predominance of xeromorphic ecotypes. In the area of study however, secondary vegetation dominates, since the area has been disturbed in the past for various purposes. Loggers exploited timber since the early 1900s for commercial species such as wallaba and mora, which have now been depleted. The Guyana Forestry Commission in the 60's also temporarily operated a sawmill in this location. Use of timber for firewood and charcoal was common and charcoal burning is still practised today. The construction of the highway, which consequently saw an increase in the number of settlements, tourist resorts and other development projects thereby contributing to the cumulative impacts in the area. This area is now been referred to by the GFC as "Converse" forest.

As a result of interference by man and because of the nature of the soil, vegetation tends to be sparse, in most parts. Small plants, shrubs and various grasses are common. The area is also often prone to wild fires and as such vast open areas referred to as "muri" are common, this is especially the case in the abandoned mines. In other parts much denser secondary forests are evident, however, the trees tend to be less than 15 feet and are usually only 2-6 inches in diameter-at-breast-height. Other factors which would have contributed to such low regeneration rate of such disturbed forests would be the low nutrient content of the soil, the loss of faunal habitats, such as birds, which are instrumental in seed dispersal and the absence of enough trees to promote wind dispersal or cross pollination.

It should be noted that floral and fauna communities are more diverse whenever there is a creek or watercourse nearby. Within the Soesdyke Linden Highway approximately seven creeks have been documented, but these however, did not contribute significantly to improvement in the biodiversity in the area. A number of factors contribute to a low level of faunal biodiversity in the area. These factors include:

- dry humid conditions,
- few watercourses,
- well-drained soils,
- limited vegetation cover,
- frequent wild fires,
- human presence,
- reduced cover from potential predators,
- greater exposure to desiccation,
- loss of habitats,
- barriers to migration..

Although studies on the biology/ecology taxonomy, distribution and abundance of species in this area is limited, it has been documented in few small studies that they are no endemic or endangered local species nor critical habitats on the highway.

4.3.3.1 Flora

A few areas on the Linden highway are engaged in farming/crop planting, this has also been attempted at few abandoned mines although it has not been very successful. Some of the crop being grown includes, peanuts, pineapples, bananas, peppers, ground provisions- eddoes, yams, etc. An 11 acres nursery owned by the GFC exists in the Yarrowkabra area, where experimental planting of trees adapted to the soil type is being conducted.

Some areas along the Highway are characterised by swamp vegetation. In such parts > 60 % of the vegetation consist of woody trees of over 17 ft in height, with fairly dense growth of shrubs and herbs below. Riparian vegetation is also common along the creek banks. Approximately 30 % of the vegetation consist of palms of various kinds. In these areas there is a notable absence of commercial forest species such as mora, except for a few wallaba, which is a clear indication that the area is not pristine but has been disturbed for over 100 years. For such reason currently vegetation is predominantly succession communities or secondary vegetation.

Table 4.7 lists some flora species that can be found in the mining area.

Table 4.7: Some Flora species, which can be found on the Linden Soesdyke Highway

No.	Scientific Name	Common Name
1	Tapirira guianensis	Duka
2	Dimorphandra conjugata	Dakama
3	Chrysobalams icaco	Fatpork
4	Goupic glabra	Kabukalli
5	Terminala sp.	Fukadi
6	Jacararanda copaia	Futui
7	Licania sp.	Kauta
8	Euterpe Oleracea	Manicole
9	Bactrise gaviona	Plumpa Palm
10	Ptercarus officinalis	Corkwood
11	Vismia angusta	Bloodwood
12	Licania laxiflora	Marishiballi
13	Eschweilera corrugata	Kakaralli
14	Oliomorphondra conjugata	Congo Pump
15	Anacardium occidentale	Cashew
16	Symphonia glabuliftia	Manni
17	Siparuna cuspidata	Muniridan
18	Pentaclethra macroloba	Trisil
19	Ischrusiphon sp.	Mukro
20	Iribachia alata	Wild tobacco
21	Maurita flexuosa	Ite palm
22	Maximiliana regia	Kokerite palm
23	Astrocaryum tucumoides	Awara palm
24	Astrocaryum tucuma	Korwu palm
25	Eperua sp.	Wallaba
26	Exthroxylu, phyllanthus	Wild cherry
27	Myrcia sylvatica	Wild guava
28	Pteridium aquilinum	Bracken Fern

No.	Scientific Name	Common Name
29 30	Hymenaea sp.	Locust Jamoon
31		Whitie
32		Helicona
33		Coconut palm
34		Muka muka grass
35		Various types grasses
36		Sweet sage & black sage
37		Cultivated crops

Source: Ramdass, et al. (1998).

4.3.3.2 Fauna

The Soesdyke-Linden area represents a limited number of faunal species when compared to the local biodiversity in other parts of the country. The following animals can be found on site.

Insects

Insects belonging to the orders Isoptera-termites, Hemioptera- bugs, ants, Lepidoptera-butterflies and moths, Odonata – Dragonfly, flies and Hymenoptera-wasps are common. Lots of the vertebrate groups in the location usually feed on these insects.

Birds - Aves Class

Locally the largest vertebrate group is known to come from the Avian group of vertebrates, over 750 species of these animals have been documented. However less than 20 such species have been reported in this area in previous sand mine EIA studies (Table 4.8). This would seem to indicate that biodiversity may be relatively low in the area. Possible reasons for such low numbers may be loss of forest vegetation, which provides the habitat and nesting grounds for these arboreal organisms, the rarity of food supplies (fruits, insects and works), noise disturbance and other interference form humans.

Table 4.8: List of some Aves species, previously identified in the area

No.	Common/Vernacular Name	Scientific Name
1	Kiskadee	Pitangus sulphuratus
2	Swallon Wing	Celioloptera tenebrose
3	Tropical Ring Bird	Tyrannus melanchalicus
4	Black Vulture	Coragyps atratus
5	White Faced Duck	Dendrocygna vidnota
6	Dove	Columbina sp.
7	Macaw	Ara sp.
8	Palm Tanger	Thraupis sp.
9	Parrot	Amazonia sp.
10	Yellow Rumped Cacique	Thraupis episcopus

No.	Common/Vernacular Name	Scientific Name
11	Toucan	Ramphastos sp.
12	Savannah Hawk	Bululcua rbis
13	Carcara	Milvago cp.
14	Currasow	
15	Egret	
16	Blue sakie	

Source: Ramdass, et al. (1998).

Reptilian and Amphibian Groups

These animals are found to be the most rare vertebrate group in the area, although few species of lizards, snakes, crocodiles, turtles and frogs have been seen (Table 4.9). Two major reasons for the low abundance of these species are because they are better adapted to moist/wet environments, since in the more open dry "muri" conditions they may be susceptible to frequent wild fires and desiccation from the sun. In addition to be now exposed to predators from a reduce forest canopy, reptilian groups are also known to be excellent candidates in the wildlife trade and domestic trapping.

Table 4.9 Herpetofauna Known to Occur in the Area.

No.	Common/Vernacular Name	Scientific Name
1	Frog	Bufo sp.
2	Crocodile	Crocodilys crocodiles
3	Camoubi	Eunectus murimus
4	Labaria	Fur de Lance
5	Lizard	Euphractus sexcintus
6	Turtle/Tortoise	Geohelone sp.
7	Snakes	

Source: Ramdass, et al. (1998).

Fishes

Sand mining operations seldom pose significant impacts on the aquatic resource, except in rare cases of a fuel spill, massive erosion or spill of sand and runoff of soil into the surface water. The water table tends to lie with 10 –14 m of the watertable; thereby it would not take long for fuel or other leachate to percolate to the groundwater.

There are only about 7 creeks around the project site, generally referred to as "black water" because of the colouration when afar. Fishes are the second most diverse group listed locally with over 352 fresh water species described. However, the Ministry of Agriculture has documented that the site has a very low fishery resource, such fish; patwa, hurri, sunfish, catfish and eels can be found in the area. A few arthropods-molluscs, including shrimps, snails, leeches and benthos have been listed as present also (Table 4.10).

Table 4.10: Fish and Aquatic Species Known to Occur in the Area.

No.	Common Name/Vernacular Name	Scientific Name
1	Patwa	Cichlasoma sp.
2	Sunfish	Crenicichla sacatillis
3	Hurri	
5	Eels	
6	Leeches	
7	Snails	
8	Shrimps	

Source: Ramdass, et al. (1998).

Mammalian

Just a few mammals are known to exist around the project location, many of which are nocturnal in habit (Table 4.11). The more common mammals are labbas, tapirs, agouties, yassie, watras, bats and savannah foxes, which have been recorded also in a number of studies. With the exception of bats and foxes, these mammals are commonly hunted by locals for their meat.

This may be one element that accounts for their few numbers. Other considerations would be destruction of their habitats, scarcity of food, noise and physical barrier to migration to breeding and feeding grounds. The Savannah fox has been the only mammal that had raised some concern for protection, since it has been recorded on the list of the Convention for International Trade of Threatened and Endangered Species (CITES). However, the abundance and distribution of this species locally has not been documented but it has been reported to be abundant in most parts of the country and as such may not warrant a placement on the Guyana list.

Because of the nocturnal habits of these animals accurate predictions of their abundance may be difficult. On a positive note however, mining operations occurs during the daytime hours, when also workers and residents are most active. Hence the level of disturbance would be obviously reduced at nights where the animals can be much safer and at peace to dwell.

It should be noted also that with the introduction of settlement a few domesticated animals also exist in the location, these include poultry, pigs, cattle, dogs, horses and cats.

Table 4.11: Mammals Known to Occur in the Region.

No.	Common Vernacular Name	Scientific Name
1	Red Deer	Mazama americana
2	Opossum	Didelphis marsupialis
3	Yassie	Euphractus sexcintus
4	Grey Fox	Urocyon Cinereoargenteus
5	Bush Hog (Precarry)	Tayassu Pecari
6	Grey Deer	Mgouazoubira cineroargenteus
7	Labba	Agouti paca
8	Watras	Hydrochaeris hydrochaeris
9	Savannah Fox	Cerdoyon thos
10	Spotted Cat	Feilis tigrina
11	Bat	Chiroptera
12	Agouti	Dasyprocta agouti

Source: Ramdass, et al. (1998).

4.3.4 Impact Assessment

4.3.4.1 Project-VEC Interaction

Table 3.1 identifies the activities of past and present mining and the potential environmental impacts associated with these. Various activities of mining and related potential accidents, malfunctions and unplanned events have likely resulted in environmental impacts on flora and fauna. Environmental impacts that are likely to have or are currently occurring as a result of past and present mining include:

- Habitat loss;
- Habitat avoidance;
- Change in Biodiversity;
- Habitat fragmentation; and
- Direct mortality.

These project related impacts are acting in combination with similar environmental impacts as a result of other past, present and likely future land uses within the project area (e.g., agriculture, tourism, recreation).

4.3.4.2 Impact Analysis

Table 4.12 summarizes the impact analysis of the past and present project on flora and fauna. For the purpose of this assessment the impact analysis of the past and present sand and loam mining activities is done together. This is mainly because the project activities and their impacts as well as they mitigation measures (although limited) are very similar. In the past and present mining activities, flora and fauna were severely affected and this was mainly because there was a lack of an environmental regulatory framework and mining was done without regard for the environment. Also, there was generally a lack of mitigation measures to minimize these impacts. Certainly, if there were mitigation measures in place impacts would have been far less. However, in a very few cases there were some efforts to mitigate against these impacts and these were done mainly in the form of reclamation. In cases where there were attempts to mitigate it was not properly done, for example, topsoil was stockpiled but this was done in a manner where it was difficult to reclaim. Activities from mining in the past and at the present have significantly affected flora and fauna but this was mainly due to the lack of mitigation measures.

Table 4.12: Environmental Effects Assessment Matrix
Valued Environmental Component: Flora and Fauna
Phase: Past and Present Mining, Accidents, Malfunctions and Unplanned Events

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Clearing	Habitat Loss (A)	None	2	4	1/7	R	2
	Habitat Avoidance (A)	None	1	4	1/6	R	2
	Change in Biodiversity (A)	Maintenance of adequate vegetative buffer zones from roads, creeks, and other land uses. Promotion of reclamation in a few cases.	1	3	5/7	R	2
	Habitat Fragmentation (A)	None	1	2	1/1	R	2
	Direct Mortality (A)	None	2	5	1/2	R	2
Site Access	Habitat Loss (A)	None	1	1	6/7	R	2
	Habitat Avoidance (A)	None	1	1	6/7	R	2
	Change in Biodiversity (A)	None	1	1	6/7	R	2
	Habitat Fragmentation (A)	None	1	1	6/7	R	2
	Direct Mortality (A)	None	1	1	6/7	R	2
Mine Buildings	Habitat Loss (A)	None	1	1	1/1	R	2
	Habitat Fragmentation (A)	None.	1	1	1/1	R	2

Table 4.12: Environmental Effects Assessment Matrix
Valued Environmental Component: Flora and Fauna
Phase: Past and Present Mining, Accidents, Malfunctions and Unplanned Events

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Socio-Cultural and Economic Context
Stripping\ Stockpiling of Topsoil	Habitat Loss (A)	None	2	4	1/7	R	2
	Habitat Avoidance (A)	None	1	4	1/6	R	2
	Change in Boidiversity (A)	None	2	4	1/6	R	2
	Habitat Fragmentation (A)	None	1	4	1/6	R	2
	Direct Mortality (A)	None	1	4	1/6	R	2
Mining	Habitat Avoidance (A)	Progressive mining and reclamation is undertaken in some present operations	2	4	1/7	R	2
Mine Reclamation by Natural Regeneration	Habitat Loss (P)	Mining reclamation in a few cases.	1	2	1/7	R	2
	Habitat Avoidance (A)	Mining reclamation in a few cases.	1		1/7	R	2
	Change in Biodiversity (A)	Mining reclamation in a few cases.	1	2	1/7	R	2
	Habitat Fragmentation (P)	Mining reclamation in a few cases.	1	2	1/7	R	2
	Direct Mortality (A)	Mining reclamation in a few cases.	1	2	1/7	R	2
Solid and Liquid Waste Disposal	Habitat Avoidance (A)	None	1	1	1/2	R	2
Hazardous Materials Spills	Habitat Avoidance (A)	None	1	2	1/1	I	2
Vehicular Accidents	Direct Mortality (A)	None	1	1	1/1	I	2
Forest and Bush Fires	Habitat Loss (A)	None	1	2	1/2	R	
	Change in Biodiversity (A)		1	2	1/2	R	2
	Habitat Avoidance (A)		1	2	1/2	R	2
	Habitat Fragmentation (A)		1	2	1/2	R	2
	Direct Mortality (A)		1	2	1/2	R	2
Illegal Dumping	Habitat Avoidance (A)	None	1	1	6/2	R	2
Illegal Settlement	Habitat Loss (A)	None	2	2	6/3	R	2
	Habitat Avoidance (A)		2	2	6/3	R	2
	Change in Biodiversity (A)		2	2	6/3	R	2
	Habitat Fragmentation (A)		2	2	6/3	R	2
	Direct Mortality (A)		2	2	6/3	R	2

Table 4.12: Environmental Effects Assessment Matrix
Valued Environmental Component: Flora and Fauna
Phase: Past and Present Mining, Accidents, Malfunctions and Unplanned Events

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Standing Water	Habitat Loss (A)	Restriction of mining to within 2 m of water table in some mines.	1	2	2/1	I	2
	Habitat Avoidance (P)		1	2	2/1	I	2
	Change in Biodiversity (P)		1	2	2/1	I	2

KEY

Magnitude:
1 = Low: few organisms of a specific group or small ecosystem confined to one generation or less within natural variation, which tend to be affected occasionally.
2 = Medium: small portion of population,habitat, ecosystem or two generations which tend to be seldom affected and undergo rapid and unpredicted change temporarily outside the range of natural variability.
3 = High: Continuously affecting a very large portion of the population, habitat or ecosystem outside the range of natural variation.

