

**(ATLANTIC GOLD INC.)
SUN AND SAND MINING
RESOURCES
INC (GUYANA)**

FINAL ENVIRONMENTAL AND SOCIAL IMPACT

ASSESSMENT

**QUARTZ STONE
GOLD MINING
PROJECT**

OCTOBER 2017

EXECUTIVE SUMMARY

This Environmental and Social Impact Assessment (ESIA) was undertaken for an alluvial mine to be operated by Sun and Sand Resources Inc (Guyana) at PL-45 in the Mazaruni and Cuyuni Mining Districts. The Guyana Environmental Protection Agency (EPA) has determined that construction and operation of the mine site may potentially impact the environment and has mandated that an ESIA be conducted. This ESIA conforms to guidelines and policies developed by Guyana Environmental Protection Agency (EPA). Further the ESIA describes the physical, biological, social and economic environment within the study area which are relevant to the Project.

The property is located approximately 150 kilometres northwest of the main regional administrative center of Bartica and is accessible by air and overland. A detailed exploration program to determine the extent and to quantify alluvial gold deposits at the site was undertaken by Sun and Sand prior to 2015. The exploration results indicated that economic alluvial deposits are present within the mining concession. Sunand Sand is proposing to mine the economic alluvial deposits. The Project will involve both a preliminary work phase and a mining and beneficiation phase.

Preliminary works will be undertaken to support the mine site operation and will consist of upgrading the access road from Itaballi to the mine site at Quartz Stone, construction of fuel and lubricant containment and storage facilities, installation of sewer, water and power services, construction/upgrade of workers accommodation, kitchen and offices, construction of maintenance workshop and laboratory and construction of an airstrip.

The alluvial deposits will be mined by open pit methods. Before commencement of the ore excavation operation any creek(s) within the area to be mined, will be diverted by excavating a channel to connect points on the creek upstream and downstream of the mineralized zone. Each mineralized zone will be excavated as several ponds consisting of bands. Excavation will only commence on another band after completion of the removal of paydirt from the preceding band. At the commencement of operations, water will be withdrawn from the creek being mined for mineral processing. The ore recovery operation will function in a closed loop for water supply. Water overflow from the previously excavated pond will be limited by a berm maintained around the pond. After the completion of mining, the creek beds will be restored to their original depths and alignments and the diversion channels will be backfilled.

Gold will be recovered by gravity separation using mobile screens and concentrator units. The alluvial gold process plant will recover gold totally by gravimetric separation. No chemicals will be utilized in the process. The process circuit will be comprised of screening, sluicing and concentration units.

This Environmental and Social Impact Assessment (ESIA) and its associated public consultation are parts of the implementation process for design, construction and operation of the mine site. The Environmental and Social Impact Assessment objective is a systematic study, analysis and evaluation of the potential environmental and social impacts related to project execution. The assessment includes an evaluation of the environmental implications of The Project and its alternatives including the no action alternative.

This ESIA is guided by several international policies and local legislation and regulations developed to ensure sound management of the environment. National Policies, Regulations and Legislations which are relevant to the deliberations of this ESIA include the National Environmental Action Plan, The Environmental Protection Air Quality Regulations, The Environmental Protection Water Quality Regulations, The Environmental Protection Noise Management Regulations, The Environmental Protection Hazardous Wastes Management Regulations, The Environmental Protection Authorizations Regulations, The Environmental Impact Assessment Guidelines for Mining, The Mining Guidelines for Water Quality,

The Mining (Amendment) Regulations 2005, The Guyana Geology and Mines Commission Act of 1979 and Mining Act of 1989, The Amerindian Act No. 6 of 2006, The Occupational Safety and Health in Mining, The Wild Birds Protection Act Chapter 71:01, The Town and Country Planning Act Chapter 20:01, The National Biodiversity Action Plan, The Public Health Act Cap 145, The Forest Act 2008 and

Guyana Forestry Commission Act 2007 and the Code of Practice for Timber Harvesting 2002. The ESIA also identifies the EPA's Role in EIAs.

International policies which are relevant to the preparation of this ESIA include Agenda 21, The Protocol Concerning Pollution from Land-Based Sources and Activities (LBS), The Protocol Concerning Specially Protected Areas and Wildlife (SPAW), The Treaty on Cooperation for the Development of the Amazon Basin and The UN Framework Convention on Climate Change (UNFCCC).

The assessment of the environmental and social impacts of the proposed project was preceded by a baseline characterization of environmental and social variables in the project areas. The biological baseline characterization focused on examining the biodiversity of the proposed mine site. It was based on field surveys of the mine site area to capture temporal and spatial variations. The biodiversity survey was supplemented by a review of literature on the area biodiversity and the results of that review have been incorporated into the biological baseline characterization.

The socio-economic and socio-cultural baseline was compiled based both on literature review and on field surveys conducted in communities considered to be within the project area of influence. The definition of the socio-economic and socio-cultural baseline and the identification of potential impacts associated with the project were aided by a public consultation process. Primary stakeholders for this project include groups and individuals directly affected by the project. Secondary stakeholders are the public and/or private sector organizations who may have a role and responsibility in the implementation and/or monitoring of the project. In addition to residents in close proximity to the site, other primary stakeholders include Guyana Geology and Mines Commission (GGMC) and the Region 7 Regional Development Council in which the mine site is located. Secondary stakeholders are regulatory bodies consisting of the Environmental Protection Agency (EPA), the Ministry of Labor, Occupational Safety and Health Department (OSHD), and commercial and industrial enterprises located within close proximity to the site.

Consultations were held with all primary stakeholders. Consultations with residents of communities within the project area of influence were facilitated by a meeting hosted by the Environmental Protection Agency (EPA) on August 22, 2016. A description of the project and its anticipated environmental and social impacts were outlined at the meeting. Residents were subsequently invited to identify issues and concerns for inclusion into the impact assessment and management measures for the facility.

Guyana is located in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by seasonal shifts of the ETZ and its associated rain-bands called the Inter Tropical Convergence Zone (ITCZ). There are no major industries in the area. Aerial emissions in the Project area are directly related to the emission of gases by rotting trees and other vegetative matter. Airborne discharges and particulate matter are not monitored in the area. Tropical conditions of the study area have produced an environment dominated by chemical weathering. The surficial soil is generally a saprolitic clay material that retains some elements of the original bedrock structure. Natural slopes in the area range from being relatively mild to steep.

Surface water and sediment samples were recovered from two streams within PL-45 and from a stream outside the concession. All samples were analyzed to determine the concentration of parameters mandated in the EPA guidelines for Environmental Impact Assessment for the Mining Sector.

A biodiversity baseline was compiled for the concession to track both spatial and temporal trends of biodiversity. Surveys were conducted in periods corresponding to a single wet and a single dry season in

Guyana. The primary mechanism utilized for development of the baseline consisted of field surveys supplemented by a desk top review of existing baseline data compiled for areas with similar habitat characteristics within the landscape region of the concession.

The concession is dominated by mixed forests on clayey soils characteristic of forest of the Northwest District. Two True Guyana endemics and 6 Guiana Shield endemic species were recorded during the surveys. The surveys did not record any critically endangered or endangered floral species.

The surveys recorded the presence of sixteen species of non-volant mammals. No critically endangered or endangered non-volant mammals species, migratory or endemic mammalian species were recorded during the surveys. A total of 19 amphibian species were recorded by the surveys. None of the herpetofauna species documented are endemic or is listed by the IUCN Red List. Fifty-nine species of birds belonging were recorded by surveys. No critically endangered or endangered bird species were recorded. Sixteen taxonomic orders of terrestrial macro-invertebrates were recorded by the surveys. Twenty species of fish were documented by the surveys. No endemic or migratory fish species were recorded during the surveys.

The socio-economic baseline study was undertaken to create a profile of the communities within the project area of influence. The zone of influence has been thus defined as the physical radius to which the project footprints or impacts may potentially extend. There are no communities located in close proximity to the project. A zone of influence or study area was determined that took into consideration all possible interactions and impacts due to the project even if they are to relatively far away communities.

The potential impacts related to construction activities at the mine site and to mining operations include potential impacts to the atmosphere, aquatic and terrestrial resources and to human, socio-economic and cultural resources. An impact rating system was employed to ensure the application of analytical rigor to the assessment of impacts. Impacts were initially rated as direct, indirect or cumulative. The direct, indirect and cumulative impacts were further subdivided into positive and negative impacts, random and predictable impacts, local and widespread impacts, temporary and permanent impacts and short- and long-term impacts. Impacts were further categorized according to their seriousness by examining the likelihood and severity of each impact. The impact mitigation measures were then identified and the residual rating of impacts was then classified as to both severity and likelihood.

Potential impacts to soil could result from widening of the access road from and from vegetation clearance of the areas to be mined and excavation for creek diversions. The likelihood of soil erosion and sedimentation will be minimized or avoided by the implementation of Best Management Practices (BMPs). The movement of heavy equipment during construction and mining may impact soil resources by causing rutting and compaction of susceptible soils. The impacts to the soil resources are expected to be minor (low severity, low likelihood). Topsoil mixing could potentially occur during the project execution. BMPs implemented during construction and operation will result in minor impacts.

Construction works will result in emissions of fugitive dust and products of combustion. Impacts to air quality could be moderate. These impacts will be mitigated by scheduling land clearing activities to less windy days, limiting vehicle speed during construction to a maximum 30 km/hr and employing dust suppression technique. Analyses indicated very minor changes in air quality resulting from equipment emissions.

Removal of the surficial soils will result in insignificant impacts on the geology of the area. An erosion and sediment control plan will mitigate potential impacts to water quality from erosion. The potential for accidental spills of fuels, oils and grease and the associated contamination of surface waters will be minimized by implementation of a Spill Prevention and Contingency Plan. The beneficiation will occur in a closed loop and no water will be discharged from the mineral processing circuit to the environment. Water from mining and the mineral processing operations will have no impacts on surface water quality.

Widening of the access road and clearing for the airstrip, workshop and laboratory facilities will fragment the area. The physical disturbance and noise produced by equipment may impose additional stresses upon wildlife and may lead to increased migration. These impacts will be mitigated by minimizing the area cleared for the facilities and by maintaining wildlife corridors within the cleared areas.

The LCDS is focused primarily on the consequences of deforestation and avoided deforestation. The intent is to ensure a carbon neutral position results from forestry operations. It has very little discussion on the mining sector and proposes “to align all land-use policies with the LCDS - most importantly forestry and mining policies”. The project will entail progressive reclamation of areas cleared for mining. The project impacts on forest resources will consequently be carbon neutral. The beneficiation process to be utilized will entail the use of no chemical reagents thereby ensuring early compliance to the mercury ban proposed by the GGMC. The impacts of the project on the LCDS are minor.

The development of the mine and potential employment opportunities may attract people to the site for work. The uncontrolled influx of people from outside could possibly create health risks to Sun and Sand employees and vice versa. The project will create a demand for skilled labor. The project may therefore result in people in the communities acquiring new skills.

The project will introduce chemical free technology to Guyana gold mining industry and will serve as a demonstration project for application elsewhere.

An Environmental Management Plan was developed to mitigate the potential negative impacts and risks and to enhance the potential positive impacts of the proposed action. Environmental management measures address the environmental impacts and risks to both the physical and socio-cultural environments.

A monitoring program has been developed for the project. The monitoring program will provide data which would serve as the basis to determine the environmental performance of the operation. The project will be monitored to confirm its adherence to sound environmental management practices and contractually established operational standards. Monitoring will be conducted during the construction and operation phases of the project. The monitoring program is designed to ensure that the trends for specific parameters are tracked. It will also provide information on compliance with legislation, guidelines and contractual requirements for the construction and operation of the facility.

The monitoring program has been designed to track terrestrial resources, surface and ground water quality, the use and disposal of hazardous materials, the effectiveness of the proposed reclamation program for mined out areas, air quality and dust emissions, noise levels and the effectiveness of the proposed social impact measures.

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1.0 INTRODUCTION

Sun and Sand Resources (Guyana) Inc. (Sun and Sand) hold rights to Prospecting License B-45 located in the Mazaruni and Cuyuni Mining Districts. The Prospecting License (PL) is described as follows:

Commencing from Point A, located at geographical coordinates of longitude of 59 27'0"W and latitude 6

29'46"N, thence at true bearing of 81 6'0", for a distance of approximately 1 mile 1240 yards, to Point B, located at geographical coordinates of longitude 59 25'32"W and latitude 6 30'N, thence at true bearing of

90 for a distance of approximately 1 mile 1326 yards to Point C, located at geographical coordinates of

longitude 59 24'0"W and latitude 6 30'N, thence at true bearing of 180 °; for a distance of approximately 5 miles 1281 yards, to Point D, located at geographical coordinates of longitude 59 24'0"W and latitude 6

25'0"N, thence at true bearing of 270 °; for a distance of approximately 3 miles 771 yards, to Point E, located at geographical coordinates of longitude 59 27'0"W and latitude 6 25'0"N, thence at true bearing of 0 °; for a distance of approximately 5 miles 814 yards, to the point of commencement at Point A. The PL encloses an area of approximately 12500 acres.

Examination of the regional geological and regional aeromagnetic maps of the area containing PL B-45 reveals that it is underlain essentially by Palaeoproterozoic granite – greenstone belt rocks of the Barama – Mazaruni Supergroup, which have been intruded by dolerite dykes of the Mesoproterozoic Avanavero Suite. The bedrock geology of the area is composed of the following lithological components:

- Palaeoproterozoic greenstone rocks - mainly metasediments of the Barama – Mazaruni Supergroup
- Palaeoproterozoic greenstone rocks – mainly intermediate metavolcanics of the Barama – Mazaruni Supergroup
- Palaeoproterozoic granitoid rocks and
- Dolerite dykes of the Mesoproterozoic Avanavero Suite

Structural geology maps of PL B-45 show faults having three distinct orientations

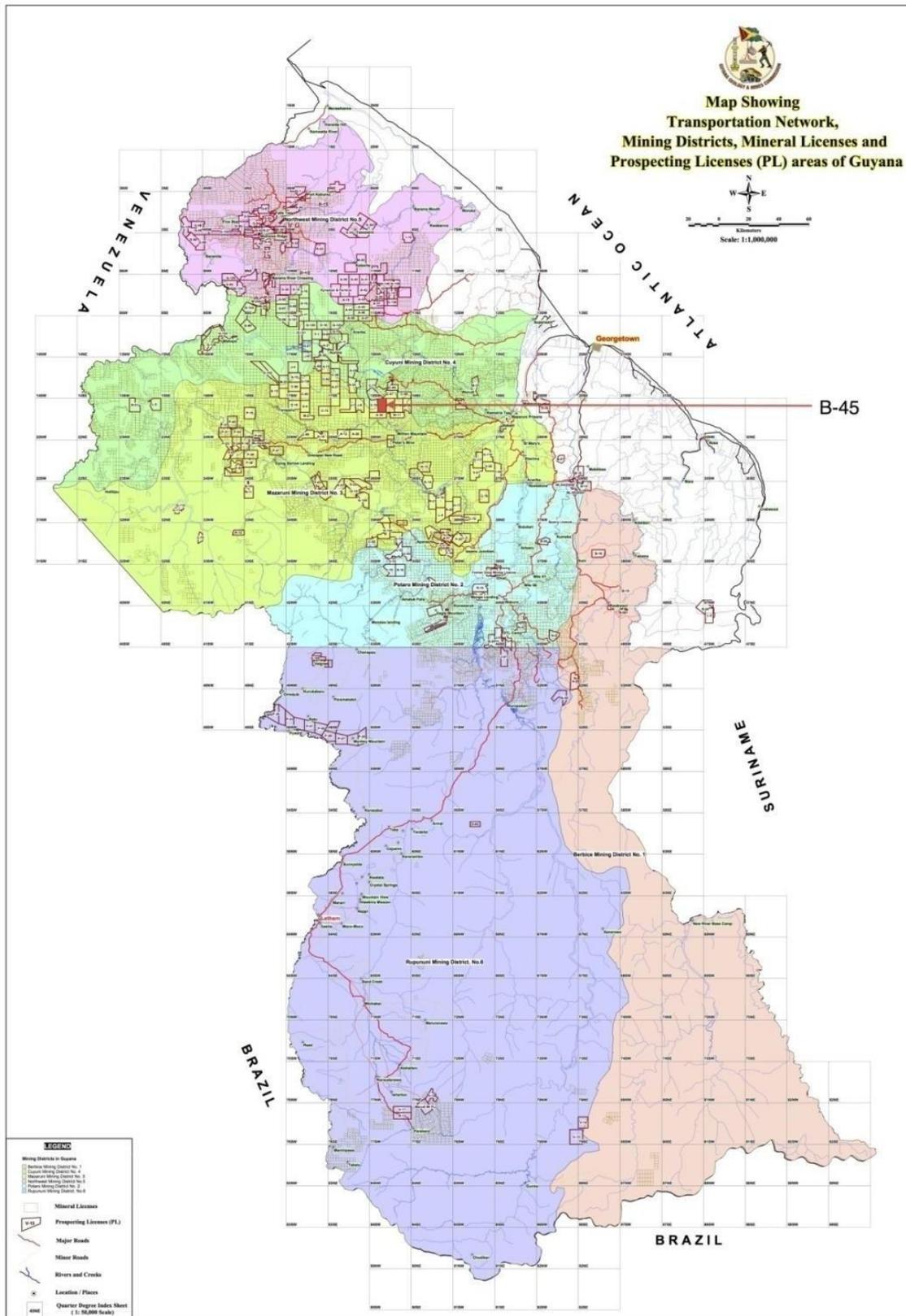
- Trending northeast – southwest
- Trending northwest – southeast and
- Trending north – south

PL B-45 consists of flat terrain and rolling hills. There are several lineaments, possibly related to bedding trending NE-SW in the northern sector of the PL. Several diabase dykes of the Younger Basic Group trending ENE-WSW appear to occur also in the northern sector of the area. Both are indicators of the location and remobilization of gold mineralization. PL B-45 is surrounded by a number of gold mining areas which have past histories of gold production. These include Akaiwong, Quartzstone, Aremu-Okò Mountain, Peter's Mine, Million Mountain and Aurora which have all been producing gold since the early 1900s. The location of the property is depicted on Figure 1.

1.1 Purpose of and Need for Action

Sun and Sand undertook an exploration program within the boundaries of PL B-45. During the program samples were collected from pits within the boundaries of PL B-45 to assess the viability of the ore deposit. Pits were sited along sloped areas and within all flat areas within the PL. All pits were approximately 0.9 m (3 ft.) square and extended to depths of 3 m (10 ft.). Pit samples were collected from the fragmented/fractured mineralized host rock with or without quartz veins and from the sand and clay matrix to determine the average gold grade in parts per million (ppm). The sampling and analyses program of the PL provided 76.46 tonnes of measured geological gold resource which equates to a total minable gold resource of 61.17 tonnes.

Figure 1 - Location of Sun and Sand Quartzstone Gold Project



Sun and Sand is now proposing to develop the PL into the Quartzstone Gold Project. The project will consist of an opencast mine and associated processing for the recovery of gold. The mine will be 2 – 3 m deep. Primarily alluvial/colluvium deposits, within the PL will be mined for the recovery of Placer gold.

The purpose of the action is therefore to operate an open pit mine for the recovery of gold from primarily alluvial/colluvium deposits, within PL B-45. The action will entail recovery and processing of the alluvial deposits to recover gold confirmed to be present in those deposits. The action is needed to recover gold confirmed to be present at the location based on the results of an exploration program undertaken at the property. The results of that investigation have verified that gold is present in adequate quantities and is of reasonable grade to warrant the establishment of a mine and mineral processing operations at the site. To attain the objectives of the proposed action alluvial/colluvium deposits will be processed to recover gold confirmed to be present at the property. Several additional facilities will be provided to ensure the viability of the proposed mining operation. These include the following:

- Upgrading the current access road to the mine site;
- Construction of an airstrip
- Construction of workshop and ancillary facilities
- A laboratory

1.2 Scope of Environmental and Social Impact Assessment

This ESIA has been prepared to conform to guidelines established by the Guyana Environmental Protection Agency and as detailed in the EPA publication titled Environmental Impact Assessment Guidelines, Volume 3 Mining, Version 1, August 2000. In accordance with those guidelines, this ESIA is comprised of three components, the Environmental Baseline Study, The Environmental and Social Assessment and the Environmental and Social Impact Management Plan. The baseline herein is a record of the present quality of the physical, biological and socio-economic and socio-cultural variables within the project area of influence. The existing environment is described only for those aspects of the physical, biological, social and economic environment within the study area that are relevant to the project.

The Environmental and Impact Social Assessment identifies and assesses the impacts of the proposed action and its alternatives taking into consideration the measures that are proposed to mitigate and/or enhance the probable impacts. The assessment identifies the project-environment interactions during design, construction and operation and after closure of the operation.