Geographic Extent:
1 = <1 ha
2 = 2-20 ha
3 = 21-100 ha
4 = 101-200 ha
5 = 201-400 ha
6 = 401-800 ha

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-60 months
4 = 61-120 months
5 = > 120 months

Frequency:
1 = < 5 events/year
2 = 6-20 events/year
3 = 21-50 events/year
4 = 50-100 events/year
5 = >100 events/year
6 = continuous
7 = discontinuous

Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

4.3.4.3 Determining Significance

Based on the residual environmental effects rating criteria established it is concluded that past and present mining activities, including the cumulative impacts of other past and present projects has had a significant adverse impact on flora and fauna (Table 4.13). The areal extent of past and present mining, and the lack of mitigation being applied has rendered the affected areas relatively sterile for an extended period of time. While the biota of the region may not be severely affected by this loss, within the boundaries set for this EIA, they are considered significant. If there were any form of mitigation measures practiced then certainly the impacts would have been far less and may have been reduced to not significant levels.

Table 4.13. Residual Environmental Effects Summary Matrix

Valued Environmental Component: Flora and Fauna

Phase	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	S	2	3	1
Accidents, Malfunctions and Unplanned Events	NS	2	1	1

Key:
Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

*As determined in consideration of established residual environmental effects rating criteria.

4.3.4.4 Monitoring and Enforcement

Monitoring and enforcement in the sand and loam mining area has been limited in recent times, and not existent prior to the establishment of the EPA and the Environmental Division at GGMC. EPA and GGMC have conducted occasional inspections of these mines in recent years on an ad hoc basis. No monitoring programs are in place. The EPA has granted several Environmental to current sand mines.

4.4 Economy

4.4.1 Basis for VEC Selection

Economy was selected as a VEC a sand/loam mining, in a significant way; affects the financial status of persons or companies involved in the sector directly or indirectly.

4.4.2 Boundaries and Residual Environmental Impact Rating Criteria

4.4.2.1 Project and Assessment Boundaries

The project's immediate boundaries are the Soesdyke Linden Highway from the east Bank/Soesdyke Junction to Yarrow-kabra Creek to the extent of the sand pits on either side of the road. The boundaries are localized (the adjacent land uses) yet had extensive impacts (special assessment of Greater Georgetown) because of the consideration that in the past mining activities had negative (positive) impacts on the land. Other VECs affected in the past are the financial status of persons or companies (economy), transportation, land use and public health safety.

Under the VEC economy, there were poor mining techniques employed and no form of reclamation, (only natural reclamation) thus at present to exploit those resources and reclaim the land will affect the economy of the industry since these activities cost money. The mine plans in the past were poor; pits reached the water table (under VEC water resources). This caused future problems and money has to be spent on the same, again, a negative economic impact.

4.4.2.2 Technical Boundary

These boundaries are the limitations, that were we encountered during the research and fieldwork that was undertaken for this EIA. As a training exercise this study involved, limitations that included cost, availability of time, other secular engagements.

The level of confidence and likelihood of the sand/loam EIA was so judged taking into consideration the fact that there were no particular experts in special areas of concern and most people of the team are inexperienced.

4.4.2.3 Residual Environmental Impact rating Criteria

A significant adverse environmental impact in the economy is one that is of sufficient magnitude, duration or frequency, such that the Sand and Loam business, or its related secondary economic activities are unable to proceed on a sustained, profitable basis.

4.4.3 Description of Existing Conditions

Sand and loam from the Soesdyke area has so far played an important role in the country's development. The sand/loam mines in this area are very valuable to Georgetown and surrounding environment. This is mainly because the area is the closest source of the resource, which is widely used in construction activities. Throughout the years this area has supplied the construction industry with the resource and is continuing to do so. Because of the importance of sand and loam to the construction industry the demand for sand/loam has escalated rapidly over a short period of time. Sand from the area is currently being used in the housing industry, which is growing as well as in the development of infrastructure such as roads and seawalls. There are lots of other relative jobs created (not necessarily spin-offs), from the sand/loam mining, without which there would be lots of unemployment. It is therefore evident that regards to economy the sand/loam industry is pivotal to the country's financial status. The reading referred to in Section 2.2.6 for a characterization of the economy associates with present sand and loam mining.

4.4.4 Impact Assessment

4.4.4.1 Project-VEC Interactions

As described in Table 3.1, sand and loam mining, the potential environmental impacts of sand and loam mining are all on balance, considered positive:

- payment of royalties;
- business revenue;
- employment; and
- foreign trade / export.

Adverse impacts can arise from accidents, due to the use of vehicles, workers and public accidents. The sand and loam is integrated with the economy of the great Georgetown area.

4.4.4.2 Impact Analysis

Table 4.14 provides a summary of the impact analysis.

Table 4.14: Environmental Effects Assessment Matrix
Valued Environmental Component: Economy
Phases: Past and Present

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/ Frequency**	**Reversibility**	**Cultural and Economic Context**
Mining	Payment of Royalties (P)	Monitoring for compliance at truck station and by surveying mines periodically	1	6	2/1	R	2
	Employment (P)	None	1	6	5/5	R	2
	Business Revenue (P)	None	2	6	5/5	R	2
	Foreign Trade/Export (P)	None	1	6	2/1	R	2
Accidents, Malfunctions and Unplanned Events	Vehicle Accidents (A)	None	2	6	1/3	I	2
	Worker Accidents (A)	None	2	6	½	I	2
	Public Accidents (A)	None	2	6	1/1	I	2

Key:

Magnitude
1 = low: less than 100 000 tons
2 = med. : 100 000 – 200 000 tons
3 = high: more than 200 000 tons

Frequency
1 = < 11 events/yr
2 = 11 – 50 events/yr
3 = 51 – 100 events/yr
4 = 101 – 200 events/yr
5 = > 200 events/yr

Geographic Extent
1 = < 1 sq. km.
2 = 1 – 10 sq. km.
3 = 11 – 100 sq. km.
4 = 101 – 1000 sq. km.
5 = 1001 – 10 000 sq. km.
6 = > 10 000 sq. km.

Cultural and Economic Context
1 = relatively pristine area/areas not adversely affected by human activity
2 = evidence of adverse effects

Duration
1 = < 1 mth
2 = 1 – 12 mths
3 = 13 – 36 mths
4 = 37 – 72 mths
5 = > 72 mths

Reversibility
I = irreversible
R = reversible

N/A = not applicable

4.4.4.3 Determining Significance

Table 4.15 summarizes the impact analysis. Overall, the project has a positive impact, however, the issues of vehicle, worker, and public accidents are significant and adverse, and clearly unacceptable, despite the economic benefit.

Table 4.15: Residual Environmental effects Summary Matrix

Valued Environmental Component: Economy

Phase	Residual Environmental Effects Rating Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	P	3	3	3
Malfunctions, Accidents and Unplanned Events	S	2	3	1
Project Overall	P	3	3	3

Key:

Residual environmental Effect rating:

S = Significant Adverse Environmental effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: base on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level

N/A = Not Applicable

* As determined in consideration of established residual environmental effects rating criteria

4.4.5 Monitoring

In the past there were no monitoring activities done on sand/loam mines with respect to any regulatory body. However, currently, truck traffic is monitored by GGMC at Soesdyke and pit geometry is surveyed quarterly. There is no monitoring of accidents related to the industry.

4.5 Land Use

4.5.1 Basis for Selection

The term “Land Use” refers to the activities that are being carried out on a land area, e.g. dwelling, farming etc. In the project/study area, sand mining is undertaken along with other multiple land uses, for example tourism, agriculture, forestry, residential and other land uses. Many aspects of sand mining are incompatible with other land uses, which alienate sand mining and sand reserves. The development of a community for residential purposes will result in the occupied land and associated reserve being inaccessible, thus resulting in a loss of that underlying reserve.

In addition to the above sand mining conflicts with other land uses, for example the residential community or an eco-lodge will be negatively affected by noise and other effects emanating from the sand mine. In view of the foregoing, Land Use was selected as a Valued Environmental Component (VEC).

4.5.2 Boundaries and Residual Environmental Impact Rating Criteria

4.5.2.1 Project and Assessment Boundaries

The project boundaries will comprise of the mining areas (abandoned and current), the surficial extent of the sand deposit identified as the basis for the development of future sand mining and those areas immediately adjacent to the full extent of the deposit. The area may be described as follows: from the Soesdyke/Linden Highway junction, thence along the highway route to the Yarrowkabra area, thence along the Glass Factory road to the Timehri Airport, then along the East Bank Public Road to the Soesdyke/Linden Highway junction. The area is enclosed by these boundaries.

4.5.2.2 Technical and Administrative Boundaries

This report is the result of the efforts of Technical personnel who have full-time jobs that are very demanding. An assessment such as this requires comprehensive research and time input, things that the team could not afford given the demands of their jobs and the timeframe allowed. However, an effort was made, notwithstanding the fact that the team has never been involved in preparing/conducting EIAs and has just recently been trained to do so. Stakeholder consultation could not be done on a large scale. This would have added valuable content to the study of Land Use as a VEC. A few agencies were approached for information on land use in the study area, but information gaps still remain.

4.5.2.3 Residual Environmental Impact Rating Criteria

A significant impact on land use is one where the proposed use of land for sand and loam mining is not compatible with adjacent land use activities as designated in local land use plans or as currently used. The sand and loam mining would create a change or disruption that restricts or degrades present land uses such that the activities cannot continue to be undertaken at current levels or with the same quality of life. Future land uses may be precluded.

4.5.3 Description of Existing Conditions

The project area consists of abandoned sand mines, existing sand and loam mining activities and other land uses.

Agriculture

Multiple agricultural activities have been reported and observed in the study area. Due to the fact that a lot of the land in the area was leased to individuals for agricultural purposes, this observation is not surprising. Among the activities seen was pig farming, poultry rearing, fish farming and planting of cash crops.

Tourism

When visiting the area, one can be treated to tourism facilities. Along the Linden highway, nature resorts can be found, e.g. Emerald Tower, Splashmin's, and Aziza Akosua.

Forestry

According to the Guyana Forestry Commission, the forest in the area comprises secondary growth and is therefore not suitable for commercial logging, but is being used for Charcoal. However, a Forestry Research Center is in the area.

Residential

Residential communities are prevalent in the area. These are generally along the major roads. However, a few small ones can be found further inland, and are accessed through secondary roads and trails. Examples of such communities are Kuru Kururu and Yarrowkabra.

Airport

The Cheddi Jagan International Airport, Timehri is located in the study area in close proximity to Loam mining.

Recreation

Recreational facilities are readily available in the area. Among these facilities are The South Dakota Circuit (motor racing), The Timehri Range (rifle shooting), and Black water creeks (swimming & picnicking).

Military

A military base (Camp Stevenson), is located in the area adjacent to the Airport. This facility conducts training on a small scale and also provides health care benefits to the surrounding communities.

Commercial

Hotels, such as Le Chalet Country Club and Emer's, are located close to the East Bank Public road. A glass factory, located in the study area, was in operation in the past using high quality sand from the area but has since ceased operation due to unforeseen circumstances.

Other Land Uses

Due to the presence of residential communities and the Airport, associated land uses such as Power lines, Cemeteries, Police Stations, Fire Stations, and Gas Stations can be found in the area.

4.5.4 Impact Assessment

4.5.4.1 Project – VEC Interaction

The activities associated with sand and loam mining in the past and present are listed in Table 3.l along with the potential impacts. Potential impacts associated with mining, accidents and other land uses include:

- Alienation of adjacent land use;
- Limitation of future land use (mine site); and
- Loss of sand / loam resources.

4.5.4.2 Impact Analysis

Table 4.16 provides a summary of the impact analysis.

Table 4.16: Environmental Effects Assessment Matrix
Valued Environmental Component: Land Use
Phase: Past and Present

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**		
			Magnitude	**Geographic Extent**	**Duration**
Mining					
Clearing	Alienation of adjacent land use (A)	Plan or Co-ordinate Activity	1	3	1
Site Access Roads	Alienation of adjacent land use (A)	Plan or Co-ordinate Activity	1	1	1
	Loss of Sand/Loam Resources (A)	Minimize number and width of roads and Mine Plan and progressive mining	1	1	3
Mine Buildings	Alienation of adjacent land use (A)	Plan this activity	1	1	1
	Loss of Sand/Loam Resources (A)	Plan before locating buildings in order minimize the loss of the resource	1	1	1
Stripping/Stockpiling Topsoil	Alienation of adjacent land use (A)	Plan this activity	1	3	3
	Loss of Sand/Loam Resources (A)	Ensure that stripping and stockpiling is done strategically (Mine Plan)	2	1	3
Mining Sand and Loam	Alienation of adjacent land use (A)	Regulate noise levels from equipment; Recommend dust suppressant for roads	1	3	3
	Loss of Sand/Loam Resources (A)	Mining Plan	2	1	3
Mine Reclamation	Enhance Future Land Use (mine site) (P)	Reclamation and Mining Plan	N/A	N/A	N/A
	Alienation of adjacent land use (A)	Plan this activity	1	3	2
Solid and Liquid Waste Disposal	Alienation of adjacent land use (A)	A strategic disposal plan	3	3	3
Accidents, Malfunctions and Unplanned Events					
Hazardous Material Spills	Alienation of adjacent land use (A)	Safe material handling practices	3	3	3
	Limitation of Future Land Use (mine site) (A)	Safe material handling practices	3	3	3
Forest/Brush Fires	Alienation of adjacent land use (A)	Care should be taken when handling flammables	3	3	3
Illegal Dumping	Alienation of adjacent land use (A)	Controlled Dumping (Regulated) Access control measures	1	3	1
	Limitation of Future Land Use (mine site) (A)	Controlled Dumping (Regulated) Access control measures	1	1	1
	Loss of Sand/Loam Resources (A)	Controlled Dumping (Regulated) Access control measures	1	1	1
Illegal Settlement	Alienation of adjacent land use (A)	Property area control measures	3	1	3
	Limitation of Future Land Use (mine site) (A)	Property area control measures	3	1	3
	Loss of Sand/Loam Resources (A)	Property area control measures	2	1	3
Standing Water	Limitation of Future Land Use (mine site) (A)	Investigate the quality of the water resource	1	3	3
	Alienation of adjacent land use (A)	Investigate the quality of the water resource	3	3	3

Key
Magnitude:
1. = Low: Land is made unusable
Occasionally for a short period of time

2. = Medium: Land is made unusable
Very often for a long period of time.

3. = High: Land is made unusable

Geographic Extent: Extent of Area Affected
1 = <10 km^2
2 = 11-100 km^2
3 = >10 km^2

Duration: Period for which area or land is affected

1	=	Short:	<3 months
2	=	Long:	<3-6 months
3	=	Very Long:	>6 months

Mining Phase Table 4.5.2

The effects associated with most of the activities in this phase are alienation of adjacent land use and loss of sand/loam resources. However, mine reclamation, or lack thereof, results in a limitation of further land use at the site.

Clearing

Clearing refers of the act of clearing the area for sand or loam mining and will not be a continuous activity. However if the nearby land use is an eco-lodge or residential then noise emanating for this activity will negatively affect these land uses. This activity will not be done very often or for long periods and as a result its effect on the above-mentioned nearby land used will only be felt when ever the activity is carried out.

Further, the natural resource sand and loam cannot be mined without first clearing the land, and by the time the mine is closed or abandoned, the area exposed would have accumulated extensively geographically.

All past and present mines have large areas, which were cleared to facilitate sand and loam mining. In most of the past mine areas there is evidence of un-planned secondary growth. While the operators of most of the present sand and loam mines are reluctant to assist with process of re-vegetation, because of cost involved.

Mitigation measures to deal with the noise coming from the activity clearing of current mines could involve a coordinated approach between the stakeholders of the different or adjacent land uses. In addition a commitment to the re-vegetation of present sand and loam mines can be achieved through the development of better progress plans and a vibrant monitoring system. None of these measures are currently being implemented.

Site Access Roads

Site access roads are an integral part of the sand and loam mining activity and refer to the area cleared for the purpose of road building. Noise coming from this activity will have effects on the nearby land use, similar to that of the activity clearing. Like clearing this activity will not be done very often and will be conducted for short periods.

In addition to the above, as long as site access roads exist, the underlying sand and loam resource cannot be mined and utilsed. These roads are built as the sand and loam mining activity progresses and therefore does not last for a long time. The underlying resource will eventually be extracted; unless the site access road is left behind or not removed at the end of the sand or loam mine.