The Environmental Management Plan (EMP) has been prepared to conform to the “Guidelines for Preparing Environmental Management Plans” detailed in the referenced document. In accordance with those guidelines, the EMP identifies feasible and cost-effective measures to reduce potentially adverse environmental impacts to acceptable levels. It also includes operational procedures to avoid environmental risks during operations as well as emergency and contingency plans in the event of accidents during operations.

The Study area considered by this ESIA includes the area defined by the limits of the proposed mine and its ancillary facilities. The study area encompasses the proposed access road to the site from Itaballi and communities within proximity of the project area which are likely to be affected by the proposed project and which may serve as sources of labour and services such as Bartica and Puruni Landing. The extent of the study area is depicted as Figure 2.

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Puruni River

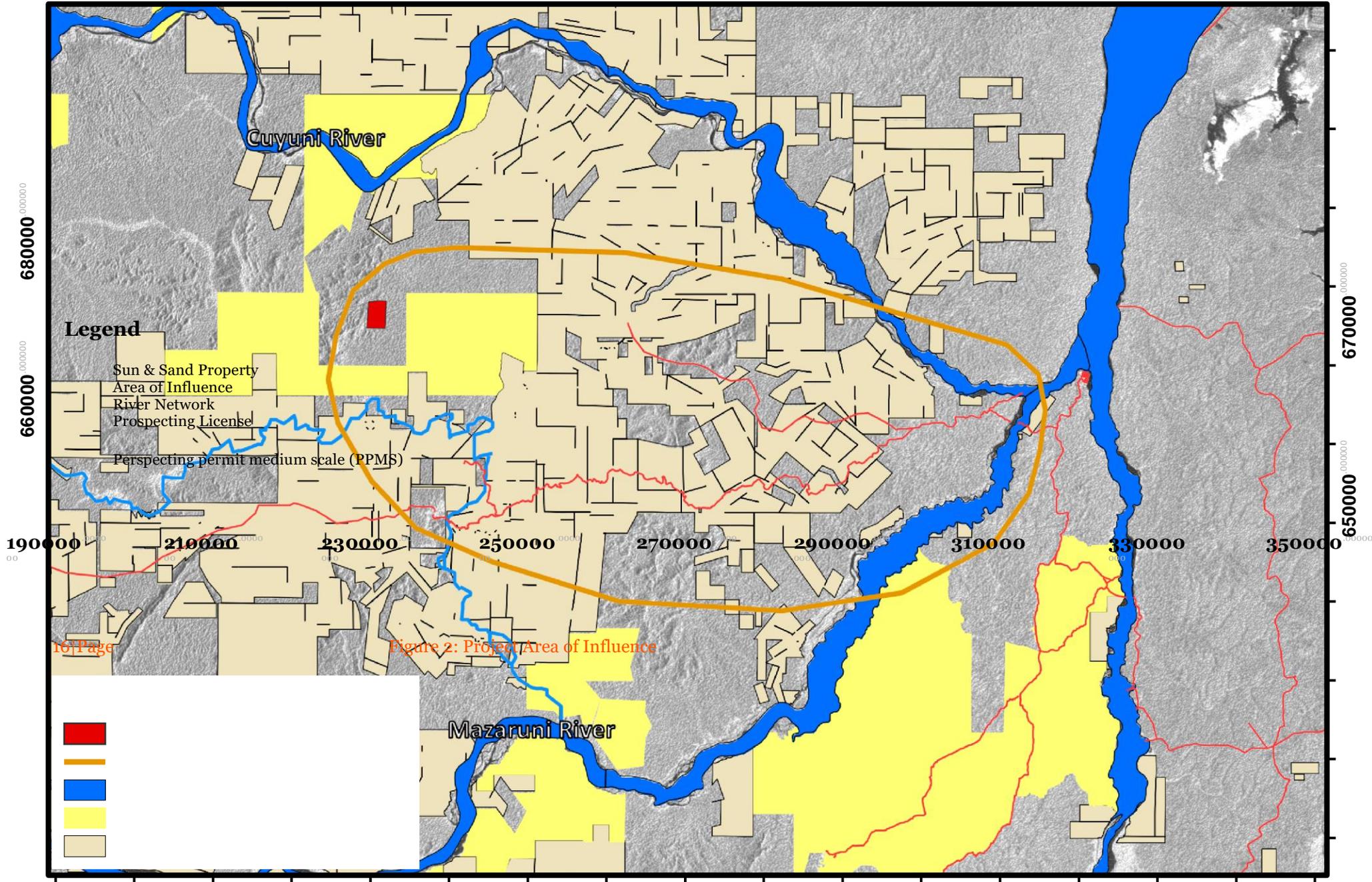
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Legend

- Sun & Sand Property
- Area of Influence
- River Network
- Prospecting License
- Perspecting permit medium scale (PPMS)

Figure 2: Project Area of Influence

1.3 ESIA Study Team

The Environmental and Social Impact Assessment was undertaken by Ground Structures Engineering Consultants Inc (GSEC). The study team assembled for this assignment consists of individuals who are recognised experts in conducting environmental impact assessments in Guyana and elsewhere. This has resulted in the creation of a unique group of professionals, all of whom have the necessary range and depth of experience and a thorough understanding of local conditions to conduct the ESIA's to GGMC, World Bank, and Guyana EPA Standards.

Charles P. Ceres is the Managing Principal of Ground Structures Engineering Consultants Inc. of Guyana. He served as the Project Director and provided strategic guidance to the team and was responsible for project co-ordination and logistics. Mr. Ceres oversaw the fieldwork and baseline studies. Mr. Ceres has been responsible for the management and execution of a wide variety of environmental projects in Guyana, the United States and the Caribbean. Mr. Ceres has also managed several ESIA's and EAs in Guyana. He managed the ESIA for the expansion of the Guyana Sugar Corporation Skeldon Estate and has served as a consultant to the Guyana Environmental Protection Agency. Mr. Ceres has supervised several environmental monitoring and remediation projects both in Guyana and overseas. His experience in Guyana includes supervision of the installation of groundwater monitoring equipment at Omai Gold Mines Tank Farm and the environmental audits for the privatization of Linmine and Bermine. His experience in the Northeastern United States includes supervising the installation of equipment for the remediation of soil and groundwater contamination and managing several National Pollution Discharge Elimination Systems (NPDES) installations.

Hance Thompson is an extremely well qualified biodiversity specialist with extensive credentials and experience in Guyana. His responsibilities on this assignment included developing protocols for baseline definition of biological resources and the development of management and mitigation plans to minimize impacts on these resources. He coordinated the work of field crews undertaking the biodiversity surveys of the project area and examined the impacts of the project on the biodiversity of the area. Hance has served in a similar capacity on several projects in Guyana including the Aurora Gold Mines Project and SandSpring Resources Gold and Copper Mine at Toroparu.

Kean Chase is an accomplished social scientist who has worked on socio-economic baseline studies for SandSpring Resources at Toroparu and Troy Resources at 14 Miles Issano. She coordinated the activities of individuals working in communities within the project area of influence to determine the socio-economic impacts of the project and was responsible for development of the management and monitoring plans to mitigate potential impacts.

1.4 ESIA Organization

This remainder of this ESIA will be developed in the following sequence:

Chapter 2 identifies the various phases of the Proposed Action and details the components of the Proposed Project.

Chapter 3 identifies and discusses alternatives to the Proposed Action.

Chapter 4 outlines the Legal and Institutional Framework for environmental compliance by large scale mining operations.

Chapter 5 is a description of the physical and biological environment within the project study area. Chapter 6 is a description of the socio-economic and socio-cultural environment within the project study area.

Chapter 7 presents the impacts on the physical environmental and identifies the risks associated

with the proposed action.

Chapter 8 examines the socio-cultural and socio-economic impacts and risks of the proposed action.

Chapter 9 outlines the Environmental Management Plan (EMP) proposed to mitigate the impacts associated with the project.

Chapter 10 outlines the Institutional framework for project execution and supervision.

Chapter 11 presents the Monitoring Plan required to ensure compliance during the various phases of the proposed action.

Chapter 12 examines the risks associated with the proposed action and details steps required to minimize those risks.

Chapter 13 details a preliminary closure plan for the site and

Chapter 14 details the results of discussions with agencies and NGOs.

2.0 DESCRIPTION OF THE PROPOSED ACTION

2.1 Proposed Action

For the purposes of conducting this Environmental and Social Impact Assessment (ESIA), the proposed action is the excavation of alluvial/colluvium deposits from areas within PL B-45 and the processing of these alluvials/colluvium to recover gold. A processing plant with three primary circuits; gravity, separation and concentration will be utilized for gold recovery from the mined ore. Several facilities will be constructed on site to support the operations. These facilities will include equipment repair shops and laboratory.

2.2 Preliminary Works

Preliminary works will consist of clearing the forested area for development into a surface mine. The forest will be cleared using conventional methods. Chainsaws will be used for felling large trees. The underbrush will be cleared by hand cutting. Felled timber will be used for construction purposes on site. Surplus timber will be stockpiled for future use. Timber and other vegetative material not suitable for use as construction material will be stockpiled together with top soil on site during the mining operation and will be used for reclamation.

In all areas to be mined, topsoil containing seed banks and other organic matter and humus will be removed and will be stockpiled for post mining reclamation. Prior to removal of any surficial soil, timber which is felled because it occurs on the resource or poses a hazard to worker safety, will be branched and cut to useable lengths. Cleared areas will be limited to areas identified for mining, water management and ore recovery only. Barren zones within mineralized areas and/or zones not required for water management or temporary storage of excavated material will not be cleared. This will result in small islands of vegetation within operational areas, thereby creating conditions for better regeneration of vegetation during reclamation.