To improve the situation, mitigation measures will be the same as that dealing with noise under clearing, but will have to involve a plan that reduces the width of the site access roads, for those roads that are left behind.

Mine Buildings

These refer to the buildings that are built for use on the sand and loam mining Permit area. The act of building these buildings or construction activity can result in noise levels that will negatively affect adjacent land use such as tourism or residential. Note however that this activity will last for a short time and, on most occasions is carried out only at the beginning of the sand and loam mining activity.

In addition to the above these buildings occupy land on the sand and loam mining permit area. These areas are usually not very extensive and can be classified as a very small geographical area. Consequently the underlying resource will not be greatly affected.

Mitigation measures will have to include a plan that outlines the location of the mines buildings so that it is strategic and minimizes loss of the resource.

Stripping/Stockpiling

This refers to the activity of removing and arranging in another location on the permit area the material or topsoil immediately above the sand and loam resource. Stripping/Stockpiling can also result in noise levels that can affect adjacent land use, such as tourism. This activity is not continuous and does not last for a long time. However the aerial extent of this act can be very extensive.

Stripping and stockpiling in past and present mines have resulted in the inability to mine valuable underlying sand and loam resource. Mitigation measures will therefore have to include recommendations for improvement (Mine Plan) to current methods (stripping/stockpiling).

Mining Sand and Loam

This refers to the act of removing sand and loam from the ground and can result in noise levels and dust pollution that will negatively affect adjacent land use such as tourism and residential. This activity is continuous, will last for a very long time and covers a large geographical area.

In addition to the above this activity can negatively affect the integrity of infrastructures such as power line poles and roads

Mitigation for present mines will therefore have to include measures, which not only deals with noise and dust emission control, but which also deals with a mine plan that outlines mining limits relative to adjacent use (such power line poles and roads).

Mine Reclamation

This involves the re-distribution of top soil (re-vegetation) over the sand or loam mine surface, following completion of mining. It also includes the breaking down of slopes and the establishment of relatively flat surfaces.

The activity reclamation can result in noise levels that can negatively affect adjacent land uses such as tourism and residential. Note however that this activity is usually carried out at the end of the sand or loam mining operation and in some cases may last for a long time. In most cases the area affected by this activity is the entire mine, which can be categorized as extensive.

Most of the past mines did not do any reclamation and are in a state where the land cannot be reused. In addition operators of the present mines claim that the cost for reclamation is too high.

Given the above, mitigation measures will have to include training for the operators and operational practices that will allow for cost effective reclamation of present mines.

Solid and Liquid Waste Disposal

Solid and liquid waste includes waste generated by the sand and loam mining activity (For example scrap tires and metal and fuels or lubricants) and waste brought from adjacent land uses. In both the past and present mines there is evidence of the haphazard disposal of solid waste. On the other hand, the disposal of liquid waste for example, fuel or lubricants can negatively affect adjacent land use. That is, if the adjacent land use is residential and ground water flows form the sand mining area to the residential land use area, then care must be taken to ensure the liquid waste do not get in the ground water system (if the adjacent land use depend heavily on the ground water system.)

The effect of liquid waste disposal can have serious long-term effect on adjacent land use (Residential). Mitigations of present mines will therefore have to include measures that prevent unauthorized personnel form entering the sand or loam mine and dumping waste. These measures will also have to include a system for monitoring the ground water quality.

Accidents, Malfunction and Unplanned Events

Hazardous Material Spills

These include spills from fuel containers, re-fueling trucks and leaking vehicles. Like solid and liquid waste and hazardous material spills can have the same effect on adjacent land use. It can also preclude future use of the land. Mitigation measures of present mines must address procedures for disposal, storage and handling of hazardous materials.

Forest/Brush Fires

This refers to fires caused by flammables. These fires can negatively the adjacent land use, for example tourism and can affect a large area and last for a long time. Mitigation measures should include handling procedures and an emergency plan.

Illegal Dumping

This refers to the dumping of material from surrounding land uses. The smell of dumped garbage (for example) can negatively affect the adjacent land use if it is residential. This can prevent future development of the residential land. The land can become unusable for a very long time.

Security around the sand and loam mining areas should form the basis of mitigation measures for illegal dumping.

Illegal Settlement

This refers to aliens settling on the mining property without the permission of the owner of the property. This can affect adjacent land use, limit future use of the land and result in loss of resources (not accessible). This activity, which can last for a long time, can cause the adjacent and current land to become unusable. Mitigation measures therefore have to deal with the development of proper security measures.

Standing Water

This refers to water from the water table or water that can progress into the water table. Adjacent land uses using wells can be affected of contaminants find their way into the standing water. This can render the adjacent land unusable for a very long time and can result affect the normal life of the residents (Residential land use).

Mitigation measures should deal with operational practices for current mines with standing water.

4.5.4.3 Determining Significance

The present projects in combination with the past, present and likely future projects is resulting in a significant cumulative impact on land use, and in addition precludes the development of other land uses (Table 4.17). Therefore in conclusion the effect on the valued environmental component land use is significant.

Table 4.17: Residual Environmental Effects Summary Matrix
Valued Environmental Component: Land Use

Phase: Past and Present	**Residual Environmental Effects Rating, Including Cumulative Environmental Effects***	**Level of Confidence**	**Likelihood**	
			Probability of Occurrence	**Scientific Certainty**
Mining	S	3	3	3
Accidents, Malfunctions and Unplanned Events	S	1	1	1
Past, Present and Future Projects	S	3	3	3

Key:

Residual Environmental Effect Rating

S – Significant Adverse Environmental Effect
NS – Not-significant Adverse Environmental Effect
P – Positive Environmental Effect

Level of Confidence

1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

N/A – Not Applicable

Probability of Occurrence: based on professional judgment

1 – Low Probability of Occurrence
2 – Medium Probability of Occurrence
3 – High Probability of Occurrence

Scientific Certainty: based on scientific information and Statistical analysis or professional judgement

1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

* As determined in consideration of established residual environmental effects rating criteria.

4.5.5 Monitoring

Monitoring should be an integral part of the activities by agencies that have bearing on specific aspects of the land use in the area. For instance, mitigation recommended in Table 4.16, with regards to reclamation and working according to a mine plan (which should deal with issues regarding the water table) should be monitored by the GGMC; with regards to a Land Use Plan, the National Land Use Committee; with regards to the safe handling of hazardous materials and safe disposal practices, the EPA.

4.6 Public Health and Safety

4.6.1 Basis for VEC Selection

Public health and safety was selected as a VEC because of the extensive issues identified associated with present mining during the scoping process.

4.6.2 Boundaries and Residual Environmental Impact Rating Criteria

4.6.2.1 Project and Assessment Boundaries

The Public Health and Safety VEC project and assessment will be limited to safety issues occurring within the mining site and during mining. Hence, the health and safety of workers and the public who visit or work at the site, or who live or work within the zone of influence of the mining can be affected by the project. The assessment boundaries extend a little beyond the mining property because certain impacts have a zone of influence that may extend beyond the mining operation (e.g., the health impacts of air emissions on adjacent property). Health and Safety issues associated with transportation are dealt with in Section 4.2.

4.6.2.2 Technical and Administrative Boundaries

Technical and Administrative limitations include the time available to undertake the EIA, the fact that it is being conducted as a training exercise in a classroom setting, the lack of readily available data, available budget to collect baseline data, and the inexperience of the participants. No field studies were undertaken beyond reconnaissance level site visits.

The assessment of the VEC was carried during a one-day field trip to the Soesdyke area. Therefore, the assessment could be described as a preliminary reconnaissance of health and safety practices and impacts. Additionally, the writing had to be completed independently within a two-week period where personnel had other work commitments.

No data describing public health and safety practices and impacts affecting sand/loam mining are available. There are also no reports governing accidents that may have occurred at the mine site or during mining.

The experience of the participants was limited since no one had carried out an impact assessment before. The assessment was done in a classroom setting where the participants had writing assignments while learning simultaneously.

4.6.2.3 Residual Environmental Impact Rating Criteria

A significant adverse impact on public health and safety would be one that occurs frequently, is irreversible and/or results in chronic illness, serious injury or death.

4.6.3 Description of Existing Conditions

Based on field observations there seem to be limited consideration for worker health and safety at mine site. There were no (no safety equipment) hard hats, safety boots, safety glasses, goggles, safety vests and respirators observed. Secondly, the mining practices were unsafe because the slopes on the sides of the mine that were extremely steep could have collapsed at any time. In fact one worker was using the collapsing sides as a method of excavation. From observation, it is assumed that there were no safety rules and regulations governing the mine. Finally, there was indiscriminant of waste since the access to mines was uncontrolled. Fuel/oil spills were also observed in some mines.

4.6.3.1 Project VEC Interaction

The potential impacts of past and present mining include injury, illness and loss of life that could be associated with hazardous material use and solid and liquid waste disposal. These interactions were identified in scoping (Table 3.1)

The likely impacts will be related to hazardous materials used at site. These include the usage and storage of Diesel, Lubricants (oil), and Grease without any safety measures in place. Waste oil from heavy-duty machines repairs are observed. The improper handling, storage and disposal of these hazardous materials can result in fire explosion, possible contamination of groundwater and hence resulted in possible loss of life and or illnesses to persons from the use of the water.

Solid and liquid waste disposal is rapidly forming part of the landscape of the existing mines. These pits at mining sites are used as reservoirs for waste disposal, waste oil and domestic run off are among the liquid waste, while solid waste are made up of all sorts of articles such as old refrigerators, stoves, tins, irons, tyres, etc. Uncontrolled liquid and solid waste disposal in these mines can result in accidents, injuries and the creation of an outbreak of diseases which can have severe effects on the nearby communities and the work force of those operations.

Injury/illness would occur mostly during accidents malfunctions and unplanned events such as hazardous spills vehicle accidents, worker accidents, public accidents, forest and brush fires, standing water.

Impacts identified here that are likely to occur are spills from the continuation use of hazardous materials. These include diesel, lubricants (oil) and grease that are used on a daily basis and in some instances stored on site. Spills can occurred from leakage of storage containers, while fueling machines, leaking fuel lines, seals and hydraulic hoses of trucks also while repairs works are being carried out at site. The cumulative effects can range from injuries to illnesses.

Vehicle accidents are unplanned, and are likely impacts, The movement of trucks that are engaged in business on a good day averaging in number to about 150. With the absence safety signs, safety awareness education in sand/loam mining the probability accident occurring is great.

Forest/bush fires are impacts that can be considered to be unplanned and even accidental and can occur only at extremely dry season. These fires in some instances occurred naturally due to sun's heat while on the other hand it can be started by the accidental flick of a lighted cigar/butt. The effects of the smoke can blind vision of person driving vehicles, inconvenient nearby communities, disturbed ecosystems of both flora and fauna life and threaten the safety of life and property.

Illegal dumping are likely impacts to be considered since this is evident at all sites visited. Evidence of this nature is seen at the entrance of one sand and loam pit. These illegal dumping are done by some of the trucks that are transporting sand/loam. The act is said to occur early in the morning before mine staff arrive on site. These activities are not only bad in principle but are creating occupational hazards, since they are dumping in a manner can cause problems to drivers of trucks and can create reservoirs for rodents and flies among other things.

Standing water was evident in one existing sand pit that was, at the time, non-operational. However, one operational sand pit shows evidence of standing water pools having dried up leaving the area in a very soft condition. None of this was noticeable at the loam pits. Standing Water are ideal reservoirs for mosquito breeding, attraction for illegal children swimming and for the source for spreading water borne diseases. Interaction with past, present and future projects include particularly the transportation network and forest resource management.

4.6.3.2 Impact Analysis

The purpose of the analysis below is to evaluate the potential impact of past and present mining on occupational health and safety. Table 4.18 provides the environment impact assessment matrix. The analysis will be based on the assumption that all activities at reference could potentially result in death and therefore all effects will be considered significant and irreversible.

Table 4.18: Environmental Effects Assessment Matrix
Valued Environmental Component: Public Health and Safety
Phase: Past and Present

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Impact**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**			
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**
Hazardous Material Use	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment, emergency response	3	1	3/3	I
Solid and liquid waste disposal	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment, emergency response	3	1	3/3	I
Hazardous material spills	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	3/3	I
Vehicle accidents	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/3	I
Worker accidents	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/3	I
Public accidents	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/3	I
Forest and brush fires	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/2	I
Illegal dumping	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	3/3	I
Standing water	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response etc.	3	1	3/3	I

Key:

Magnitude
1 – low-short term illness or injury, rapid recovery
2 – long term illness or injury, reversible
3 – chronic illness or death

Geographic Extent
1 – mine site
2 – 1km-11km2
3 –10km2 -100km2

Frequency
1 - very infrequent
2 – infrequent
3 – frequent

Duration
1 - <1 month
2 - 1-12 months
3 –12-36 months

Reversibility
R - Reversible
I - Irreversible

N/A – not applicable

The magnitude of all accidents is potentially high since from field observation mining is carried out in a manner with little or no regard for the health and safety of workers or the public. Therefore, the assumption is that accidents occur frequently with adverse effects. Although, accidents are not deliberate, they are an unplanned occurrence during mining (as opposed to clearing which results in the deliberate removal of habitat, for example), unsafe practices greatly increases the probability of occurrences. The geographic extent of the effects is limited to the mine site and surrounding areas where members of the public may fall into deep pits or drown in standing water because no signs are posted and access is not restricted. Duration of accidents ranges from long term effects of standing water or hazardous material spills to instantaneous effects of vehicle accidents. Since from the original assumption that all accidents at reference result in death, then all effects will be irreversible.

The reduction in the number of accidents is possible if certain mitigation strategies are implemented in the future. These include:

- Implementation of safety rules and regulations and safer mining practices;
- Provision of safety equipment – safety goggles, safety vests, safety glasses;
- Emergency response plan;
- Proper storage and disposal of solid and liquid waste;
- Providing workers with mine safety training; and
- Placing danger signs in pertinent area.

4.6.3.3 Determining Significance

This section discusses the significance of the residual environmental effects based on the residual environmental impact rating criteria (Table 4.19).

Table 4.19: Residual Environmental Effects Summary Matrix
Valued Environmental Component: Past and Present Public Health and Safety

Phase	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	S	1	3	1
Malfunctions, accidents and unplanned events	S	1	3	1

Key:

Residual Environmental Effect Rating

S – Significant Adverse Environmental Effect
NS – Not-significant Adverse Environmental Effect
P – Positive Environmental Effect

Level of Confidence

1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

N/A – Not Applicable

Probability of Occurrence: based on professional judgement

1 – Low Probability of Occurrence
2 – Medium Probability of Occurrence
3 – High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis of professional judgement

1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

* As determined in consideration of established residual environmental effects rating criteria.

Accidents produce a significant environmental effect since any accident at reference could possibly result in serious injury, illness or death. The level of confidence is low since the discussion is based on an assumption stated in the previous section. Based on field observation, the probability of occurrence of vehicle, worker and public accidents are high because mining is carried out with no regard for public or worker safety. For example no safety equipment is used, mining methods are unsafe (collapsing mines slopes), no danger signs are posted, dumping of waste seems to be a regular practice among other infractions. The scientific certainty is low because there is no data available to substantiate this analysis.

5.0 PROJECT DESCRIPTION OF FUTURE SAND AND LOAM MINING

This chapter will develop the project description of the future mining scenario of the sand and loam mining industry. Aspects covered include:

- an evaluation of the projected demand and reserve requirements;
- a suggested mine plan with provisions for a mode of operation and reclamation together with the associated environmental and occupational health and safety concerns; and
- licensing procedures (and recommendations if the existing one is deficient in certain areas).

This will aid in the preparation of an EIA of the future sand and loam industry in Section 6.

The main reason behind this exercise is to provide a plan for the future sand and loam mining industry that reflects the principle of sustainable development and strives to minimize the significant impacts identified in Section 4.0. It will take into consideration the sustainability of the industry, with minimal effects to the environment as a whole, and, at the same time, maximize the derived benefits to all concerned.

For the purposes of this Assessment, the future is defined to mean/include all sand and loam mining applications that will be processed immediately after the publication date of validation of this sectoral EIA.