Core activities during the preliminary phase will include:

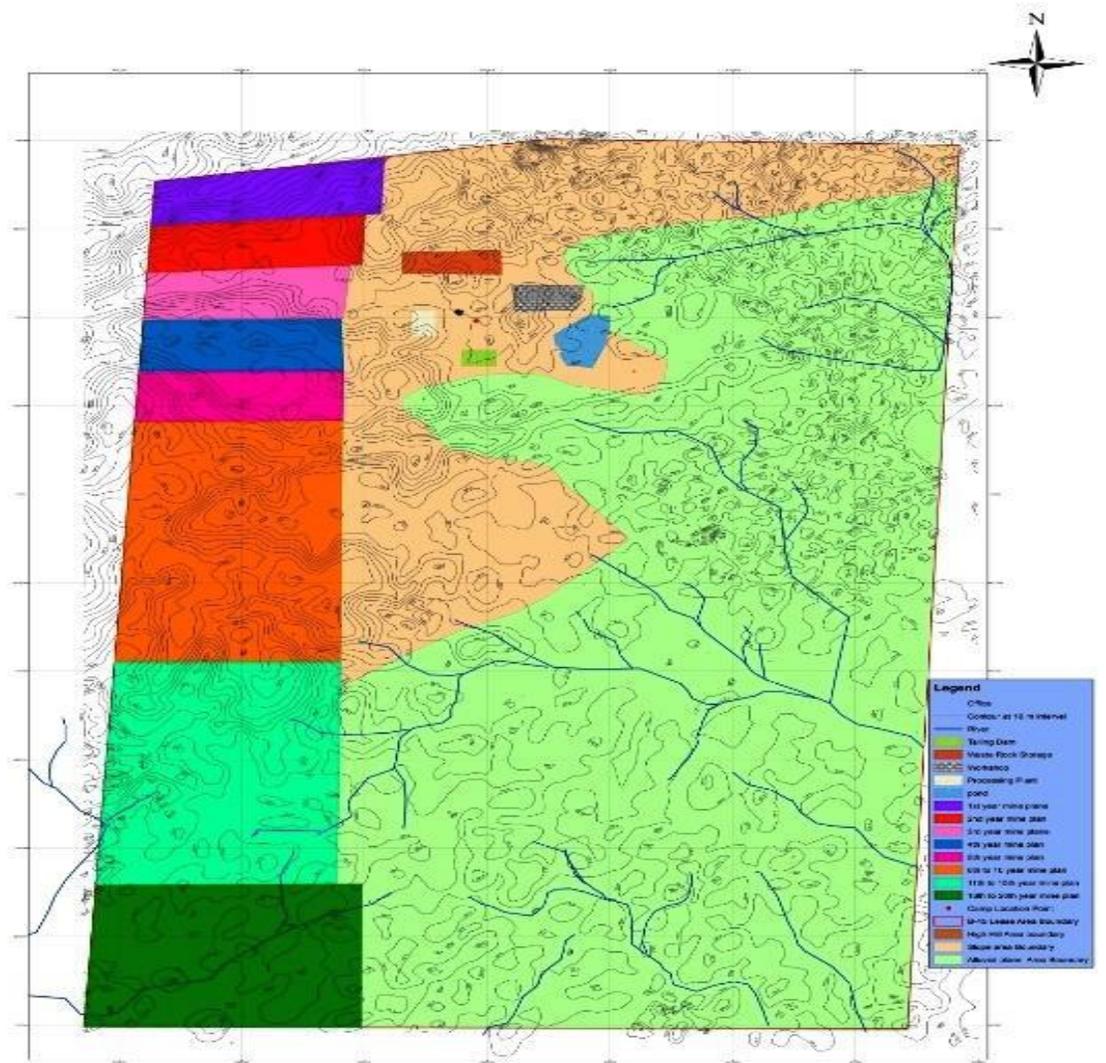
1. Upgrading the access road from Itaballi to the Mine Site
2. Construction of fuel and lubricant containment and storage facilities
3. Installation of sewer, water and power services
4. Construction of maintenance workshop and laboratory

There are existing facilities for housing workers at the site which were previously installed by Sun and Sand. These facilities will be used by Sun and Sand to house its employees. In addition, Sun and Sand has commenced construction of an airstrip at the mine site. This airstrip will also be used by Sun and Sand to support its operation.

2.3 Ore Recovery

The alluvial/colluvium deposit will be mined by open pit methods. Gold will be recovered by gravity separation using mobile screens and concentrator units. Mined out areas will be progressively reclaimed as mining progresses. Before commencement of the ore excavation operation, all creeks within areas to be mined will be diverted if necessary, by excavating a channel to connect points on the creek upstream and downstream of the mineralized zone. The diversions will be accomplished by excavation of a rectilinear channel which will have basic dimensions compatible with local hydraulics conditions. Care would be exercised during excavation to limit the depth to that of the creek bed being diverted to minimize any increase in the flow rate. The concession area will be laid out as several distinct mining pits as is illustrated on Figure 3.

Figure 3 - Layout of Proposed Mining Pits in PL During Mine Site Operations



Each pit will be mined out and reclaimed prior to commencement of work on another pit. Mining will initially progress from north to south. After the western section of the area has been mined, mining will progress to the central section of the PL which will be mined in a south to north direction. The final eastern section of the PL will be mined in a north to south direction. Each mining pit will be mined as six distinct blocks as depicted by Figure 4.

Mining will progress from the northwest corner to the southeast corner of each mine pit. Prior to excavation of paydirt, both the topsoil and other overburden material will be excavated, segregated and stockpiled for reclamation. Pay dirt will be removed by an excavator and fed into trucks for transport to the processing plant. Excavation will only commence on another block after the removal of paydirt from the preceding block. Each block will be surrounded by a berm approximately 1.5 m high with a 4 m wide crest constructed of the overburden and topsoil removed from above the mineralized zone. These berms will provide top soil material for reclamation of the mined-out areas.

2.4 Processing

To minimize impacts associated with discharge from the excavation operation, the gold recovery operation will function in a closed loop for water supply. The closed loop circuit is illustrated as Figure 5. Clear water supply, for gold recovery, will be obtained from a pond, which was previously excavated or which previously served as a tailings pond. Water overflow from both the tailings pond and the freshwater pond will be limited by the berm surrounding each pond.

The alluvial gold plant will recover gold totally by gravimetric separation. No chemicals will be utilized in the process. The process plant will consist of screen, centrifugal concentrators, hydrocyclones and vibrating tables. A pictorial representation of the plant is depicted as Figure 6.

Prior to commencement of mining operations, two ponds will be excavated, one will serve as a freshwater pond to provide water to the process plant and the second pond will serve as a tailings pond to receive process waste water. The two ponds will be connected at a point remote from the tailings discharge point. This will allow for clarified water from the tailings pond to be recycled to the freshwater pond. Ore will be trucked from the mine pit and will be dumped into a hopper through a grizzly as the first stage of the processing operation. Water will be added to the hopper to slurry the ore.

The Run of Mill (ROM) will be fed to a hopper through the grizzly screen where all material greater than 50 mm in size will be removed and placed into a reject pile for mine pit reclamation. Material, smaller than 50 mm, will be fed into a trommel, where additional water will be added to convert the material into a slurry. In the trommel all material greater than 25 mm in size will be removed and placed into a reject pile for mine pit reclamation. The underflow from the trommel will flow to a gravity circuit consisting of a series of jigs, vibrator screens with sluices and centrifugal concentrators. The underflow from the first series of concentrators will be fed to a second series of concentrators. The final overflow will be directed to a surge tank from where the slurry would be pumped to a hydro-cyclone. In the hydro-cyclone the solids will be removed and placed into a tailings stockpile. The water from the hydrocyclone will be discharged to the tailings pond for recycling thru the freshwater pond.

The underflow concentrate from the centrifugal concentrator will be fed over vibrating tables. Vibrating tables are made up of a plate slightly tilted in the direction of the width and equipped with a mechanism which communicates an asymmetrical back and forth pass. The vibrations will separate gold from the other heavy minerals present. The surface of the table is covered with longitudinal and parallel grooves the depth of which decreases gradually from the beginning point to the exit from the table which is diametrically opposite. The water from the table contains light gold particles and is discharged in the transverse direction. Final concentrate from the vibrating table will be dried. In the entire process, no mercury or any other

chemical shall be used. This type of gold processing plan is being used for the first time in Guyana and will not entail the use of any chemicals and will result in gold recovery in excess of ninety percent.