5.1 Demand and Reserve Scenario

5.1.1 Planning Horizon

In establishing the projected demand for sand and loam, the following assumptions were made in determining the planning horizon:

- the main market is assumed to be Georgetown, the surrounding areas, the access area from the source area and potential future potential future export;
- urban development along the coast and areas away from the assumed local market is assumed to use other proximal resources limiting the geographic extent of potential demand;
- demand for sand will be affected somewhat by future national development plans that will involve construction of infrastructure and hence a need for sand and loam;
- future construction needs are anticipated to include housing, commercial and business repair and development, repairs/maintenance to existing infrastructure (e.g., roads, seawalls),

construction of new infrastructure (e.g., arterial roads, airports, seawall (higher and expanded);
- the sea level is anticipated to rise over the next 50 years and will create a need to raise the sea wall; and
- the Soesdyke area contains resource deposits that are the closest to the assumed market and are hence considered the resource supply area.

Based on all of the above assumptions, the planning horizon is assumed to be fifty (50) years.

5.1.2 Reserve

To establish the reserve (and location) for sand and loam deposits that will satisfy the demand for the projected 50-year planning horizon the following criteria and/or assumptions were established or made.

- The water table is generally approximately 14-15 m below the ground surface in the project area with minor variations due to local topography.
- The water table was established from altitude readings taken at the water level in several abandoned and currently operating mines while the attitude of the layers (sand deposit) was determined from sedimentary structures observed during a reconnaissance field trip in the area.
- The water table is assumed to be the similar throughout the project area and that it is relatively consistent throughout the sand deposit as it is an unconfined aquifer comprised of relatively permeable sands.
- The upper and lower surface of the loam resource is relatively horizontal
- Sand and loam is to be mined down to a depth of two m above the water table during the wet season.

To calculate the resources required to - meet demand for the next fifty years, the following variables were used:

- The average sand and loam consumption per year were calculated from the records available from GGMC.
- This (average) figure was used as the base figure (year 1) for the first (of the fifty years).
- Growth of the demand for sand and loam was assumed to be at 5% annually.
- Calculation shows the base figure to be 900,000 tons for sand while the total for fifty
- years at an estimated growth of 5% annually is 188,413,196 tons.
- The base figure (year 1) for loam is 72,000 cubic yards per year while the total for

- fifty years at an estimated annual growth of 5% annually is 15,073,056 cubic yards

The total area required for sand mining in the next 50 years is approximately 2,620 hectares while that for loam is approximately 385 hectares.

The data used to make the above calculations are provided in Appendix A.

The GGMC are currently implementing measures to improve reporting of sand and loam mining. It is estimated that reported production may be as much as 5 (to 6) times less than actual production. Given this uncertainty, for the purposes of this EIA, the surveyors reports were used to provide the figures used. This is a more accurate reflection of the resources'extraction per year.

5.1.3 Selection of Reserve Area

The selection of the reserve area to satisfy the fifty (50) year demand for sand was done with the following considerations in mind.

- The reserves occupied by buffer zones along highways, power lines and other land use and preserves were excluded from the resource area calculations.
- The easiest access to the to the reserve area was considered in an effort to minimize
- (access and other associated) cost.
- Must not be located close to streams (if so buffer zones will be built to protect them),
- infrastructure and eco-tourism locations.
- Location is best on topographically high areas since, volumetrically, the additional
- thickness will result in less surficial area being affected.
- Location of the reserves must not be too far removed from the currently operating
- mines. This is expected to stabilize transportation costs and result in a stabilized cost of the product to the customer. With this in mind, location was done to absorb areas designated for this use by the Land Use Planning Committee.
- The estimated land surface area required for sand mining is 2,620 hectares and 385 hectares for loam. This does not include buffer zones.

5.1.4 Description of Reserve Area for Sand and Loam

After the calculations, forestry, soils, land use and ownership maps were consulted, and a reconnaissance of the project area was undertaken. All lands lawfully held or occupied have been excluded from consideration. Allowances for buffer zones have been included. Land designated as agricultural has not been excluded from consideration.

Based upon all of the above considerations, it was decided that the area (together with a description) with enough reserve for sand and loam mining, in part, is presented below. It is important to mention that the total area calculated for the future of the sand and loam is not met here. This is due to time constraints which prevented the proper investigation and isolation of other deposits. However, for the time being, the areas shown can sustain the future industry while continued exploration for additional deposits goes on.

(A) Sand

Area 1	431.8 hectares
Area 2	388.8 hectares
Area 3	535.8 hectares
Area 4	324.5 hectares
Total	**1,680.9 hectares**

These areas are plotted and referenced on Figure 5.1. The base map was generated from topographic map sheet 28NW/SW at scale 1:50,000.

(B) Loam

The area selected for the future loam mining industry is 154.3 hectares. This area is plotted and presented on Figure 5.1. The base map was generated from topographic map sheet 20SE at scale 1:50,000.

5.2 Mine Plan, Operation and Reclamation

5.2.1 Ideal Sand/Loam Pit

Planning a sand pit/mine using the strip mining method requires consideration of many variables with complex inter relationships. Following a collection of general deposit and project related information, a development and extraction plan was conceived. Project economics were determined and an economic analysis was performed to determine the project viability. Several iterations were done to determine the optimum solution for future sand and loam pit mining. Some of these are/included various mining method/equipment combinations, mine size/equipment combinations, mining method/pit layout combinations etc.

The future sand/loam pit mining requires the consideration of several variables and information such as the geology, engineering, environmental sciences and economics. As a result, the planning and development of future of sand/loam pit mining is interdisciplinary in nature and required inputs from numerous individuals with diverse backgrounds and training. The ideal mine plan will result in a feasible operating plan, as well as one that optimizes the economic return subject to the numerous contractual, environmental, legal and other constraints related to the specific property.

Clearing, grubbing and stripping will be done to remove trees, shrubs, thin stumps, roots and topsoil to expose the sand or loam resource for mining. Merchantable or salvageable timber will be harvested. Stumps, shrubs and brush will be kept for reclamation purposes where the planned future land use is to re-establish natural vegetation. Where the future use requires "clean topsoil" techniques for stump and debris removal will be employed (e.g., rakes, burning). Environmental Codes of Practice and guidelines will outline potential methods that could be used by miners for this activity.

Regulations will dictate that the topsoil be removed and ultimately replaced upon graded slopes of the exhausted mine. Topsoil can either be stockpiled at the side of the pit area for later redistribution or hauled immediately to the graded area for redistribution. Of course, this decision will be made on the basis of current economics after considering topsoil quantities and haul distances. Mining and reclamation method will be at the discretion of the miner but must be undertaken following the Codes of Practice or an approved Environmental Management Plan ("EMP"). The EMP will outline all aspects of environmental management for the mine including mining method and sequence, reclamation, future land use objectives, emergency response and contingency plans, environmental protection procedures necessary to ensure that potential environmental impacts are prevented or mitigated. Natural regeneration will be encouraged and active re-generation will be undertaken where warranted by reclamation objectives.

It will be good operating practice to divert surface water from active pit areas to eliminate in-pit water problems/flooding. This is particularly important for loam pits where internal drainage is impeded by low natural permeability. Diversion ditch systems will be used as necessary to deflect the water and direct it into natural drainages. The objective will be to minimize operational and future land use issues associated with periodic flooding.

In general, design measures will be done to meet economic standards. Miners will follow the Environmental Codes of Practice as well as the applicable regulations under the Mining Act. All work will be done in compliance with Mining Licenses or Permits and Environmental Authorizations (if required). These measures include minimizing the disturbed areas, stabilizing slopes, diverting overland, flow and re-vegetating quickly in order to reduce sedimentation in receiving water bodies and to minimize loss of topsoil.

5.2.2 Pit Floor

Pit floors will be smooth and relatively flat to ensure the safety of pit employees and equipment. Upon abandonment, pit floors will be left at grades that are conducive to the intended future land use. Where that is not known, the pit floor should be left relatively flat so as not to preclude a range of future land uses.

Scrapers, dozers or loader/trucks will be used in future sand/loam pit operations for topsoil replacement and redistribution. Some preparations such as plowing will be done to stabilize the topsoil. Traffic patterns will be designed to prevent over-compaction of the pit floor.

Re-vegetation will be encouraged by natural regeneration. Topsoil will be replaced to encourage natural regeneration. Where adjacent seed sources are limited or where future land use objectives required it, planting will be accomplished either by hydro-seeding or with conventional farm equipment. This will be done as soon as is possible with seed selection based on post-mining land use.

To avoid contamination of the ground-water resources in the future sand/loam pit mining area, the pit floor will be approximately two m above the maximum elevation (wet season) of the ground-water [table] level. Further, fueling will occur in a pre-determined location following fuel storage and handling procedures to be outlined in the EMP. These locations shall have a relatively impermeable surface that will preclude the loss of hydrocarbon to the water table. Spills will be cleaned up immediately. Contaminated soil will be disposed of at a hazardous waste management facility as approved by the EPA. An emergency response and contingency plan will be included in the EMP to address all petroleum, oil and lubricant spills. Equipment should be kept in good working order to ensure that leaks are repaired promptly. The Environmental Codes of Practice will outline best practices in this regard.

To prevent groundwater contamination, the future mine will have measures in place to ensure that illegal dumping of wastes (domestic or industrial) does not occur within pits. These measures could include security gates, signage, and education. Upon abandonment, site access can be removed or prevented.

5.2.3 Pit Wall/Face

In sand pits, the wall and face shall not exceed 5 m. Where pits exceed a depth of 5 m, they shall be mined in 5 m benches. This will ensure safe conditions for excavation and facilitate efficient reclamation. Revegetation of the wall/face will be similar to that of the pit floor.

During reclamation, pit walls and faces will be graded to stable slopes, topsoil re-spread and the re-establishment of natural vegetation encouraged. Construction of the final slopes will not exceed original slopes.

5.2.4 Extraction

The main operations in a sand/loam pit mine are ground penetration, excavation, loading and transportation. These operations are inter-dependent and the optimum cost per ton may not be obtained by attempting to minimize each of the individual operational costs.

The selection of the excavator/loader is of prime importance because it is the key to low cost production. Some of the factors that were used to determine the equipment required for the future sand pit mining includes the intact strength of the ground, the abrasive properties of sand/loam and the depth of mining. Several types of equipment can be used including loading draglines, shovel, front-end loaders (track type) and bulldozers.

Pre-stripping will be done by bulldozers or front-end loaders and trucks with a stripping lead of no less than fifty m. The waste/topsoil will be stockpiled in a manner that allows for efficient use in reclamation. The removal and stockpiling of topsoil and overburden (in the case of loam pits) were dealt with in the ideal pit design (5.2.1). Importantly, the Environmental Codes of Practice and Guidelines will outline methods to ensure the economic reclamation of all mines. To that end, topsoil must be stockpiled sufficiently far from the clearing limit to ensure that it can be accessed for reclamation by the proposed equipment. Further, the active face must be a sufficient distance from the stockpiled topsoil to ensure that at final reclaimed grade, the topsoil can be easily re-spread for reclamation purposes. Existing operations all show evidence of poor or no mining plan with respect to reclamation and efficient use of stockpiled topsoil. The Environmental Codes of Practice will describe methods of progressive reclamation designed for efficient mining and reclamation, and to ensure the fullest possible and cost-effective use of the resource.

The Environmental Codes of Practice and Mining Licenses and Permits, and Environmental Permits will specify buffer zone requirements. The actual mine property will be more extensive than the actual area of excavation, allowing for buffer zones from adjacent land use and for environmental protection.

Production scheduling is an important facet of mine planning. Scheduling determines the pit life, and therefore, cash flows including capital requirements, operating costs and revenues. Initial production scheduling will be based on the analysis of the demand for sand/loam, a haulage study based on a conceptual pit design and overall facility layout.

Operational objectives for mine planning will include minimizing pre-production costs, assuring adequate working room, timely exposure of the sand/loam resource, reclamation and maximizing production.

(a) Pre-production operational costs are normally treated as capital costs because they are incurred before production starts. These costs are not discounted, and in fact, should be assessed and an interest charge for the time period used. Therefore, mining plans should outline strategies for progressive mine development that reduces pre-production operational costs.
(b) Assuring adequate working room is important for a number of reasons. Safe mining, and efficient mining and reclamation are facilitated by having adequate working room. Timely exposure of sand/loam – Proper sequencing is achieved through incremental pit design and progressive reclamation. Each increment is related to demands within the market. Mining sequences will be tentatively established and then analysed to set the more logical development program. The pit sequence, hence, assures a predictable supply to cope with market demands.
(c) Reclamation Environmental regulations will be implemented under the Mining Act to ensure mine reclamation is undertaken. The regulations will be supported by Environmental Codes of Practice.
(d) Maximising Production – the following points provide for more efficient scheduling and equipment utilization: - (1) avoid excessive loading equipment movement, (2) minimize the number of working areas, and (3) reduce haul distances and ramp grades when practical. Increased productivity lowers operating cost per unit mined.

Based on the demand and market requirements, future sand/loam pits would have to cater for adequate transportation fleet from the mine to the markets. It is envisaged that more highway trucks will be required to supplement the current fleet. Alternately, larger trucks could be used depending upon the capability of the road infrastructure to handle the loads.

5.2.5 Access Roads

Most of the past and present sand/loam pit operators, in interest of capital cost, simply cut or fill haul roads with material existing at the location. This presents various problems such as deterioration of the road surface that result in the passage of trucks being impeded. This results in reduced production, and increased cost of fuel and maintenance. The future for sand/loam mining is to construct an improved roadbed that permits the better transfer of wheel loads over the subgrade (foundation material) so that the bearing capacity is not exceeded. It will be necessary, therefore, to recommend guidelines for material selection that allow for the use of a wide range of construction materials including, ideally, those that are on site.

In-pit roads will be constructed for single lane, uni-directional traffic. The road width will be dependent on the width of the widest vehicle proposed to traverse the road. Maximum gradients will be statutorily limited to between 8% to 15% (4.5° to 8.5°) for sustained gradients. However, in general, when considering the economics of uphill haulage, as well as downhill safety, the optimum gradient for those situations will be about 8% but up to 12% (6.8°) for larger trucks (20 tons). For safety and drainage reasons, long steep gradients will include 150ft (50m) long sections with a maximum gradient of 2% (1°) for every 1,500ft to 1,800 ft (500m to 600m) of severe gradients.

In general, current signage associated with sand mining is totally inadequate with respect to safety, traffic flow, efficiency and environmental protection. The future mine should have adequate signage for these purposes.

Runaway trucks can be a serious hazard on steep downhill gradients, therefore, safety provisions to guard against this [hazard] will be provided as part of the haul road design. The method proposed for the future sand/loam pits is the location of triangular piles of unconsolidated sand/loam along the corners of the haul road. In the event of brake or retarder failure, the truck driver can maneuver into the line of the pile(s) so that the truck straddles the pile and is brought to a halt with minimal damage.

Runoff water will create problems due to washouts and erosion. Hence, drains and culverts will be an essential part in the design of haul roads for the future sand/loam pit industry.

5.2.6 Storage, Handling and Use of Hazardous Materials and Waste Disposal

For the future, sand/loam pit mine legislation and/or guidelines and environmental codes of practice will have to be put in place to address the storage, handling and use of hazardous material and waste disposal. The current Mining Act regulations do not comprehensively outline requirements and procedures in this regard. The aquifer for the Georgetown water supply is recharged in white sand area.

It is important that a specific legislative and guideline framework be put in place to ensure that the quality of ground and surface water will not be affected as a result of sand and loam mining. Harsher penalties will have to be implemented to protect the widely used water resource from careless operators. Guidelines will deal with methods for domestic and sanitary waste disposal methods, industrial waste (oils, fuel, etc.) defining storage area for hazardous material and maintenance and refueling procedures for trucks and excavating equipment. Designating areas for domestic water supply and other areas for other uses such as dust suppression will be required.

Under the Environmental Regulations, when implemented, these new requirements can be implemented. These can be supported by the Environmental Codes of Practice that will be developed to support the regulations. Miners and GGMC staff will receive training in their implementation.