Figure 4 - Layout of Mining Blocks within each Mine Pit

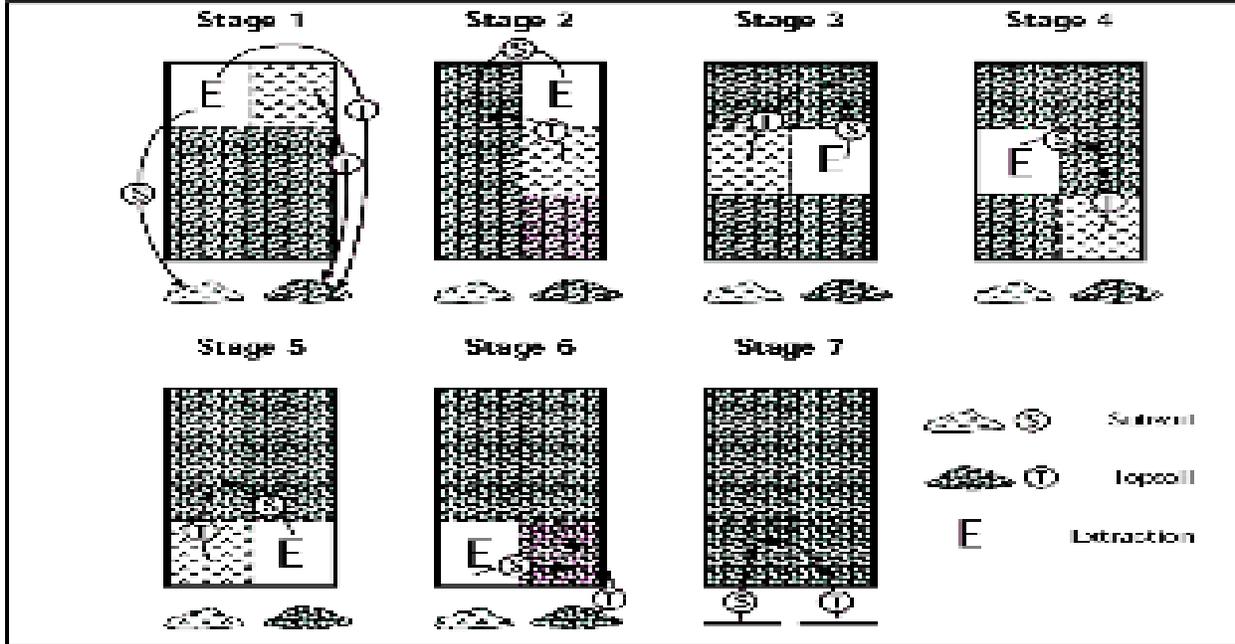
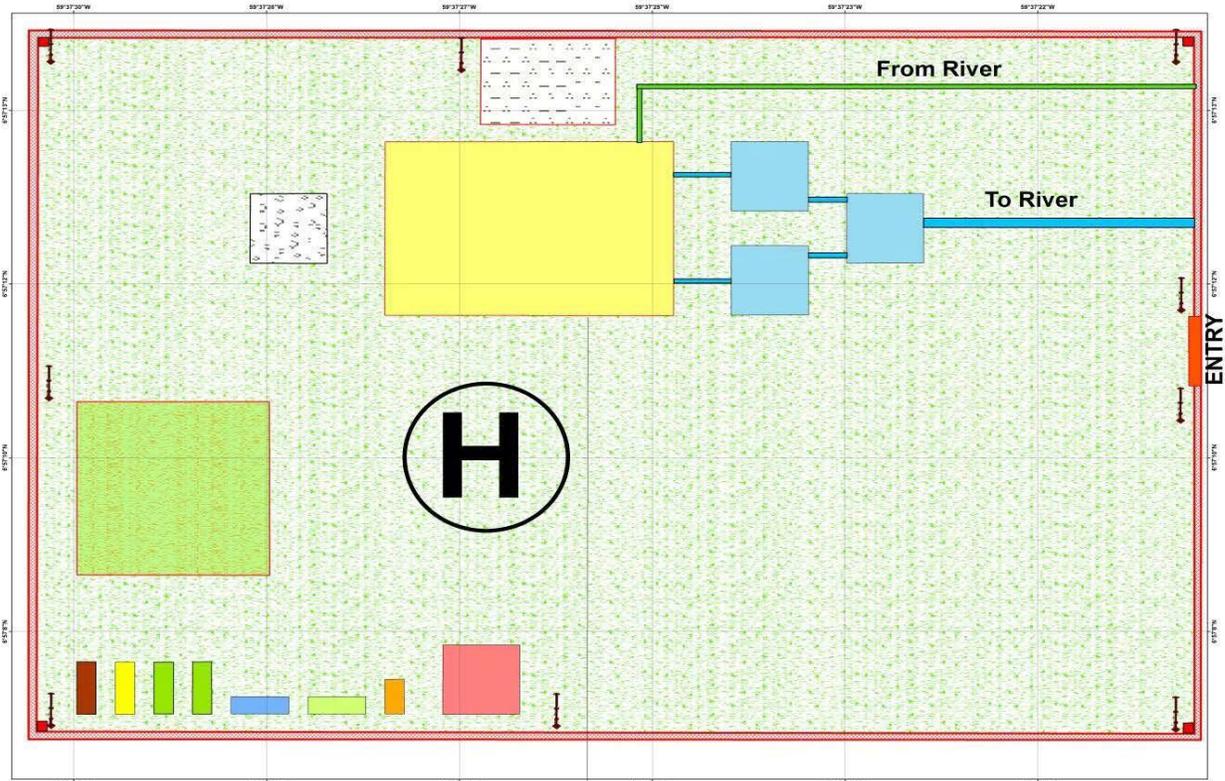
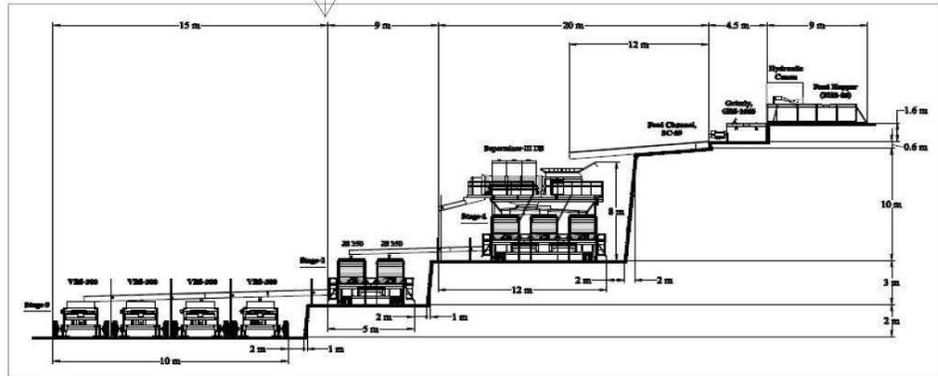


Figure 5 - Closed Loop Circuit for Gold Recovery



1 centimeter = 4 meters
 0 2 4 8 Meters
 0 2 4 8 Meters



Legend

- | | | | | |
|--------------------|---------------------|------------------|----------------------|---------------|
| Plant | Workshop | Gravel Stockyard | Rest Or Medical Room | Electric Pole |
| Director Office | Super Miner | POL | Security Post | Helipad |
| Gold Smelting Room | Parking Lot of HEMs | Pond | Entry | |
| Mine Office | Washed Gravel | Mechanical Store | Boundary | |



Figure 6 - Pictorial Representation of Gold Processing Plant

The tailings stockpiles created by the hydro-cyclones and oversize material from the grizzly and trammels will be used to reclaim the mined-out areas. The berms created from the topsoil initially used to build the berms will then be spread over the reclaimed area to enhance revegetation.

2.5 Production

The mine will operate 10 hours each work day and will process 600 m³ mineralized gravels each day. The equipment has been sized to operate for 350 days per year. The proposed production schedule is shown in Table 1.

Table 1: Proposed Production Schedule

Year	ROM		Waste	Excavation	Stripping Ratio	Production
	Qty	Head Grade				
First	400,000 t	0.95 ppm	480,000 t	880,000 t	1.2	380 kg
Second	500,000 t	0.95 ppm	600,000 t	1,100,000 t	1.2	480 kg
Third	500,000 t	0.95 ppm	600,000 t	1,100,000 t	1.2	480 kg
Forth	500,000 t	0.95 ppm	600,000 t	1,100,000 t	1.2	480 kg
Fifth	500,000 t	0.95 ppm	600,000 t	1,100,000 t	1.2	480 kg

2.6 Camp

An exploration camp currently exists at the site. Sun and Sand proposes to modify the camp and to create portable cabins with basic amenities for the level of project staff expected to be present during the mine site operations.

2.7 Roads

The mine site is accessible from Georgetown to Parika by road then by boat to Itaballi. Travel is by an all weather road approximately 68 km long from Itaballi to Aremu. A dirt road, approximately 60 km long, is the sole access from Aremu to the Quartzstone mine site. The company will undertake periodic maintenance of this road to facilitate movement of fuel and personnel to the mine site.

2.8 Airstrip

Sun and Sand proposes to construct an airstrip to service the mine site. The exact location of the airstrip will be determined as the mine site develops.

2.9 Cabins

Several portable cabins will be constructed at the site to support the operations. These cabins will include a maintenance workshop and warehouse, administration cabins, laboratory and smelting units.

2.10 Maintenance Workshop and Warehouse

A cabin with a footprint of approximately 180 m² will be constructed to house the central maintenance workshop and warehouse building at the site. The cabins will be equipped with air conditioned offices. The maintenance workshop will have a full line of equipment to cope with repairs in the remote location. The equipment will include a drill press, saws, milling machine, hydraulic press, power tools, and an instrument testing facility. The warehouse will carry a comprehensive supply of large equipment spares, to cover rainy seasons when movement of spares and consumables to the site will be restricted.

2.11 Laboratory

A laboratory with a footprint of 18 m² will be erected at the camp and will be equipped to handle all analysis and environmental monitoring.

3.0 DESCRIPTION OF ALTERNATIVES

This section reviews the factors leading to the decisions regarding the selection of the primary alternative for the mining of alluvial/colluvium deposits within the PL B-45 Concession. The physical, biological, environmental, and socio-economic impacts associated with the selected alternative are detailed separately in different sections of this ESIA.

3.1 No Project Alternative

The “No Project” alternative is not considered viable to Sun and Sand, as it would result in the foregoing of economic benefits to Guyana derived from the revenues of the gold production and creation of direct and indirect employment by the project. This alternative would also lead to the necessity to further explore other concessions and would not leverage the findings of the exploration and prospecting carried out in the Property to date, thus resulting in greater environmental impacts in areas presently not subject to such activities.

3.2 Mine and Infrastructure Location

Studies of the alluvial/colluvium deposits in the Concession have identified and delineated the existence of a viable resource in the area. There is no alternative location for the alluvial/colluvium mining activities due to absence of other significant alluvial deposits elsewhere within the Concession. The sites chosen for the support facilities have been guided by topography and the principles of minimizing the affected area and concentrating the impacts to a single zone within the concession.

3.3 Mining and Beneficiation Processes

Sun and Sand will utilize international best practice for all mining and beneficiation processes. This will include mining within a closed hydraulic circuit and beneficiation of gold utilizing no chemical reagents. Progressive reclamation will also occur as mining progresses. The alternatives to the closed circuit would be an open circuit which will result in discharges to the environment and the associated impacts. Similarly alternatives for beneficiation will entail the use of chemical reagents and the discharge of residual levels of chemical reagents to the environment based on Best Management Practices (BMPs) or discharge of chemical reagents at elevated levels if BMPs are not utilized.

Mercury amalgamation (Hg) is the method-of-choice for small and medium scale miners in Guyana. Mercury amalgamation is effective only for gold particles larger than 60-70 microns. For mercury amalgamation to be effective the gold particles must have a clean surface available, the mercury must be put in direct contact with the gold particle, the mercury must be clean enough, the gold must be already liberated from the matrix and the gold must have its surface exposed to adhere to the mercury. Further mercury amalgamation is effective only for gold particles larger than 60-70 microns.

There has been increased recognition of the harmful impact of mercury on human health and ecosystems and the Guyana Geology and Mines Commission has mandated that mercury use be discontinued. Mercury use will result in impacts to the health of employees and local people and poses threats to the environment. Mercury use is also likely to increase insurance risks and liabilities. In addition, viable alternatives to mercury now exist since mercury is ineffective at recovering gold less than 70 microns in size. Mercury amalgamation can result in significantly greater impacts on the environment in addition to replicating the impacts of the proposed action on biodiversity.

Chlorine can also be used to recover gold. As noted by WWF-Guianas (www.wwfguianas.org), a basic version of chlorination could replace amalgamation and cyanide. Two common chemicals are required for chemical leaching; 14-16% sodium hypochlorite NaOCl and 30% strength hydrochloric acid. Bleach (sodium hypochlorite solution) forms comparatively stable trihalomethanes (THMs) and haloacetic acids (HAAs) which are claimed to be carcinogenic and may pose other health risks to mine site employees.

Froth flotation of gold is possible due to surface hydrophobicity of gold. Froth flotation can recover up to 100% of very fine to moderately fine gold. Challenges to gold flotation relate to the depressed hydrophobicity, buoyancy and floatability of gold because of the presence of impurities and coatings. Effective froth flotation will mandate the use of expensive reagents and the recycling of process effluents.