5.2.7 Occupational Health And Safety

The possible threats to health of sand/loam pit workers are: exposure to toxic gases and dust, exposure to excessive heat and humidity, noise and inadequate illumination. Some of these environmental stresses may interact to produce a greater overall effect. In combination or alone, if environmental stresses exceed tolerance levels for prolong periods of time, feeling of discomfort will occur, performance and productivity will drop and accidents or illness will occur. Threat to workers' safety may arise from slope failure, from haulage and excavating equipment or from fire.

The future of sand/loam mining will focus on maintaining environmental stresses under control at all times and this cannot be over-emphasized. There will be strong measures of government control and inspection of mines unclear legislation specific to sand/loam pit mining that is intended to safeguard the health and safety of these workers. Changes in the government's policy for sand/loam pit safety will have to be developed through a series of legislative and policy actions that will enable them to enforce the legislation. This strong legislative initiative will be supported by Environmental Codes of Practice that will include measures to ensure a safe and healthy work place.

Employers must ensure that all employees wear protective gear, are subjected to periodic medical examination and trained in occupation, health and safety. Management in future operations must provide leadership in safety with clear definition of the goals and means to achieve them. They must promote and seek highest standards of safety performance at work through consistent and persistent development and use of knowledge and skills. It will be management's responsibility to provide a working environment for miners in which the equipment, processes and procedures are so reliable, well defined and understood as to eliminate hazards to miners in the case of system failures. Management will be required to exemplify through actions at every available opportunity its deepest commitment to safety.

5.3 Regulatory Framework

The major regulations governing Sand and Loam Mining are the Mining Act 1989, Lands Act, to a lesser extent, the Occupational Health and Safety Act, and the Environmental Protection Act. Mining Environmental Regulations under the Mining Act, which are under preparation, will also govern Sand Mining. Sand Mining will also be influenced by government policies and plans, notably, the National Land Use Plan and the national Water Policy.

Codes of Best Practices and Guidelines will complement and strengthen the Mining Environmental Regulations, into which they are to be incorporated. To this end, *Sand Mining Guidelines* are being finalized by a joint EPA-GGMC Committee.

Where export of sand is done in the future, this is likely to be on a large scale, and it is expected to include beneficiation, storage and shipping by river. Legal requirements for building and operating wharfing facilities and for export of sand will have to be met, as well as additional environmental management of storage, loading and shipment of sand, and beneficiation processes involved.

5.3.1 Regulatory Procedure

5.3.1.1 Lands and Surveys, Ministry of Agriculture

Although all mineral rights are vested in the State, the project area is currently outside of the six Mining Districts, and is administered under the Lands Act by the Lands and Surveys Department of the Ministry of Agriculture. Since these lands are designated for agricultural purposes, official approval has to be given by Lands and Surveys for alternative land use. The owner of the Agricultural Lease also has to give formal approval for the 'conversion' of land use to mining.

5.3.1.2 GGMC

After approval is obtained from Lands and Surveys, application to mine sand or loam is made to GGMC, and simultaneously, application for an Environmental Permit is made to EPA. A Mining

Permit (medium scale) or Quarry License is only issued after approval has been given or an Environmental Permit is issued by the EPA. Geological Services, Mines and Environmental Divisions of the GGMC are involved in the professing, grant and issue of the Mining Permit or Quarry License.

5.3.1.2 EPA

The EPA may determine that an Environmental Permit is needed, in which case, an EIA has to be done by the proponent. EPA will consult with GGMC prior to the approval of the EIA. The Environmental Permit is administered by the EPA.

5.3.2 Mining Environmental Regulations

Under the draft Mining Environmental Regulations, Sand and Loam Mining are included under the mining of industrial minerals, or quarrying. As industrial minerals mining, Sand Mining can be done on a medium and large scale, since the definition of *'small scale mine'* excludes Sand Mining. The following requirements apply:

- Environmental Code of Practice for Sand and Loam Mining;
- Reclamation and Closure Plan;
- For medium and large-scale operators, an Environmental Management Plan for 3 to 5 years, subject to update on an annual basis or from time to time as requested by GGMC;
- For small scale operators, and holders of existing medium and large scale Mining Permits/Licenses, that are currently being mined or already mined, a Reclamation and Closure Plan including measures for:
    - Stripping and stockpiling of topsoil for use in reclamation
    - Replacement of topsoil and vegetation of disturbed lands
    - Restoration of water courses, where appropriate
- For medium scale operators, Contingency and Emergency Response Plans, and communication of such plans to employees and independent contractors.
- For small scale operators, Clean Up Plans for materials stored, and proposed site of operation in event of a spill. The Clean Up Plan shall take the form of a checklist provided by GGMC. As far as practicable, every precaution shall be taken to prevent the draining of oil from equipment onto the ground.
- Restrictions of Mining Activities in Protected areas, viz
    - Within 200 metres of the low water mark of a river bank;
    - In specified nature reserves and parks where resource extraction is prohibited
    - In buffer areas without the express approval of GGMC and the notification of parties likely to be affected by the activity.

- For large scale operators, an Environmental Bond;
- For small scale operators, a reclamation fee;
- Monitoring site drainage and any water discharge affected by Sand/Loam Mining (*it is unclear if these provisions only apply to tailings pond effluent)*, viz;
    - Flow measurements
    - Receiving waters at a location approved by GGMC, monthly downstream and quarterly upstream. Annual characterization of samples upstream and downstream of discharges.
- Environmental Effects Monitoring.

In addition, these general provisions apply:

- Refilling of mined out areas, or putting same to an approved, alternative, *beneficial* use;
- Deforestation and debushing prior to and durind mining; Clearing rivers and creeks, river channels;
- Removal, storage and re-spreading of topsoil;
- Revegetation;
- Sediment loading of streams;
- Disposal of petroleum products; Inspection of environmentally damaged areas, prior to commencement of mining.

5.3.3 Important additional requirement:

- Water table monitoring – monthly and as specified by GGMC.

For *'routine'* operations within the project area up to a specified size, an EMP will apply, that will adequately address all of the requirements of the Mining Environmental Regulations. In addition, it will give clarity to the intent and application of the *'Pollution Control'* measures stipulated by the regulations and simplify/unify these requirements. The Sand and Loam Mining Guidelines will also be modified, to make them more consistent with the EIA.

Likewise, the application, operation and monitoring procedures will be consistent with the National Water Policy, since the project area is located in the important recharge zone for the coastal artesian wells, and surface water in the area is used by local communities and other land users. The future Sand and Loam Mining area will be governed by the National Land Use Plan for zoning in the area, and this may obviate the need for prior approval by Lands and Surveys, deleting a loop in the permitting process. Adoption of the EIA will negate the need for an EIA for *'routine'* operations, taking out a second loop in the permitting process.

Large Scale Mining in the future will follow applicable procedures for large scale mining or quarrying, including an EIA and an Environmental Permit. Such Permits will consider any negative effects from stockpiling (dust and erosion), loading, shipping and beneficiation of the sand. Larger tonnages of sand will be mined *(note that this was not considered in calculation of demand, and consequently, reserves and project area)*, with the possibility of mining below the water table. If this happens, environmental management will become more involved, and water management will be more critical.

6.0 IMPACT ASSESSMENT OF THE FUTURE MINING SCENARIO

In this section the impact of future mining as described in Section 5.0 is undertaken. Given the extensive mitigation built into the future scenario, the potential interactions are minimized and in fact several of those described in Table 3.1 are unlikely to occur in the future scenario (Table 6.1).

Table 6.1. Potential Interaction of Future Mining and Other Land Uses with the Environment

Project Activities and Physical Works	**Potential Environmental Impacts**																
	Change in Water Quantity	**Change in Water Quality**	**Habitat Loss**	**Habitat Avoidance**	**Change in Bio-diversity**	**Habitat Fragmentation**	**Direct Mortality (fauna)**	**Change in Traffic**	**Injury, Illness, and Loss of Life**	**Deterioration of Infrastructure**	**Payment of Royalties**	**Employment**	**Business Revenue**	**Foreign Trade/Export**	**Alienation of Adjacent Land Use**	**Limitation of Future Land Use (mine site)**	**Loss of Sand/Loam Resources**
Mining																	
Clearing	√	√	√	√	√	√	√								√		
Site Access Roads			√	√	√	√	√								√		
Mine Buildings				√		√									√		
Stripping/Stockpiling of Topsoil	√	√	√	√	√	√	√								√		
Mining Sand and Loam	√			√		√									√		
Transportation to Market								+		√							
Employment and Business											+	+	+	+			
Hazardous Material Use		√							√								
Mine Reclamation	√	√	+	√	√	+	√										
Solid and Liquid Waste Disposal		√		+					√								
Accidents, Malfunctions and Unplanned Events																	
Hazardous Material Spills		√		√					√				√		√	√	
Vehicle Accidents							√	+	+				√				
Worker Accidents									+				√				
Public Accidents									+				√				
Forest/Brush Fires	√	√	√	√	√	√	√		√				√		√		
Illegal Dumping																	
Illegal Settlement																	
Standing Water																	
Past, Present and Future Projects																	
Residential Land Use	√	√	√	√	√	√	√	√		√		√	√		√	√	√
Transportation Network		√	√	√	√	√	√	√	√			√	√	√	√	√	√
Recreational Land Use	√	√	√	√	√	√	√	√		√		√	√		√	√	√
Tourism Land Use	√	√	√	√	√	√	√	√		√		√	√	√	√	√	√
Commercial Land Use	√	√	√	√	√	√	√	√		√		√	√		√	√	√
Forest Resources Harvesting	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√
Agriculture	√	√	√	√	√	√	√	√		√		√	√		√	√	√

“+” indicates positive interaction

“Ö” indicates interaction

6.1 Water Resources

6.1.1 Impact Analysis

Table 6.2 outlines the impact analysis for water resources. Under the future scenario it is assumed that extensive mitigation strategies are implemented to mitigate the significant impacts predicted for the past and present scenario (Section 4.1). This mitigation is expected to eliminate impacts attributable to illegal settlement, illegal dumping and standing water. Importantly, with progressive mining and reclamation, improved hazardous materials practices and other mitigative strategies described in Table 6.2, it is anticipated that the significant impacts will be lessened to not significant levels (Table 6.3).

Table 6.2. Environmental Effects Assessment Matrix, Future Mining
Valued Environmental Component: Water Resources

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Socio-Cultural and Economic Context
Mining							
Clearing	Change in Water Quantity (A)	Limit extent of clearing to that which is absolutely necessary. Progressive mining and reclamation. Land Use Planning and Siting of Mines.	2	6	5/6	R	2
	Change in Water Quality (A)	Limit extent of clearing to that which is absolutely necessary. Progressive mining and reclamation.	1	6	5/6	R	2
Stripping and Stockpiling of Topsoil	Change in Water Quantity (A)	Limit extent of stripping to that which is absolutely necessary. Progressive mining and reclamation.	2	6	5/6	R	2
	Change in Water Quality (A)	Limit extent of stripping to that which is absolutely necessary. Progressive mining and reclamation.	1	6	5/6	R	2
Mining Sand and Loam	Change in Water Quantity (A)	Progressive mining minimizing the area of active mining.	1	3	5/6	I	2
Hazardous Material Use (Routine)	Change in Water Quality (A)	Employee education. Maintenance of equipment in good working order and good housekeeping practices with respect to hazardous materials.	1	2	5/5	R	2
Mine Reclamation	Change in Water Quantity (A)	Progressive reclamation.	2	6	5/6	R	2
	Change in Water Quality (A)	Progressive Reclamation.	1	6	5/6	R	2

Table 6.2. Environmental Effects Assessment Matrix, Future Mining
Valued Environmental Component: Water Resources

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological/Socio-Cultural and Economic Context
Solid and Liquid Waste Disposal	Change in Water Quality (A)	Properly designed sanitary treatment. Disposal of solid and oily wastes in approved facilities.	1	3	5/6	R	2
Accidents, Malfunctions and Unplanned Events							
Hazardous Materials Spills	Change in Water Quality (A)	Employee education. Emergency Response and Contingency Plan.	1	3	5/1	R	2
Forest/Brush Fires	Change in Water Quantity (A)	Employee education. Emergency Response and Contingency Plan.	2	6	5/1	R	2
	Change in Water Quality (A)	Employee education. Emergency Response and Contingency Plan.	2	6	5/1	R	2

KEY

Magnitude:

1 Low: *e.g.,* the water resources of a few persons adversely affected
2 Medium: *e.g.,* the water resources of 1,000 -10,000 persons adversely affected
3 High: *e.g.,* the water resources of greater than 10,000 persons adversely affected

Geographic Extent:
1=<1 km²
2=1-10 km²
3=11-100 km²
4=101-1000 km²
5=1001-10,000 km²
6=>10,000 km²

Duration:
1=< 1 month
2=1-12 months
3=13-36 months
4=37-72 months
5= 72 months

Frequency:
1=< 11 events/year
2=11 -50 events/year
3=51 -100 events/year
4=101-200 events/year
5=>200 events/year
6=continuous

Reversibility:
R=Reversible
I=Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

Table 6.3. Residual Environmental Effects Summary Matrix Template, Future Mining

Valued Environmental Component: Water Resources

Phase	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	NS	1	3	1
Accidents, Malfunctions and Unplanned Events	NS	1	2	2

Key:

Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analys
or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

*As determined in consideration of established residual environmental effects rating criteria.

6.1.2 Monitoring

One of the first steps of monitoring water resources in future loam/sand pit mining is to compile all the existing data that are available in a manner that is readily available to all interested proponents. A network grid for continuous water level and water quality will be established within the assessment boundaries of the future projects. Guyana Water Authority (GUYWA) has several wells along the coast and three or probably four of these wells will be used as monitoring wells. Water levels/depths will be measured at least once per month and water samples will be analyzed for pH, temperature, total dissolve solids, total suspended solids, alkalinity, chloride (due to sea water seepage in dry seasons), total coliforms and faecal coliforms.

In order to carry out the above tasks for monitoring future operations, field technicians will be trained appropriately to conduct accurate sampling procedures. An experienced hydrologist will be employed by the monitoring agency/agencies to train field technicians and the sand/loam pit operators so that they can effectively conduct the required activities.

A laboratory will be set up to analyze all water samples. Special interest will be placed on the analysis of microbiological parameters since it is envisaged that more people will be residing and several recreation and agricultural facilities will be set up.

6.2 Transportation

6.2.1 Project VEC Interaction

In the future the conditions experience in the present are only likely to get worse. However, this can be mitigated by the following methods.

6.2.2 Impact Analysis

The effects of sand and loam transport on the transportation network would be the same as mentioned in Table 6.4 for the past and present conditions. These effects however, would be dependant on the demand for sand/loam. Since there would be an increase in demand, this would result in an increase in vehicular traffic. This would exacerbate the level of these effects.

Table 6.4. Environmental Effects Assessment Matrix
Valued Environmental Component: Transportation (to market)
Phase: Future

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Transportation	Increased Traffic (A)	Stockpiling in areas close to market and trucking in off-peak hours. Barging to market. Construction of a new, limited access highway to Georgetown, bypassing East Bank Demerara communities. Establish transportation planning and scheduling practices. Establish signage and stoplights at key points to minimize accidents. Increase weight capacity of truck fleet to reduce number of trips.	2	4	1 / 2	R	2
	Deterioration of infrastructure (A)	Use of double axle trucks. Use of load restrictions. Ensure that laden weight of trucks is compatible with infrastructure design. Construction of a new, limited access highway to Georgetown, bypassing East Bank Demerara communities. Barging to market.	2	4	2/2	R	2

Table 6.4. Environmental Effects Assessment Matrix
Valued Environmental Component: Transportation (to market)
Phase: Future

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Accidents, Malfunction and unplanned events	Injury , Illness and loss of life (A)	Scheduling trucking in off-peak hours. Properly maintained trucks (e.g., brakes) and vehicle inspection. Observe speed limits and signs. Avoid convoying. Construction of a new, limited access highway to Georgetown, bypassing East Bank Demerara communities. Barging to market. Limit hours of work for employees. Driver Education. Improved traffic law and enforcement.	2	4	2/1	R	2

KEY

Magnitude:
1 = Low: *e.g.*, < 8 trucks per hour,
2 = Medium: *e.g.*, 9-36 trucks per hour,
3 = High: *e.g.*, >37 trucks per hour

Geographic Extent:
1 = <5 km
2 = 5-40 km
3 = 41-60 km
4 = >60 km

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Frequency:
1 = < 50trips/day
2 = 50-500 trips/day
3 = >500 trips/day

Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = ...