The environmental impacts of alternative beneficiation and mining methods will consequently result in greater environmental impacts and validate the choice of this option for recovery of gold from the alluvials at this location.

Sun and Sand utilization of international best practice for all mining and beneficiation processes will incorporate appropriate Environment, Health and Safety Guidelines in the final design of all facilities and processes. Mercury amalgamation, froth flotation and chemical leaching will not conform to Best Management Practices as these practices are likely to create health and environmental impacts.

3.4 Alternative Tailing Management Facilities

The purpose of a tailings impoundment is to contain fine-grained tailings, often with a secondary or co-purpose of conserving water for use in the mine and mill. This must be accomplished in a cost-effective manner that provides long-term stability of the embankment structure and the impounded tailings coupled with long-term protection of the environment. The design of any tailings embankment and impoundment must be balanced against three interests, cost, stability, and environmental performance, with situation-specific conditions establishing the balance at each stage of the process. The long-term costs of tailings disposal depend in part on mechanical stability and environmental integrity since stable and environmentally acceptable structures are cost effective.

Two basic types of structures are used to retain tailings, raised embankment and retention dams. Either type of structure, raised embankments or retention dams, can be used to form tailings impoundments. The four main types of impoundments include the Ring-Dike, In-Pit, Specially Dug Pit, and variations of the Valley design. The design choice is primarily dependent upon natural topography, site conditions, and economic factors. Costs are directly related to the amount of fill material used in the dam or embankment. Major savings are realized by minimizing the size of the dam and by maximizing the use of local materials, particularly the tailings themselves.

Impoundment of slurry tailings is the most common method of disposal. Impoundments are favored because they are economically attractive and relatively easy to operate. Tailings impoundments are designed to perform a number of functions, including treatment functions. These functions include

- Removal of suspended solids by sedimentation
- Precipitation of heavy metals as hydroxides
- Permanent containment of settled tailings
- Equalization of wastewater quality
- Stabilization of some oxidizable constituents (e.g., thiosalts, cyanides, flotation reagents)
- Storage and stabilization of process recycle water
- Incidental flow balancing of storm water flows

One disposal option is dewatering of the tailings (thickened to 60 percent pulp density or more) or dried (to moisture contents of 25 percent or below) prior to disposal. Advantages of this option include minimizing seepage volumes and land needed for an impoundment and simultaneous tailings deposition and reclamation. The efficiency and applicability of using thickened or dry tailings depends on the ore grind and concentrations of gypsum and clay as well as the availability of alternative methods. These methods are prohibitively expensive due to additional equipment and energy costs.

Tailings can also be used to backfill former open-pit mines. In active pits, embankments will be required to keep the tailings away from active areas. However, seepage from the tailings can adversely affect the stability of the pit walls or embankments and disposal of tailings into active pits is typically not practiced.

Tailings may also be disposed underwater in rivers. Underwater disposal sometimes prevents the oxidation of sulfide minerals in tailings, thus inhibiting acid generation. Subaqueous disposal is most often used in areas with high precipitation, steep terrain, or high seismicity. This method is however limited to coarse tailings that can settle quickly. High pH tailings can modify the acidity of the river resulting in environmental degradation.

Since mine tailings are usually in slurry form, disposal of slurry tailings in impoundments made of local materials is the most common and economical method of disposal. It is economically advantageous to use natural or man-made depressions to contain tailings. The advantages include reduced dam size, since the sides of the valley or other depression serve to contain tailings. In addition, tailings in man-made or natural depressions present less relief for air dispersion of tailings material. In addition, man made depressions can be constructed singly, allowing for the tailings to be contained behind a single dam or embankment.

The man-made depressions, created by excavations for ore, will be reclaimed by the tailings disposal operation and will provide less relief for wind-blown emissions from the tailings pond surface. The design of the tailings disposal option selected for this project will provide the best balance of cost, stability, and environmental performance. This option presents major savings to the project by eliminating the need for a tailings dam and by maximizing the use of materials already at the site, particularly the tailings for progressive site reclamation.

3.5 Access/Transport Mode

Access to the project and transportation of materials and products is possible by three primary modes: overland, river, or air. Air transport will be used as one of the transportation mode for personnel to and from the mine. This will reduce the number of persons and vehicles/vessels travelling along the access road or on the river and keep the camp as an “offshore operation”. The primary mode of transport of materials and supplies to the mine and product from the mine will be overland by truck from the mine to a port on the Mazaruni River.

3.6 Haul/Access Road Route

In order to avoid impacts of constructing an entirely new road, the route for overland transport was selected based on the availability of existing roads that extend west of the Essequibo River toward the project area. There are very few existing roads in the region, limiting the selection to the road initially constructed to the mine site. The road runs roughly E-W from the lower Essequibo through forested uplands to the Mine Site. There are no roads from the Bartica or the Mazuruni areas that reach the project area; therefore, the only alternative that would not require construction of a new road through currently inaccessible areas would be to use the existing road from the Mazaruni River to the proposed Mine Site.

4.0 POLICY, LEGISLATIVE AND REGULATORY CONSIDERATIONS

4.1 Introduction

The legislative and regulatory framework, for the project, is a combination of guidelines for construction and operation of the mine and its associated facilities. That framework is a combination of national, international and regional policies, regulations, legislations and guidelines to which Guyana is a signatory. The environmental and social impact assessment process for development and operation of the project will be undertaken in accordance with the legislative and regulatory framework detailed below.

4.2 National Policies, Regulations and Legislations

4.2.1 National Environmental Action Plan

The National Environment Action Plan (NEAP), developed in 1994, outlined the Government of Guyana main environmental policy objectives for sound management of the environment and natural resources. *The project must be undertaken based on sound environmental management practices. The National Environmental Action Plan is consequently considered applicable to this project.*

Twelve policy objectives are outlined in the NEAP. One of the policy objectives calls for the Government of Guyana to require that environmental assessments are undertaken for proposed development activities that may significantly affect the environment. In keeping with this environmental policy objective, the Environmental Protection Act was made law in June 1996 and the legal framework for undertaking an environmental impact assessment was outlined. Further, the Act established the Environmental Protection Agency and outlined the legal process for undertaking sustainable and effective management of the environment and its natural resources.

This plan was updated in 2000. It states Guyana's Policy position as 'sustainable development that integrates economic, environmental and social values during planning, and recognizes the need to distribute benefits equitably across socio-economic strata and gender upon implementation.' The main goals of protecting the environment as defined in the plan are:

1. The prevention or control of pollution in order to maintain the integrity of the land and the natural purity of the air and water resources;
2. The general preservation and conservation of ecological integrity and the protection of natural habitats and fragile ecosystems in particular;
3. Ensuring sustainability through best practice of the management and use of natural resources for economic development.

4.2.2 Environmental Protection Act 1996

The Environmental Protection Act under which the Environmental Protection Agency was established provides for the management, conservation, protection and improvement of the environment. It also has provisions for prevention or control of pollution, assessment of the impact of economic development on the environment and the sustainable use of natural resources. The Act mandates the performance of Environmental Impact Assessments for projects with significant impacts on the environment.

This Act was amended in 2005 and includes a section on record keeping and monitoring requirements. Under this section, the Environmental Protection Agency requires that any person who releases or engages in the handling of hazardous substances or contaminants to:

1. Sample and analyze such contaminant or hazardous substance, or material contaminated by that person for specific constituents or characteristics;

2. Install, use and maintain monitoring equipment, and implement environmental audit procedures as may be specified in any environmental authorization issued pursuant to this Act;
3. Establish and maintain records regarding such sampling, monitoring, and environmental auditing activities;
4. Establish and maintain records regarding pollution control equipment on the premises (including records on control equipment parameters, production variables and other indirect data when direct monitoring is not required);
5. Submit reports including compliance reports; and
6. Provide such other information as the authority may require.

There are five (5) pieces of legislations governing environmental protection which were enacted in 2000 as a consequence of the Environmental Protection Act. These are:

- The Environmental Protection Air Quality Regulations
- The Environmental Protection Water Quality Regulations
- The Environmental Protection Noise Management Regulations
- The Environmental Protection Hazardous Wastes Management Regulations
- The Environmental Protection Authorizations Regulations

This Act is applicable to the project due to its potential to impact the environment. The provisions stipulated in this Act would be adhered to by Sun and Sand.

4.2.2.1 Environmental Protection (Authorizations) Regulations 2000

Under this regulation, Sun and Sand is mandated to keep records of all environmental monitoring (not less than 3 years), sampling procedures, maintenance and calibration procedures and all problems and malfunctions. These records should be made available to the Environmental Protection Agency. This regulation includes such information as:

- Steps to avoid, minimize, mitigate and compensate for impacts
- Records of monitoring information such as date, place and time of measurement etc.
- Proper maintenance of facilities and appropriate quality assurance procedures;

4.2.3 EPA's Role in EIAs

The Environmental Protection Act mandated four functions for the EPA which relates to environmental assessment. *The EPA has determined that this project is likely to have significant environmental impacts. These four functions of the EPA are consequently applicable to this project.* These four functions are:

1. To take such steps as are necessary for the effective management of the natural environment so as to ensure conservation, protection and sustainable use of natural resources;
2. To promote the participation of members of the public in the process of integrating environmental concerns in planning for development on a sustainable basis;
3. To ensure that any development activity which may cause an adverse effect on the natural

environment be assessed before such activity is commenced and that such adverse effect is taken into account in deciding whether or not such activity should be authorized.

4. The EPA also has responsibility for coordinating environmental management activities of all persons, organizations and activities. The EPA would consequently be responsible for monitoring this environmental Authorization.

The Agency is required to implement several principles of environmental management as part of this process. These principles are:

- The “polluter pays principle”: the polluter should bear the cost of measures to reduce pollution
- The “precautionary principle”: where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation.
- The “strict liability” legal principle: any person who contravenes this Act or regulations shall be liable to the penalties prescribed thereafter;
- The “avoidance” principle: it is preferable to avoid environmental damage, as it can be impossible or more expensive to repair rather than prevent damage;
- The “state of technology” principle: measures protecting the environment are restricted by what is technologically feasible and as technology improves, the improved technology should be used to prevent and repair environmental damage.

The management plan detailed in the ESIA will conform to principles of environmental management proposed by the EPA and which is detailed above.

4.2.3.1 The EIA Process

The ESIA being undertaken for mining of the alluvial/colluvium deposits must conform to the EIA process established by the Guyana EPA. A summary of that EIA process is detailed below.

Commencement of the environmental impact assessment process is preceded by an application for an environmental authorization and a summary of the project including information on the site, design and size of the project, possible effects on the environment and a non-technical explanation of the project. The Environmental Protection Agency would then indicate whether an environmental and social impact assessment is a mandatory requirement for the issuance of an environmental authorization for the operation.

A Project Summary is prepared by the EPA. The EPA publishes a notice of the Project Summary in at least one daily newspaper. The Project summary is made available to members of the public for a period of 28 days. Within this period the EPA accepts written submissions to the Agency related to the project. These submissions detail questions and matters which members of the public consider relevant to the deliberations of the EIA.

If considered necessary, by the EPA, public consultation meeting(s) is/are held within this 28 day period. Additional concerns of the public are noted at the meeting(s). The EPA then finalizes a Terms of Reference for The Project and provides it to the ESIA Consultants for preparation of the ESIA.

During the environmental impact process, the Developers and Consultants are required to consult members of the public, interested bodies and organizations and also provide to members of the public on request, and at no more than reasonable cost, copies of information obtained for the purpose of the EIA. The key objectives of public involvement in the EIA process are to:

- give the public a voice in project planning;
- obtain local knowledge, information and ideas;

- provide information to the people on planned activities to stimulate local interest and involvement in the project;
- ensure early detection of environmental and social impacts arising from the project;
- initiate and establish mechanisms and procedures to enable local people to participate in all phases of the project.

The Developer and Consultant must submit to the EPA, the ESIA report along with an Environmental Impact Statement (EIS) for evaluation and recommendations. Every environmental impact assessment is required to contain a description of the project, an outline of the main alternatives studied and reasons for

choices, a description of significant effects of the development on the environment, an indication of any difficulties encountered by the developer in compiling information for the ESIA, a description of the best available technology, a description of any hazards or dangers which may arise and a risk assessment of same, a description of mitigation measures for any adverse effects, a monitoring plan and an emergency response/contingency plan and a program for rehabilitation and restoration. The decision by the Agency to grant an environmental authorization for a project shall be subject to conditions, which are reasonably necessary to protect human health and the environment.

The ESIA must be completed to conform to the TOR and copies submitted to the EPA for review and public comment. The EPA subsequently publishes a notice in at least one daily newspaper notifying the public of the submission of the ESIA. The public has 60 days from the publication date of the notice to make submissions to the EPA and/or the EAB related to the EIA. The EPA, along with relevant sector agencies review the EIA during this sixty day period to ensure that the EIA is in line with any plans, guidelines, regulations or codes of practice developed by the EPA and sector agencies. Copies of the EIA and the findings of the review by EPA and sector agencies are passed to the EAB for review and recommendation.

A public meeting, chaired by the EPA may be held, if considered necessary, at the end of the 60 days period. Additional comments are provided by members of the public at this meeting. A final ESIA is prepared to address the comments of the EPA, the sector agencies, the public and the EAB. The EAB will then recommend to the EPA whether the EIA is acceptable and the conditions to be attached to the Environmental Permit, should it be granted.

The Environmental Assessment Board, being an independent Body, is mandated by the Environmental Protection Act, 1996 to recommend whether the EIA should be accepted, amended or rejected, whether an Environmental Permit should be issued by the Agency, and what terms and conditions should be included in the Environmental Permit.

The EPA takes into account the recommendations of the EAB and sectoral agencies, comments of the public and its own review, and decides whether or not the project should be approved. For approved projects, the EPA issues an Environmental Permit with the terms and conditions necessary to effectively manage the environment. If an Environmental Permit is not granted, the developer can file an appeal within 28 days with the Environmental Appeals Tribunal (EAT). The EAT is a superior court of record and has in addition to the jurisdiction and powers conferred by the EP Act, all the powers inherent in such a court. The Tribunal has the power to enforce its own orders and judgements and the same power to punish contempt as the High Court of Justice. The EAT has the jurisdiction to hear and determine appeals against:

1. The refusal of an Environmental Permit;
2. The requirement of an Environmental Permit;
3. Cancellation or suspension of an Environmental Permit.

While the act mandates the EAT as the final authority in the process, an actual EAT does not currently exist.

This ESIA is being undertaken in accordance with the framework for the EIA process established by the EPA. The EPA issued the Terms of Reference for the Project in February 2017. The finalization of the TOR was preceded by public consultations with sectoral agencies and communities in proximity to the proposed operations. The additional components of the ESIA will conform to the procedure outlined above.

4.2.3.2 Environmental Impact Assessment Guidelines

The Environmental Protection Agency (EPA) in collaboration with the Environmental Assessment Board (EAB) has produced guidelines for conducting Environmental Impact Assessments (EIA) for Mining

Projects in Guyana. The guidelines are intended to compliment those in Section IV of the Environmental Protection Act, 1996 (EP Act).

This ESIA is being conducted in accordance with guidelines established by the EPA for the mining sector. In accordance with these guidelines, EIAs for the mining sector shall consist of three components; Environmental Baseline Study, Environmental Assessment and Environmental Impact Statement. The Environmental Baseline Study records the quality of the environment within the area of influence before the project is implemented. The data is analysed in the environmental assessment and is used to predict and quantify impacts. The Environmental Assessment (EA) is the identification and assessment of impacts of the proposed project and of its alternatives. The EA considers mitigation measures to offset negative impacts and assesses the impact of implementing these measures on the environment. The Environmental Impact Statement is a summary of the findings of the Environmental Baseline Study and the Environmental Assessment and includes an Environmental Management Plan.

4.2.3.3 Environmental Protection Regulations

The mining project will utilize fuel oils and greases in its operation. Improper discharges of these substances can impact water quality and wildlife. In addition, equipment used for mining and processing will have emissions to air that can potentially impact air quality. Noise from equipment operation may also impair communication. Local and international environmental protection regulations related to these media are therefore applicable to the project. These include Guyana EPA, World Bank and WHO standards detailed below.

Regulations on Hazardous Waste Management, Water Quality, Air Quality and Noise Management were established, in 2000, under the Environmental Protection Act. These pollution management regulations, which would be applicable to this project, were developed to regulate and control the activities of development projects during construction and operation.

4.2.3.3.1 Environmental Protection Air Quality Regulations 2000

Environmental Protection (air quality) regulations were developed in 2000 under the Environmental Protection Act 1996. In accordance with these regulations anyone who emits any air contaminant in the construction, installation, operation, modification or extension of any facility related to industry, commerce, agriculture or any institution shall apply to the EPA for an environmental authorization and shall submit an application to the EPA at least one hundred and eighty days before the date on which the emission is to commence. In accordance with the regulations the EPA shall establish parameter limits with respect to emission of smoke, solid particles, sulfuric acid mist or sulfuric trioxide, fluoride compounds, hydrogen chloride, chlorine, hydrogen sulfide, nitric acid or oxides of nitrogen and carbon monoxide. No parameters limits have been mandated to date. This project proposes to adhere to a combination of WHO Ambient Air Quality (2007) and World Bank Guidelines. These guidelines (2007) are detailed in Table 2.

Table 2: WHO Air Quality Guidelines

POLLUTANT	AVERAGING PERIODS	GUIDELINE VALUE ($\mu\text{g}/\text{m}^3$)
Nitrogen Dioxide (NO_2)	1-hour average	200 $\mu\text{g}/\text{m}^3$
Particulate Matter (PM_{10})	24-hour average	70 $\mu\text{g}/\text{m}^3$
Sulphur Dioxide (SO_2)	24-hour average	125 $\mu\text{g}/\text{m}^3$

4.2.3.3.2 World Bank Guidelines

Concentrations of contaminants in ambient air, measured at the project property boundary, should not exceed the following limits:

Particulate matter (<10 mm)

Annual Arithmetic Mean	100 mg/m^3
Maximum 24-hour Average	500 mg/m^3

Nitrogen Oxides as NO₂

Annual Arithmetic Mean 100 mg/m³

Maximum 24-hour Average 200 mg/m³

Sulphur Dioxide

Annual Arithmetic Mean 100 mg/m³

Maximum 24-hour Average 500 mg/m³

Workplace Air Quality

Arsenic 0.05 mg/m³

Carbon Monoxide 29 mg/m³

Copper 1 mg/m³

Free Silica 5 mg/m³

Hydrogen Cyanide 11 mg/m³

Hydrogen Sulphide 14 mg/m³

Lead, Dust and Fumes, as Pb 0.15 mg/m³

Nitrogen Dioxide 6 mg/m³

Particulate (Inert of nuisance dusts) 10 mg/m³

Sulphur Dioxide 5 mg/m³

If warranted, emission modeling will be conducted to determine whether the most stringent of these air quality standards will be exceeded. If these standards are exceeded mitigation measures will be identified to minimize impacts associated therewith.

4.2.3.3 Environmental Protection (Hazardous Wastes Management) Regulations, 2000

These regulations outline the rules and procedures to transport, store, treat and dispose of hazardous wastes. There are no regulations for the management of hazardous substances. These regulations are intended to ensure, through the environmental authorization process, that all operations that generate, transport, treat, store and dispose of hazardous wastes are managed in a manner that protects human health and the environment. The regulations allow for the provision of information on the types of facilities and quantity of hazardous waste generated, treatment standards and efforts to reduce the waste generated. An emergency preparedness plan is required for anyone who operates a hazardous waste facility. For the purposes of that regulation, hazardous material/waste is regarded as the following:

- Explosives
- Flammable liquids
- Flammable solids or waste solids other than explosives which may be readily combustible

- Oxidising substances
- Organic peroxides
- Poisonous substances
- Infectious substances
- Corrosives
- Toxic gases
- Toxic substances which if inhaled or ingested may cause delayed or chronic effects
- Ecotoxic substances which if released may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon systems
- Materials capable, after disposal, of yielding another material which possesses any of the characteristics specified above

A larger proportion of the hazardous material identified above will not be utilized by this project. The fuel used to power equipment can however be classified as a hazardous material. The hazardous wastes regulations will therefore apply to fuel oil/used oils at the project site.

4.2.3.3.4 Environmental Protection Water Quality Regulations 2000

These regulations require registration and environmental authorization of any person whose construction, installation, operation, modification or extension of any facility cause the discharge of effluents. These regulations cover parameter limits of effluent discharges, new sources of effluent discharges, fees for registration and environmental authorization, sampling points, records and reports and general provisions for the registration of water effluent, biological integrity, spills or accidental discharges and standard methods of analysis. Guidelines on the discharge of effluents and disposal of sludge are detailed in these regulations.