The effects mentioned in the past and present are likely to be increased in the future. However, if the mitigation measures, such as barging and the construction of a new access road are widely practised, then the effects can be reduced to non significant (Table 6.5).

Table 6.5. Residual Environmental Effects Summary Matrix, Future Mining

Valued Environmental Component: Transportation

Phase: Past and Present	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	NS	2	3	1
Accidents, Malfunctions and Unplanned Events	NS	2	1	1

Key:

Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

6.3 Flora and Fauna

6.3.1 Project – VEC Interaction

Table 6.1 identifies the activities of future sand mining and the potential environmental impacts associated with these. Various activities of mining and related potential accidents, malfunctions and unplanned events have likely resulted in environmental impacts on flora and fauna. Environmental impacts that are likely to occur as a result of future mining include:

- Habitat loss;
- Habitat avoidance;
- Change in Biodiversity;
- Habitat fragmentation; and
- Direct mortality.

These project related impacts are acting in combination with similar environmental impacts as a result of other past, present and likely future land uses within the project area (e.g., agriculture, tourism, recreation).

6.3.2 Impact Analysis

Table 6.6 presents the impact analysis for the future mining scenario. To address the many impacts identified in Section 4.3 and the lack of mitigation in past and present mining, this analysis focuses on strategies for mitigation.

Table 6.6: Environmental Effects Assessment Matrix
Valued Environmental Component: Flora and Fauna
Phase: Future Mining, Accidents, Malfunctions and Unplanned Events

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Clearing	Habitat Loss (A)	Minimise unnecessary clearing of vegetation. Maintain adequate vegetative buffer zones from creeks and other habitats. Promote progressive reclamation and natural re-generation.	2	4	1/7	R	2
	Habitat Avoidance (A)	Minimise unnecessary noise at site to below 70dDa.	1	4	1/6	R	2
	Change in Biodiversity (A)	Minimise unnecessary clearing of vegetation. Maintain adequate vegetative buffer zones from creeks and other habitats Promote progressive reclamation and natural re-generation..	1	3	5/7	R	2
	Habitat Fragmentation (A)	Minimise unnecessary noise at site to below 70dDa. Maintain corridors for wildlife movement between active or recently abandoned mines Avoid continuous operation (i.e., 24-hour per day)	1	2	1/1	R	2
	Direct Mortality (A)	Schedule clearing outside of nesting periods for birds and herpetofauna Employee education	2	5	1/2	R	2
Site Access	Habitat Loss (A)	Minimise number and width of access roads to less than 18 ft.	1	1	5/7	R	2
	Habitat Avoidance (A)	Minimise width of access roads to less than 18 ft. Minimise unnecessary noise at site to below 70dBa. Avoid continuous operation (i.e., 24-hour per day)	1	1	5/7	R	2
	Change in Biodiversity (A)	Minimise width of access roads to less than 18 ft. Minimise unnecessary clearing of vegetation. Promote progressive reclamation and natural re-generation.	1	1	5/7	R	2
	Habitat Fragmentation (A)	Minimise unnecessary noise at site to below 70Db. Maintain corridors for wildlife movement between active or recently abandoned mines Avoid continuous transportation (i.e., 24-hour per day)	1	1	5/7	R	2
	Direct Mortality (A)	Schedule clearing outside of nesting periods for birds and herpetofauna Employee education	1	1	5/7	R	2
Mine Buildings	Habitat Loss (A)	Place buildings in areas that need to be cleared for other purposes including in mined out areas	1	1	1/1	R	2
	Habitat Fragmentation (A)	Avoid use of physical barriers, for e.g. fences.	1	1	1/1	R	2

Table 6.6: Environmental Effects Assessment Matrix
Valued Environmental Component: Flora and Fauna
Phase: Future Mining, Accidents, Malfunctions and Unplanned Events

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Stripping\ Stockpiling of Topsoil	Habitat Loss (A)	Progressive stripping and reclamation	2	4	1/7	R	2
	Habitat Avoidance (A)	Progressive stripping and reclamation	1	4	1/6	R	2
	Change in Boidiversity (A)	Progressive stripping and reclamation	2	4	1/6	R	2
	Habitat Fragmentation (A)	Progressive stripping and reclamation	1	4	1/6	R	2
	Direct Mortality (A)	Employee Education	1	4	1/6	R	2
Mining	Habitat Avoidance (A)	Progressive mining and reclamation Minimise unnecessary noise at site to below 70dBa. Avoid continuous operation (i.e., 24-hour per day)	2	4	1/7	R	2
Mine Reclamation by Natural Regeneration	Habitat Loss (A)	Progressive mining and reclamation	1	4	1/7	R	2
	Habitat Avoidance (A)	Progressive mining and reclamation	1	4	1/7	R	2
	Change in Biodiversity (A)	Progressive mining and reclamation	1	4	1/7	R	2
	Habitat Fragmentation (P)	Progressive mining and reclamation	1	4	1/7	R	2
	Direct Mortality (A)	Progressive mining and reclamation Employee Education	1	4	1/7	R	2
Solid and Liquid Waste Disposal	Habitat Avoidance (A)	Avoid burning of solid waste on site.	1	1	1/2	R	2
Hazardous Materials Spills	Habitat Avoidance (A)	Procedures for storage and handling of hazardous materials in EMP Emergency Response and Contingency procedures	1	2	1/1	I	2
Vehicular Accidents	Direct Mortality (A)	Employee Education.	1	1	1/1	I	2
Forest and Bush Fires	Habitat Loss (A)	Procedures for Burning in EMP Emergency Response and Contingency procedures Employee Education	1	2	1/2	R	
	Change in Biodiversity (A)		1	2	1/2	I	2
	Habitat Avoidance (A)		1	2	1/2	I	2
	Habitat Fragmentation (A)		1	2	1/2	R	2
	Direct Mortality (A)		1	2	1/2	R	2
Illegal Dumping	Habitat Avoidance (A)	Posting of signs stating that dumping is prohibited. Sites access control.	1	1	6/2	R	2
Illegal Settlement	Habitat Loss (A)	Private land—notify and evict squatters Government land—notify government	2	2	6/3	R	2
	Habitat Avoidance (A)		2	2	6/3	R	2
	Change in Biodiversity (A)		2	2	6/3	R	2
	Habitat Fragmentation (A)		2	2	6/3	R	2
	Direct Mortality (A)		2	2	6/3	R	2

Table 6.6: Environmental Effects Assessment Matrix
Valued Environmental Component: Flora and Fauna
Phase: Future Mining, Accidents, Malfunctions and Unplanned Events

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Standing Water	Habitat Loss (A)	Restriction of mining to within 2 m of water table.	1	2	2/1	I	2
	Habitat Avoidance (P)		1	2	2/1	I	2
	Change in Biodiversity (P)		1	2	2/1	I	2

KEY

Magnitude:
1 = Low: few organisms of a specific group or small ecosystem confined to one generation or less within natural variation, which tend to be affected occasionally.
2 = Medium: small portion of population, habitat, ecosystem or two generations which tend to be seldom affected and undergo rapid and unpredicted change temporarily outside the range of natural variability.
3 = High: Continuously affecting a very large portion of the population, habitat or ecosystem outside the range of natural variation.

Geographic Extent:
1 = <1 ha
2 = 2-20 ha
3 = 21-100 ha
4 = 101-200 ha
5 = 201-400 ha
6 = 401-800 ha

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-60 months
4 = 61-120 months
5 = > 120 months

Frequency:
1 = < 5 events/year
2 = 6-20 events/year
3 = 21-50 events/year
4 = 50-100 events/year
5 = >100 events/year
6 = continuous
7 = discontinuous

Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

For the future mining most of the impacts on flora and fauna will be significantly reduced or prevented by implementing mitigation measures. Unlike the past where the impacts were severe in the project area because mitigation measures were often lacking, in the future the situation will be different. The impacts on flora and fauna in the project area will be reduced while this impact will not affect the species generally since the project area will be very small as compared to the type of environment. The potential impacts including habitat loss, change in biodiversity, and habitat avoidance during mining will be restricted by the maintenance of buffer zones, restriction of the operation time, etc. Maintaining direct control over the project area will reduce a lot of unplanned events such as illegal dumping and illegal settlements. Most of the impacts that occurred in the past and present will be mitigated by various means and the regulatory framework will be strengthened to ensure that the mitigation measures are implemented.

Importantly, the application of progressing mining and reclamation will ensure that a minimum area will be dedicated to active mining whereas abandoned mines will be in various states of re-vegetation. This will tend to also reduce habitat avoidance and fragmentation related impacts.

6.3.3 Determining Significance

Based on the residual environmental effects rating criteria established it could be concluded that future mining activities would not have a significant adverse impact on the flora and fauna mainly because mitigation measures will be implemented to reduce these impacts (Table 6.7).

Also, the project area will be a small area as compared to the rest of the region which have similar conditions. No particular species or species group will be significantly affected by future sand mining.

Table 6.7: Residual Environmental Effects Summary Matrix

Valued Environmental Component: Flora and Fauna

Phase: Future Mining	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	NS	2	2	1
Accidents, Malfunctions and Unplanned Events	NS	2	1	1

Key:

Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

*As determined in consideration of established residual environmental effects rating criteria.

6.3.4 Monitoring and Enforcement

Based upon the conclusions of the impact analysis, a number of measures are suggested for monitoring and enforcement in the future.

- Miners should make an individual at the mine site responsible to ensure that all staff is adhering to sound environmental practises are being implemented during the pre-operational, operational and decommissioning/reclamation phases of the project.
- Ensure that appropriate fire prevention and control equipment are available on site and are fully functional.
- Employees should be trained or made aware of environmental concerns and mitigation measures required (e.g., fire prevention and control, fuel handling and storage and containment of fuel spills, removal and safe storage of topsoil, protection of fauna and flora and adherence to vegetative buffer zone limits, stipulated depth for excavation).
- Check vehicles and fuel storage area daily to observe any signs of leakage and contamination. If found immediately try to stop the leak, contain the spill and initiate clean-up as soon as possible.
- Inspect vehicles monthly to ensure they are properly maintained and in excellent working conditions, e.g., have good engines and fuel/oils and exhaust are provided with lids.
- Inspect mine daily to ensure solid wastes from mineworkers or other residents in the area are not being dumped on reserves.
- Avoid pit latrines on site and check sewage systems monthly to ensure they are operating well.
- Conduct tests on surface and or ground water if there is cause for alarm from fuel spills, or contamination of water by other means and runoff or erosion of large amounts of sediments. Such parameters that may be tested include BOD, COD, TSS, DS, DO and pH, oils and grease.
- Ensure that mine is done progressively in blocks and that reclamation is also progressive. Including, demarcation of boundaries and buffer areas, careful removal and storage of top soil, softening of slopes, replacement of tops soil, replanting of vegetation/crops which may require use of small amounts of mulch/fertilizers.
- Ensure mining is not conducted below 2 m above the water table level as determined in the wet season, and that all other guidelines, codes of practice and permit conditions are being adhered to.
- Check to see vegetation is not wastefully or unnecessarily removed (i.e., before that are may be ready to mine, since in some cases mine may suddenly be abandoned, or removal of vegetation in an area that would not be mined). Ensure that topsoil is being properly salvaged and adequate space is provided to reclaim that topsoil without affect nearby vegetation.
- Ensure that creeks are not being polluted, over fishing conducted or terrestrial fauna being hunted down or wilfully killed or harassed by employees.
- Posting and maintenance of signs in the area, e.g., no dumping, caution-fire hazard, reduce noise level in area, safety on cliff/slope.

- Document any observation or rare or endangered species in the area which are worth protecting, or the notable absence of common animal species. Implement special measures for rare or endangered species if encountered under the advice of a professional biologist or the EPA.
- Ensure that fuel bond is kept free of combustible material.
- Ensure that used fuels/oils, tyres, batteries, vehicle parts are stored separately from other waste matter and are disposed of as prescribed by the municipality, EPA, GGMC or other regulatory body.

6.3.5 Recommendations

Owing to the paucity of data on the natural resources of the area, the following studies or data collection initiatives are recommended.

- The need for further studies in the Linden Soesdyke area to document:
    - *Characteristics of soil and overburden*
    - *Type of animal and plant species best adapted to such conditions during and after mining.*
- Studies on the time required for regeneration and good secondary succession of plant species.
- Baseline data on the biodiversity of the area (abundance and distribution of species) and the ecological relationships of the various species.
- The baseline data on the quality of surface water in the creeks in the area and the diversity of aquatic species.
- The quality of the groundwater, flow patterns and recharge zones.
- Strengthen institutional capacity to ensure mitigation measures are implemented.

6.4 Economy

This part of this chapter deals with the interaction between the future project scenario and the economy VEC. Numerous references will be made to Table 6.8 which describes the project activities and the potential environmental effects that were identified in scoping (Table 6.1). Of all the project activities and physical works listed in Table 6.1, only those bearing an economically related interaction with the potential environmental impacts are considered in the impact analysis.

6.4.1 Project – VEC Interaction

This part of the chapter will refer to Table 6.8. In the Mining Phase, only the employment and business activity interacts potentially with royalties, employment, business revenue, foreign trade/export and a loss of the sand/loam resource. This will be more evident, as this report progresses, due to the fact that employment and business includes all businesses associated directly and indirectly with the industry. Directly, the government receives royalties on the amount of sand and loam mined. The amount of royalties received, and highlighted in the introductory chapter of this EIA, gives one an idea of the size and economic importance of the industry. This importance is further highlighted in the amount of employment generated (by the industry). Truckers, equipment operators, gas station operators, food industry operators (farmers, restaurant and snackette owners), exporters and construction workers, just to name a few, are all employed either directly or indirectly by its (industry) operation. Closely associated with the employment generated, is the amount of revenue generated by the employees, in terms of taxes, to the national treasury. Loss of the industry would impart a significant, negative impact on national earnings. Sand exports, particularly, earns a significant amount of foreign exchange for the country. Consequently, if these resources are to be lost the ripple effect throughout the employment and earning sectors will be lost.

In considering the accidents, malfunctions and unplanned events and its interaction with the list of potential environmental impacts, only the business revenue impact and loss of the sand/loam resource will be substantively affected. In the event of a fuel/hazardous material spill, business revenue will be affected since the industry would be partially, and probably temporarily, be shut down. This would impact negatively on jobs, and revenue generation. The spill would probably contaminate resources, which would render them useless thereby losing them. This loss of resources will limit the supply potential, increase demand and the associated price rise associated with the creation of this artificial scarcity. On a similar note, vehicle, worker and public accidents would cast a negative impact on the industry. This will affect progress and all the associated benefits discussed above. The magnified (by default) negatives will take a heavy toll overall. Forest fires hinder the work progress, causes damage to other elements of the eco-system and, together with fuel/hazardous material spills, is very expensive to cleanup and pay damages to the affected parties. This contributes to negative revenue growth. Further, [cost of] training in fire control/fighting and the proper handling procedures for fuel / hazardous materials adds to the already negative revenue growth. Illegal dumping also contributes negatively to revenue since there is a cost attached to cleanup. Leachate from the dumps could contaminate nearby resources thereby rendering them useless, and like in the fuel/hazardous materials spills, losing them. And finally, settlements on prime resources would effectively render them (resources) lost.

This industry does not operate in a vacuum, but rather, in a vibrantly interactive environment. The potential environmental effects of its activities will, therefore, have a cumulative effect on similar activities of other industries, organizations and enterprises in the same environment. These activities are residential land use, transportation network, recreational land use, tourism land use, commercial land use, forest resource harvesting and agriculture. These activities generate a substantial employment base, and, together with that generated by the sand and loam industry, contribute significantly to create employment in the country. As a consequence of this cumulative creation of employment, the spin-off jobs/employment created all contribute revenue (taxes) quite significantly to the national treasury. Foreign trade earnings will cumulatively increase with the addition of forestry product exportation proceeds, income derived from the tourism industry and transportation network, adding to that (foreign currency) generated by the sand exports. On another note, foreign exchange can also be earned from exportation of agricultural produce and products from commercial [land use] entities.

Consequently, the cumulative effects of the outlined activities, together with that of sand and loam mining, have a profound economic impact on income and employment generation and foreign exchange earnings.

Table 6.8: Potential Interaction Between Future Project Activities and Environmental Impacts

- Noted Interaction **+ Positive Interaction** **Project Activities And Physical Works (All Project Phases)**	**Potential Environmental Impacts**				
	Royalties	**Employment**	**Business Revenue**	**Foreign Trade/ Export**	**Loss of Sand/Loam Resources**
Mining					
Employment and Business	+	+	+		
Accidents, Malfunctions and Unplanned Events					
Hazardous Materials Spills	-	-		-	
Vehicle Accidents	-	-		-	-
Worker Accidents	-	-		-	-
Public Accidents	-	-		-	-
Forest/Brush Fires	-	-		-	-
Illegal Dumping	-	-		-	
Settlement	-	-		-	
Future Projects					
Residential Land Use	-			-	
Transportation Network	-				
Recreational Land Use	-			-	
Tourism Land Use	-				
Commercial Land Use	-				
Forest Resources Harvesting	-				
Agriculture	-				

6.4.2 Impact Analysis

6.4.2.1 Mining Phase

This part of the chapter will refer to Table 6.9. The sand mining industry, generally, is a long term one and affects the entire area of influence. It not a small industry, but rather, one of high magnitude due to the fact that it supplies one of the most important building raw material. Because of this, there are mostly positive interactions between the employment and business activity and environmental events in the mining phase of the industry. The most important positive interactions, in this case, are royalties (to the government), employment, business revenue (generation) and [the benefits of] foreign trade/exports. The lone adverse interaction is the loss of sand/loam resources due to extraction [of the resource]. Again, this adverse interaction is dealt with here, in part, although it is mainly a land use issue, due to the fact that loss of resources means loss of jobs, but more importantly, loss of revenue. This loss will impact negatively on the economics of the industry. As mentioned before, since the industry is a long term one, then the cultural and economic influences will be positive due the fact that it will be a part of life of those involved, both directly and indirectly. Consequently, the reversibility (or irreversibility) of the positive (and adverse) effects will depend on monitoring, and advice, where necessary. This (monitoring) is an important step if one wants to sustain the industry positively, in the future.

Table 6.9: Environmental Effects Assessment Matrix
Valued Environmental Component: Economy
Phase: Future Mining

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Areal Extent**	**Duration**	**Reversibility**	**Cultural and Economic Context**
Mining							
Employment & Business	Royalties (P)	Monitoring	3	3	L	R	2
	Employment (P)	N/A	3	3	L	R	2
	Business Revenue (P)	Monitoring	3	4	L	R	2
	Foreign Trade/Export (P)	Monitoring	3	4	L	R	2
	Loss of Sand/Loam Resources (A)	Monitoring and advising	3	1	L	R	2

Key:

Magnitude
1 – less than $10 Million/yr
2 – $10 Million –$ 20 Million/yr
3 – greater than $20 Million/yr

N/A – Not Applicable

Areal Extent
1 – immediate area
2 – East Bank & immediate area
3 - # 1&2 and G/T
4 - # 1,2,3 & Exports

Duration
L – Long term
S – Short term

Reversibility
R – reversible
I – irreversible

Ecological/Socio-cultural & Economic Context
1 – Relative pristine area/areas not adversely affected by economic activity.
2 – Evidence of adverse effects.

6.4.2.2 Malfunctions and Unplanned Events Phase

This part of the chapter will refer to Table 6.10. Accidents, malfunctions and unplanned events must be catered for since it is an integral part of good planning. Hazard material spills, vehicle accidents, worker accidents, public accidents, forest/brush fires, illegal dumping and settlements are all activities/events which must be addressed. In all cases these bear negative impacts to revenue, and in some cases, damage to the resource thereby leading to its loss. Mitigation factors can greatly minimize the chances of all of the aforementioned events occurring if they are closely adhered to. Hazardous material storage procedures, emergency response, contingency plans and employee education can all reverse the potential loss suffered by business revenues and sand/loam resources to a short term one since less money will be spent on cleanup. Since the potential losses are small and centered mainly in/around the location of the sand/loam pits, there will be no significant negative impact on the inhabitants nearby. Similar reasoning can be applied to the unlikely event of forest/brush fires except that, in this case, the potential damage can cover a wider area. Operational safety procedures can greatly minimize unplanned occurrences of vehicle, worker and public accidents. This mitigating strategy is strongly recommended because the sphere of influence of these accidents is small, of a low magnitude, is easily reversible and does not have any long term effects on the cultural and economic aspects of the nearby residents. Illegal dumping is one event which can pose some problems resulting in reduced business revenue and loss of resources. This negative impact can become a reality where money has to be spent on cleanup and clearing the resource for exploitation. However, due to its low magnitude, signage, proper security measures and employee education are all excellent mitigating strategies which can reduce/reverse the adverse effects. In other words, less will have to be spent on cleanup and more for the industry generally. Adherence to the recommended mitigating strategies will result in a positive effect, culturally and economically, to the residents since they will be able to live in a reasonably beautiful area. Settlement on top of resources leads to loss of revenue and resource since the buildings will be covering valuable exploitable resources. Further, settlements can reduce the beauty of the area because of human activities associated with living, waste disposal etc. However, all of these can be reduced/reversed with proper mitigation factors being in place to check this activity. Notifying settlers of private and government (GGMC) ownership and prevent/evict squatters from illegally occupying the land. This will eventually lead to a reduction of resource loss and an increase of business revenue due to more resources being made available for exploitation.

Table 6.10: Environmental Effects Assessment Matrix
Valued Environmental Component: Economy
Phase: Future Mining

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Areal Extent**	**Duration**	**Reversibility**	**Cultural and Economic Context**
Accidents, Malfunctions and Unplanned Events							
Hazard Material Spill	Business Revenue (A)	Hazardous material storage procedures Emergency response and contingency plan Employee Education	1	1	S	R	1
	Loss of Sand/Loam Resources (A)	Hazardous material storage procedures Emergency response and contingency plan Employee Education	1	1	L	R	2
Vehicle Accidents	Business Revenue (A)	Operational safety procedures	1	1	S	R	1
Worker Accidents	Business Revenue (A)	Operational safety procedures	1	1	S	R	1
Public Accidents	Business Revenue (A)	Operational safety procedures	1	2	S	R	1
Forest/Brush Fires	Business Revenue (A)	Emergency response and contingency plan Employee Education	1	3	S	R	1
Illegal Dumping	Business Revenue (A)	Security Signage Employee Education	1	3	L/S	R	1/2
	Loss of Sand/Loam Resources (A)	Security Signage Employee Education	1	3	L/S	R	1/2
Settlement	Business Revenue (A)	Private Land notify and evict Government Land notify GGMC	2	4	L/S	R	1/2
	Loss of Sand/Loam Resources (A)	Private Land—notify and evict Government Land—notify GGMC	2	1	L/S	R	1/2

Key:

Magnitude

1 – less than $10 Million/yr
2 – $10 Million – $20 Million/yr
3 – greater than $20 Million/yr

N/A – Not Applicable

Areal Extent

1 – immediate area
2 – East Bank & immediate area
3 - # 1&2 and G/T
4 - # 1,2,3 & Exports

Duration

L – Long term
S – Short term

Reversibility

R – reversible
I – irreversible

Ecological/Socio-cultural & Economic Context

1 – Relative pristine area/areas not adversely affected by economic activity.
2 – Evidence of adverse effects.

6.4.2.3 Impact Analysis – Future Projects (Cumulative) Phase

Since the activities associated with this industry affects other activities in the long term, it is necessary to discuss it here although such a discussion was initiated in Section 6.4.1 of this chapter. As a consequence of this, the activities/benefits of this industry contributes to the general pool of activities/benefits. The extent of this contribution is dependent on the size of the industry. Notwithstanding the fact that, physically, the sphere of activities is relatively small, the contributions, cumulatively, is very significant and widespread areally, far beyond the sphere. This significance of the contributions is highlighted when one considers the long [term] life of the industry. Even the loss of the resource, though irreversible, can be minimized through effective land use planning as a mitigating factor. The overall irreversibility of the other aspects simply indicates the level positive contributions which only a miraculous catastrophe can render negatively reversible. Since, as mentioned before, the industry is a long term one, the benefits accrued, cumulatively will also be long term. This will impart a positive impact on the cultural and economic context of all concerned. This long term positive impact will even serve to minimize, by comparison, the few, small, reversible adverse effects of the industry.

6.4.3 Determining Significance

Table 6.11 will be discussed in this part of the chapter. Any analysis must have an overall scheme to determine the significance of the residual effects. For this industry, the overall residual environmental effects including the cumulative environmental effects are positive. This finding resulted from recommendations, mitigations, longevity of the industry and the high degree of reversibility of the adverse effects. There is a high degree of confidence in making this pronouncement since all the possible angles, concerned departments/ organizations, maps/charts, reports and respective authorities were consulted. The probability of occurrence of the phases is high due to its long life. One notable low probability of occurrence is the accidents, malfunctions and unplanned events phase. This is low since it is expected that all the mitigating factors are adhered to and that there is effective monitoring to ensure this. However, the scientific certainty of making these statements is best at a medium level of confidence. This is because there is little or no baseline data available and the density of sand/loam is in question since it will affect the entire calculation and land requirements. The degree of accuracy of some of the available data is in some degree of doubt. This severely hinders the ability to make any tangible comparisons. In addition to this, it is the first time that the industry is being subjected to this degree of scrutiny. All of the afore mentioned sentiments and levels of confidence of the overall analyses are reflected/summarized in the overall project analysis.

Table 6.11: Residual Environmental Effects Summary Matrix—Future Project Scenario
Valued Environmental Component: Economy

Phase	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	P	3	3	2
Accidents, Malfunctions and Unplanned Events	P	3	1	2
Future Projects	P	3	3	2
Project Overall	P	3	3	2

Key:

Residual Environmental Effect Rating
S – Significant Adverse Environmental Impact
NS – Not-significant Adverse Environmental Impact
P – Positive Environmental Impact

Level of Confidence
1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

N/A – Not Applicable

Probability of Occurrence: based on professional judgement
1 – Low Probability of Occurrence
2 – Medium Probability of Occurrence
3 – High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis of professional judgement
1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

*As determined in consideration of established residual environmental effects rating criteria.

6.4.4 Monitoring

The base year (year 1) figure used in the final calculation of the total amount of sand expected to be demanded for the next 50 years is 900,000 tons while that for loam is 72,000 cubic yards. The current customer price for sand (per ton) and loam (per cubic yard) is $1000.00. This translates to base year total price paid by the customer for sand is $900,000,000.00 and $72,000,000.00 for loam. Royalty is paid to the government to the tune of $25.00 per ton of sand/cubic yard of loam. Royalty collected by the government, in the base year, for sand is $22,500,000.00 and $1,800,000.00 for loam. The total expected demand for sand in 50 years is expected to amount to $4,710,329,904 for sand and $376,826,392 for loam. These figures just serve to illustrate the magnitude of the industry we are considering.

Such an industry requires protection and close monitoring. Monitoring is an important aspect of this project. This activity must not be construed to be a policing one, but rather, one of adherence to regulations and offering of advice in order to make the industry a more viable one with a minimum of overall, negative impacts. Applicants and prospective sand/loam miners must first be advised of what the rules and regulations governing the industry are. They must be notified of the periodic presence of monitors who will supervise the compliance to the rules and regulations, and if necessary, offer advice as they see fit or if requested upon to do so. They will monitor rate of extraction of the resource, revenue generation and collection, the proportion of the resource going towards different uses (to be used for baseline data compilation). Any change in the rate of extraction must be reported to GGMC so that proper contingency monitoring measures can be instituted. As a consequence of the nature of all of these demands, monitors assigned to this task must be professional employees comprising a team from GGMC, EPA and GFC. Monitoring reports must be filed, remedial measures (if any) must be recommended, and most importantly, acted upon. Follow up monitoring and feedback mechanisms must be in place. The acquired information should be used to constantly update the existing regulatory documents as the respective regulatory bodies see fit.

6.5 Land Use

The focus of the sections brings to beat the future the Sand and Loam Mining would operate to reduce impacts or frictions on completing Land uses, respective to Timehri/Soesdyke. Land uses prominent are Agriculture (though the soil may not sustain this activity in the long term) (inclusive of hogs and poultry), tourism, forestry, residual, airport, recreation (including motor racing), military facilities and activities commercial, electrical power transmissions, road networks, cemeteries, and other land uses (preferably charcoal burning, and inclusive of sand and loam mining). Examination of project activities against potential Land use environmental impacts, fit into future plans (e.g., Land Use Committee) for the establishment of Sectoral Environmental Plan (with impact reduction), enforcement of regulation (s) (GGMC' EPA, etc.) and proper compliance. We can include our Potential Interactions of future mining and other land uses, with the environment. Degrees of impacts, (Alienation of adjacent land use, loss of Sand Loam, limitations of future land use) assessed in the environmental effects, Assessment Matrix template, how mining activities brings to bear on other land uses, their mitigation in cases of conspicuous adverse changes. The basis for understanding any serious anomalous effects that can be mitigated to allow minor changes to project content, cannot be mitigated as environmental effects out way, economic benefits or the basis of limited environmental scars that allows for mining to proceed (green light) is enshrined in the Residual Environmental effects matrix.

6.5.1 Project VEC Interaction

6.5.1.1 Alienation of Adjacent land uses: Future

Mining Phase

Potential VEC Interaction during project activities would inhibit or affect land uses that strive on surface environs for their existence. Cleaning site, access, mine building, stripping, stock piling, mining of sand and loam, all possess negative VEC Interactions and impacts on tourism, forestry and agriculture, (particular in loam areas) industry, relevant to Sand and Loam Mining as a Land Use. In the reverse the mining phase, would be limited to the activities of tourism, potential agricultural plans (though the topsoil cannot sustain long term projects). Coal production and Military facilities (toxic military ordinates).

Accidents, Malfunctions and unplanned events

It is expected that during Sand/Loam operations, accidents will take place to preclude and inhibit activities in tourism, agriculture and residential sectors but will also inhibit its productions in the Sand and Loam operations. Tourism, forestry and agriculture are temporarily impacted upon by forest/bush fires caused by the industry and natural or otherwise causes. Illegal dumping through an intentional act by the polluters but incorporated under this section, would limit access to recreational, commercial, Sand/Loam mining, residual complexes, agriculture (Loam mining areas specifically), tourism and sand/Loam mining. Sand/Loam mining because of their lucrative sights for dumping and disregarding undesirable waste indirectly provides the means for alienation of the impacted land uses. Settlement (legal/illegal) within the zone for Sand/Loam mining will hamper access to the vital resources so required by the industry. Such acts would allow for a reduction in sand and Loam productions, whether significantly or otherwise limited to few sand pits. The term illegal settlement should not be construed or categorize to mean only housing but should be extended to illegal, recreational, commercial, sand and loam, tourism and coal pit activities. Standing water prohibits access to vital Sand/Loam resources but provide breathing place for unwanted insects (Malaria) that would gradually affect competing land uses, (tourism, residential, recreational, commercial). Standing water though it promotes fish farming, it introduced effects farming, therefore negotiations between the lesser of the evils that impacts negatively on this activity.

Future Projects

Residential land uses as a project activity within a sand mining zone as is postulated will restrict sand and loam mining over the occupied surface areas. Potential impacts on the forestry; agricultural, recreational, commercial, sectors are envisaged. Therefore as a result of a residential land use activity indirectly cemeteries are envisaged thus, further restrictions subsurface sand resources. Transportation Network: Areas of identifiable transportation routes, and parallel electrical transmission lines will suffocate, and isolate (which is a necessary attribute to open sand and loam areas) vital sand reserves (e.g., Linden/Soesdyke highway), which raises the question of the importance of the resources against a transportation network whose foundation is constantly being eroded by sand miners against the legal (Mining regulation, 1979) requirement which restricts sand or loam mining within 200 metres of these structures. The economic in the assessment of sand and loam mining sectoral environmental review. Recreational (Tourism), Tourism (Recreational), Commercial entities, Agricultural land uses: The impact of these future projects has some commonality as to the land uses that would be affected. Tourism, Forestry, Agriculture, Residential, Commercial, Sand and Loam mining, Road Network, and recreational land uses, fall into this category. Land uses which are similar to the project descriptions compliment their activities in most cases but compete with opposing land uses. Sand and Loam reserves would be restricted to the above activities, agriculture specifically in loam areas (ref. To topsoil in sandy areas are not fertile), and residential and commercial activities are also affected. Forest Resources harvesting (FRH): FRH will impact on agriculture (Loam areas) and coal production indirectly.

6.5.1.2 Limitation of Future Land Use(s)

Accidents, malfunctions and unplanned events: The factors which persist under this heading in the section of Alienation of adjacent landuse(s) except brush fires will prevail in this section. Future projects: Specifically common to this section is the loss of sand and loam resources that would directly be impact, as a result of the realisation of these of these projects.

6.5.1.3 Loss of Sand and Loam Resources

The loss of sand and loam resources have been expanded in the sections above but illegal dumping, settlement (legal or illegal occupation of the land which includes other land uses which inhibits access to sand and loam resources e.g agriculture, tourism, recreation and commercial activity which was observed on the Linden-Soesdyke highway), or future projects will influence sand and loam production.

6.5.2 Impact Analysis

6.5.2.1 Mining Phase

Examining the mining phase environmental assessment against the future view of a well organised industry with a sectoral zoning of sand and loam mining, it is the view that clearing would affect the land use of Tourism, Forestry and Agriculture in a potential positive (PP) manner, but will positively affect forest resources if forest products are not cleared prior to clearing. All things being true in the future that should be corrected (Table 6.12). There will be a PP alienation of sand and loam (SL) resources if tourism, forestry, agriculture, coal production, and military facilities are allowed in the sector. The mitigation circumstances should be progressive reclamation, monitoring and the application of sectoral EIA. For access roads, PP alienation of sand and loam resources are possible and positively (P) may affect ecotourism by opening pristine areas. Mine building, stripping, stockpiling of topsoil, mining of SL will alienate land uses (tourism, agriculture in PP, P way respectively.). Tourism and agriculture on the other hand can influence alienation of SL reserves which may be P conservation of the environment. Mitigation would be the same as above. In the future the magnitude, geographic extent, duration, frequency, reversibility, and cultural and economic context, are low, short term and reversible. In some cases the geographic extent is of a very small area (AS), reversible and not applicable for cultural and economic impacts. For the mining phase monitoring (proactive), exchange of technical advice, progressive reclamation, zoning or sectoral landuse is reiterated.

Table 6.12. Environmental Effects Assessment Matrix
Valued Environmental Component: Land Use
Phase: Mining

Project Activity	**Potential Positive (PP), positive(P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Clearing	Alienation of adjacent land(AAL) use(s)(PP(+),(P(+),PP(-))	Progressive reclamation, monitoring (proactive), zoning or sectoral land use,.	1	S	L	R	N/A
Site access roads	-ditto-(PP(+), P(+)	-ditto-	1	S	L	R	N/A
Mine building	-ditto-(PP(+))	-ditto-	1	S	L	R	N/A
Stripping and stock piling of topsoil	-ditto-(P(+), PP(-))	-ditto-	1	S	L	R	N/A
Mining sand and loam	-ditto-(P(+), PP(-)	-ditto-	1	S	L	R	N/A

KEY
Magnitude:
1 = Low: measurable inhibitation of adjacent land uses, but where guidelines, objectives and or legislation are not exceeded.
2 = Medium: -ditto- are exceeded occasionally
3 = High: -ditto- are exceeded on a frequent basis.

Geographic Extent:
Area L = Large, S + Small distance(L, S).
Duration:
Short term= S, long term = L

(+) sand/loam comparison to other land uses.
(-) Land uses comparison to sand/loam.
Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.
N/A = Not Applicable

6.5.2.2 Accidents, malfunctions, and unplanned events

This category of events in the future, magnitude is not serious and the extent is low- small-nontoxic (LSN), a short term. It is believed that in the near future close monitoring of occupational health and safety matters, spillage preventions and management of waste material will be highly advocated (Table 6.13). Material spills, forest and brush fires, illegal dumping, settlement (legal and illegal) and standing water are potential for the alienation of adjacent land uses, limitation of future land, and loss of S.

Table 6.13. Environmental Effects Assessment Matrix
Valued Environmental Component: Land Use
Phase: Accidents, malfunctions, and unplanned events

Project Activity	**Potential Positive (PP), positive(P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Hazardous material spills	-Alienation of adjacent land(AAL) use(s)(P(+),PP(-)). -Limitation of future land uses(LFL)-(P(+), PP(-))	Proactive monitoring OSH spillage prevention and waste management	1	L,S, N	S	R	N/A
Forest and brush fires	-ditto AAL-(PP(+))	-ditto-	1	L,S, N	S	R	N/A
Illegal dumping	-ditto AAL-(PP(+,-)) -ditto LFL-(PP(+,-)) -Loss of SL(PP(+,-))	-ditto-	1	L,S, N	S	R	N/A
Settlement(legal and illegal)	-ditto AAL -(P(+), PP(-)) -ditto LFL -(P(+), PP(-)	-ditto-	1	L	S	R	N/A
Standing water	-ditto LFL-(PP(+))	-ditto-	1	L	S	R	N/A

KEY

Magnitude:
3 high = Serious/ Catastrophic/ Fatal
2 Medium = Temporary/ hospitalization
1 low = not serious

Geographic Extent:
High, large, toxic.
Low, small, nontoxic

Duration:
Short term(S), long term(L)

(+) sand/loam comparison to other land uses.
(-) Land uses comparison to sand/loam.

Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

The influence of future projects planned in the sand/loam belt will affect future possible land uses, and may lose Standard Loam reserves (Table 6.14). Land uses too if executed in an unmanaged way may affect or impact on Standard Loam resources, but monitoring will be a key mitigator to prevent degradation that would require correction. Assessment evaluation criteria, for assessing environmental effects, has shown relatively limited effects under this heading.

Table 6.14. Environmental Effects Assessment Matrix
Valued Environmental Component: land use.
Phase: Future projects.

Project Activity	**Potential Positive (PP), positive(P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Ecological/Socio-Cultural and Economic Context**
Residential land use.	-Alienation of adjacent land(AAL) use(s)(PP(+)). -Limitation of future land uses(LFL)-(P(+), PP(-)). Loss of sand and loam(LSL)-(PP(+, -))	Proactive monitoring .	L	N	S	R	N/A
Transportation Network	-ditto AAL-(PP(-)) - ditto LFL-(PP(+)) - ditto LSL- (PP(+))	-ditto-	L	N	S	R	N/A
Recreational land use.	-ditto AAL-(PP(+,-)) -ditto LFL-(PP(-), P(+)) - ditto LSL(PP(-))	-ditto-	L	N	S	R	N/A
Tourism / commercial entities	-ditto AAL -(P(+), PP(-)) -ditto LFL -(P(+), PP(-) -ditto LSL- (P(+))	-ditto-	L	N	S	R	N/A
Forest resources harvesting.	-ditto AAL-(P(+), PP(-). -ditto LFL-(P(+), PP(+) -ditto LFL-(PP(+))	-ditto-	L	N	S	R	N/A

KEY

Magnitude:
1. Low
2. Medium
3. High

Geographic Extent:
Dense.
Less dense.
Sparse.
Non existent.

Duration:
Short term(S), long term(L)

(+) sand/loam comparison to other land uses.
(-) Land uses comparison to sand/loam.

Reversibility:
R = Reversible
I = Irreversible

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not adversely affected by human activity.
2 = Evidence of adverse effects.

N/A = Not Applicable

6.5.3 Determining significance

Under this section no significant environmental effects are foreseeable, low probability of occurrence, medium probability of occurrence likely, and low level of scientific certainty is expected, but future sectoral plans, monitoring, self monitoring, progressive mining, etc., are expected for SL sector will mitigate much favourable in the future than in the past (Table 6.15).

Table 6.15. Residual Environmental Effects Summary Matrix

Valued Environmental Component: Land use

Phase	Residual Environmental Effects Rating, Including Cumulative Environmental Effects*	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Mining	NS	1	2	1
Accidents, Malfunctions and Unplanned Events	NS	1	2	1
Future projects	NS	1	2	1

Key:

Residual environmental Effect Rating:

S = Significant Adverse Environmental Effect
NS = Not-significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgement

1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgement

1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

N/A = Not Applicable

*As determined in consideration of established residual environmental effects rating criteria.

6.6 Public Health and Safety

6.6.1 Project - VEC Interaction

The VEC interaction proposed for the Future Sand and Loam mines will be the continuous use of hazardous material which includes diesel fuel, lubricants (oil), and grease. Solid and liquid waste disposal will continued to be an interaction but will be significantly reduced. The assumption is that at most sites permanent structures are likely to be erected with dwelling facilities in place, hence the generation of waste from domestic chores, latrines, vehicles repairs among other things will be better managed based on the proposed improvements earmarked for the future.

Injury, although significantly reduced, will occur during the hazardous material use and solid and liquid waste disposal and during accidents such as hazardous spills and forest fires. Vehicle, worker and public accidents have a positive interaction since for the future certain changes will be in place.

Sand and Loam mining, in the future will be greatly enhanced by establishing workable safety rules and regulations. These rules and regulations should include general duties, including those of the government, owners, managers, supervisors and workers

Safer mining practices will be practiced (e.g., in excavation, single-bucket excavators, scrapers, bulldozers and loading). The provision of safety equipment such as safety goggles, glasses, vests and respirators. Emergency response and contingency plans, the proper storage and disposal of solid and liquid waste, and the placing of warning signs at strategic points on roadways to alert road users of potential dangers will be in place.

Although there will be a reduction in the potential for accidents in transportation network and forest resources harvesting, accidents will still occur.

6.6.2 Impact Analysis

The purpose of the analysis below is to evaluate the potential impact of future mining on occupational health and safety. Table 6.16 provides the environment impact assessment matrix.

Table 6.16: Environmental Effects Assessment Matrix
Valued Environmental Component: Public Health and Safety
Phase: Future

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Cultural and Economic Context**
Hazardous materials	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment, emergency response	3	1	3/2	I	N/A
Solid and liquid waste disposal	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment, emergency response	3	1	3/2	I	N/A
Hazardous material spills	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	3/2	I	N/A
Vehicle accidents	Injury, illness and loss of life(P)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/2	I	N/A
Worker accidents	Injury, illness and loss of life(P)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/2	I	N/A
Public accidents	Injury, illness and loss of life(P)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/2	I	N/A

Table 6.16: Environmental Effects Assessment Matrix
Valued Environmental Component: Public Health and Safety
Phase: Future

Project Activity	**Potential Positive (P) or Adverse (A) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**				
			Magnitude	**Geographic Extent**	**Duration/Frequency**	**Reversibility**	**Cultural and Economic Context**
Forest and brush fires	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	1/2	I	N/A
Illegal dumping	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	3/2	I	N/A
Standing water	Injury, illness and loss of life(A)	Training, safety regulations, safer practices, safety equipment emergency response	3	1	3/2	I	N/A

Key:

Magnitude
1 – low-short term illness or injury,
2 – long term illness or injury, reversible
3 – chronic illness or death

Geographic Extent
1 - <1km^2
2 – 1km-11km^2
3 – 10km^2-100km^2

Duration
1 - <1 month
2 - 1-12 months
3 - 12-36 months

Frequency
1- very infrequent
2 - infrequent
3 – frequent rapid recovery

Reversibility
R – Reversible
I – Irreversible

Ecological
N/A – not applicable

Public health and safety in future sand/loam mines impact analysis hinges around hazardous material use and solid and liquid waste disposal, along with potential adverse cumulative effect in areas of transportation network and forest resource harvesting.

While vehicle, worker and public accident will have injury, illnesses and possible death, the impacts will be positive due to the improvements over past and present practices mentioned in Section 4.6.

The magnitude of accidents in the future will remain high based on the assumption that all accidents will result in death. The difference between the past and present, and future conditions is that the frequency of occurrence of accidents will be significantly reduced because mitigation strategies will be in place. Thus, the overall effect of mining on public health and safety would be potentially positive relative to the future condition.

6.6.3 Determining Significance

This section discusses the significance of the residual environmental effects based on the residual environmental impact rating criteria (Table 6.17).

Table 6.17: Residual Environmental Effects Summary Matrix
Valued Environmental Component: Occupational Health and Safety—Future

Phase	**Residual Environmental Effects Rating, Including Cumulative Environmental Effects***	**Level of Confidence**	**Likelihood**	
			Probability of Occurrence	**Scientific Certainty**
Mining	P	1	2	1
Malfunctions, accdidents and unplanned events	P	1	2	1

Key:

Residual Environmental Effect Rating

S – Significant Adverse Environmental Effect
NS – Not-significant Adverse Environmental Effect
P – Positive Environmental Effect

Level of Confidence

1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

N/A – Not Applicable

Probability of Occurrence: based on professional judgement

1 – Low Probability of Occurrence
2 – Medium Probability of Occurrence
3 – High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis of professional judgement

1 – Low Level of Confidence
2 – Medium Level of Confidence
3 – High Level of Confidence

* As determined in consideration of established residual environmental effects rating criteria.

In the future, the effect of mining on occupational, health and safety will be positive overall because mitigation strategies will be in place that improve over current public conditions and practices. Additionally, the probability of occurrence will be significantly reduced because of the mitigation strategies. The level of confidence and scientific certainty, that are evaluated based on projected judgment, are low.

APPENDIX A
FUTURE MINING RATES

APPENDIX A

Future Mining Rates

Year	Sand	Loam
	500 loads/day	40 loads/day
	6 tons/load	6 cu.yd/load
	6 days/week	6 days/week
	50 weeks/year	50 weeks/year
	900,000 tons/year	**72000 cu.yd/year**
1	900,000	72000
2	945000	75600
3	992250	79380
4	1041862.5	83349
5	1093955.625	87516.45
6	1148653.406	91892.2725
7	1206086.077	96486.88613
8	1266390.38	101311.2304
9	1329709.899	106376.792
10	1396195.394	111695.6316
11	1466005.164	117280.4131
12	1539305.422	123144.4338
13	1616270.693	129301.6555
14	1697084.228	135766.7382
15	1781938.439	142555.0752
16	1871035.361	149682.8289
17	1964587.13	157166.9704
18	2062816.486	165025.3189
19	2165957.31	173276.5848
20	2274255.176	181940.4141
21	2387967.935	191037.4348
22	2507366.331	200589.3065
23	2632734.648	210618.7718
24	2764371.38	221149.7104
25	2902589.949	232207.1959
26	3047719.447	243817.5557
27	3200105.419	256008.4335
28	3360110.69	268808.8552
29	3528116.225	282249.298
30	3704522.036	296361.7629
31	3889748.138	311179.851
32	4084235.545	326738.8436
33	4288447.322	343075.7857

Future Mining Rates

	Sand	**Loam**
34	4502869.688	360229.575
35	4728013.172	378241.0538
36	4964413.831	397153.1065
37	5212634.522	417010.7618
38	5473266.248	437861.2999
39	5746929.561	459754.3649
40	6034276.039	482742.0831
41	6335989.841	506879.1873
42	6652789.333	532223.1466
43	6985428.8	558834.304
44	7334700.24	586776.0192
45	7701435.252	616114.8201
46	8086507.014	646920.5611
47	8490832.365	679266.5892
48	8915373.983	713229.9186
49	9361142.682	748891.4146
50	9829199.816	786335.9853
Total	**188,413,196**	**15,073,056**

Cost per ton/ cu. yd	1000G$	
Total cost of resource (G$)	**1.88413E+11**	**15073055691**
Royalty per ton/cu. yd. (G$)	25G$	
Total Royalty (G$)	**4710329904**	**376826392.3**
Density (tons/cu. yd.)	**1.65**	**1.8**
Volume (cu. yd)	114189815.8	15073056
1 cu yd = 0.7646m		
Volume (m3)	87309533.19	11524858.62
Depth (m)	4	3
Surface Area (m2)	21827383.3	3841619.539
Surface Area (ha)	2182.73833	384.1619539
Square Dimension (mxm)	4671.978521	1960.004984