In accordance with these regulations the EPA was mandated to establish parameter limits for concentration of constituents of effluent which can be discharged into any inland or coastal waters or lands of Guyana for Ammonical Nitrogen, Sulphate, Chloride, Cobalt, Colour, Detergents, Anionic, Fluoride (as F), Molybdenum, Phosphate 9 as P, Polychlorinated Biphenyls, Selenium, Silver, Beryllium, Vanadium, Radioactive Material, Nitrate Nitrogen, Temperature, Pesticides, Fungicides, Herbicides, Insecticides, Rodenticides, Fumigants or any other Biocides or any other Chlorinated Hydrocarbons. Standards were also to be established for any substance that either by itself or in combination with other waste or refuse may give rise to any gas, fume or odour or substance which causes or is likely to cause pollution. The Guyana National Bureau of Standards (GNBS), along with the EPA, have developed interim industrial effluent standards which, however, are not specific to mining.

4.2.3.3.5 EPA EIA Guidelines Mining Version 1, August 2000 Water Quality

In addition to the mandates for effluent discharge to the environment, the EPA has established guidelines for water quality monitoring parameters associated with mining. *Since this is a mining project these standards are applicable to all phases of the project.* These guidelines mandate that both surface and groundwater associated with mining operations be analyzed for pH, TDS, TSS, turbidity, conductivity, organic compounds (phenol and oil and grease), major anions (Ca, Mg, Na, K), nutrients (TKN, total ammonia, phosphate, nitrate + nitrite), trace metals (Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se, Sb, Zn). The EPA further dictates that concentration levels of these substances shall not exceed levels of environmental concern (normally set as levels to protect aquatic species). The EPA also reserves the right to request analyses to determine bacteriological levels (coliforms, fecal coliforms and standard plate counts), rare earth elements, radioactive elements and other trace metals.

4.2.3.3.6 World Bank Water Quality Standards

Tolerable limits have not been established by the EPA for water quality for construction or mining operations which would be applicable to this project. The 2007 IFC EHS guidelines for the mining and milling industries are therefore considered to be applicable. These guidelines for liquid effluents and residual heavy metals are detailed below.

Liquid Effluents

The following guidelines for effluent discharged to receiving waters from tailings impoundment, mine drainage, sedimentation basins, sewage systems and storm water drainage are considered applicable to this project.

pH	6 to 9
BOD ₅	50 mg/l
Oil and Grease	10 mg/l
Total Suspended Solids	50 mg/l
Temperature-at the edge of a designated mixing zone:	Max.5°C above ambient temperature of receiving waters,

Max 3°C if receiving waters

>28°C

Residual Heavy Metal

The following recommended target guidelines, which are expected to pose no risk for significant adverse impact to aquatic biota or humans are considered applicable to this project.

Arsenic	1.0 mg/l
Cadmium	0.1 mg/l
Chromium, Hexavalent	0.05 mg/l
Chromium, Total	1.0 mg/l
Copper	0.3 mg/l
Iron, Total	2 mg/l
Lead	0.6 mg/l
Mercury	0.002 mg/l
Nickel	0.5 mg/l
Zinc	1.0mg/l

If natural concentrations exceed these levels, the discharge may contain concentrations up to natural background levels. Concentrations up to 110% of natural background are acceptable if no significant adverse impact can be demonstrated. *Effluent discharged from the site during all project phases will be required to adhere to the most stringent of the water quality standards detailed above.*

4.2.3.3.7 Environmental Protection Noise Management Regulations 2000

Under these regulations operations that emit noise in the execution of various activities such as construction, transport, industry, commerce and other institutions are required to apply to the Agency for an environmental authorization. The EPA is responsible for the establishment of standards for permissible noise levels in industry, construction and other areas. The categories for which permissible noise levels are fixed by the EPA were identified as follows: Residential, Institutional, Educational, Industrial, Commercial, Construction, Transportation and Recreational. The Guyana National Bureau of Standards (GNBS) and the EPA together with other relevant agencies developed Interim Guidelines for Noise Emission into the Environment. Under these guidelines, noise emissions from Industrial and Commercial sources for both day (06:00h – 18:00h) and night (18:00h – 06:00h) would be 100 and 80 decibels (Industrial) and 80 and 65 decibels (commercial) respectively at the property boundary or 15 meters from the source. *This ESIA will form the basis of an authorization for a permit to emit noise from the proposed operation.*

4.3 Gold Board Act (1981)

This Act provided for the establishment, constitution, and functions of the Guyana Gold Board and for matters connected therewith. The functions of the board as defined by the Act include to carry on the business of trading in gold, to secure at all times an adequate supply of gold and to ensure its equitable distribution in Guyana at fair prices, subject to this Act, to purchase all gold produced in Guyana, subject to this Act, to sell all gold in Guyana and to sell gold outside Guyana and to engage in other related commercial

or industrial activities. The act further mandates that no person shall sell any gold to, or purchase any gold from, any person other than the Board or any agent authorized in writing by the Board or export any gold. The Act also allows the Board to authorize a person to have in his possession or to sell or export such quantity of gold as the Board may allow subject to such conditions as the Board may think fit to impose.

4.4 Gold Board (Amendment) Act (1994)

This Act amended the Guyana Gold Board Act 1981. Section 2 of the Gold Board Act was amended for the word "claim" to have the same meaning as assigned to it by the Mining Act 1989. This amendment repealed

Section 6 of the Gold Board Act and substituted it with the requirement for every producer who possesses gold, won or obtained during operations as a producer, before the date of coming into operation of the Guyana Gold Board (Amendment) Act 1994, to sell such gold to the Board or to any agent authorized in writing by the Board. The amendment further mandated that every producer who wins or obtains gold during operations as a producer shall, within twenty-eight days after his winning or obtaining such gold and within twenty-four hours of conveying such gold to Georgetown or any other place determined by the Minister by notice in the official Gazette, or such longer period as the Board may allow, sell such gold to the Board or to any agent authorized in writing by the Board.

4.4.1 Guyana Geology and Mines Commission Act of 1979 and Mining Act of 1989

The Guyana Geology and Mines Commission established by the GGMC Act 1979 is responsible for the implementation of the Mining Act 1989, which establishes the legal framework for the utilization of mineral resources in Guyana. The Act makes provision for a system of mineral agreements and licences for regulating prospecting. It gives the Commission the responsibility for establishing regulations for mining and quarrying operations. A mining licence is required in order to mine any mineral and is issued at the discretion of the Commissioner of the GGMC based on agreement of the Minister responsible for mining. In addition, the act makes provisions for the disposal of sanitary waste and the storage of poisonous substances in mining areas.

Sections 76 and 77 of the Mining Act of 1989 details provisions for regulations related to safety in mines or quarries or in prospecting, mining or quarrying operations and the welfare of workers. The Guyana Geology and Mines Commission is currently developing a document on Occupational Health and Safety in Mines. The provisions of this act are superseded by the Mining Act 1989 if inconsistencies prevail.

4.4.1.1 The Mining (Amendment) Regulations 2005

The GGMC amended its mining regulations in 2005. These amended regulations together with the Mining Act 1989 are applicable to this project.

Sun and Sand holds a Prospecting Licence issued by the Guyana Geology & Mines Commission (GGMC). When this ESIA satisfies both the EPA and GGMC, a mining licence would be issued for the recovery of gold from the concession. GGMC would be responsible for enforcing the provisions in this regulation. Environmental provisions applicable to current mining operations are detailed in the Mining (Amendment) Regulations 2005. The Mining (Amendment) regulations 2005 contain mandates for several areas. The mandates which are applicable to this project are as follows:

- Requirements for Environmental Management for Large Scale Mining
- General Requirements
- Protected Areas
- Pollution Control

4.4.1.1.1 Requirements for Environmental Management for Large Scale Mining

There are specific requirements for environmental management of large scale mining operations. Every person who proposes to dispose of effluent is required before commencing any action related thereto, to apply either personally or in writing to the Commission for a permit and shall submit with such application, the prescribed fee and a description in summary of the activities including information on:

- the site, design or process; site characteristics and layout; distance to water bodies; ground water regime and mode of tailings disposal;

- possible effects on the environment and
- a simplified description of the activity.

Where the Commission is satisfied with regard to an application that the proposed use does not significantly affect the environment and that the requirements of these Regulations have been complied with, together with the requirements of the Environmental Protection Act 1996 and the recommendations of the EPA it shall grant the permit applied for on such terms and conditions and in such form as the Commission may from time to time determine.

The Commission may refuse to grant a permit under this regulation where it has reason to believe that the application is based on false or misleading information; or after consultation with the Agency, it is satisfied that the preservation and character of the environment, including flora and fauna will be adversely affected. If the Commission, after consultation with the EPA is satisfied that there has been material changes in the circumstances that existed at the time the permit was granted, the Commission shall convey this in writing to the permit holder and advise that a new permit must be applied for and the current permit will remain valid only up to a stipulated date.

A person to whom a permit has been granted in accordance with this regulation can apply to the Commission to vary or modify the permit stating clearly the reasons and the Commission may issue a written warning to the permit holder and manager of the operation for any breach of provisions of these regulations or any terms and conditions subject to which the permit is granted. The Commission may suspend a permit for a breach of any provision of these regulations or for any term or condition subject to which the permit is granted.

The Commission is required, on suspending a permit to notify the holder in writing stating the breach that gave rise to the suspension, requiring the holder of the permit to remedy the breach, stating the time within which the breach is to be remedied and stating whether the permit is to be returned within a specific time to the Commission.

Where the Commission cancels a permit, the Commission is required as soon as practicable thereafter, to notify in writing the person to whom the permit or certificate was granted of the cancellation. The notice shall state the reason for the cancellation, and such cancellation shall take effect on receipt of the notice by the addressee. Any person who is aggrieved by a decision of the Commission shall within twenty-eight days of the decision, appeal in writing against such decision to the Minister. The Minister after examining all relevant information on the matter appealed shall issue an appropriate order.

A permit is mandated not to be transferable except with the permission of the Commissioner and where the Commissioner authorizes the transfer of such a permit, he may vary the conditions already imposed on the permit or he may impose such other conditions as he may consider appropriate. The Commission, EPA, the mining associations and educational training institutions shall in accordance with the curricula approved by the Commission jointly or singularly provide training and certification courses for miners on environmental hazards in mining activities.

Every holder of Mining licence, Prospecting Permit or Mining Permit is also mandated to lodge an Environmental Bond in favor of the Commission, for an amount to be determined by the commissioner. The Environmental Bond or part thereof, shall be used by the Commission to restore the environment where restoration of the said area was not done to the satisfaction of the Commissioner provided that the Commission shall retain no third party to carry out such restoration before the miner has been given three months from the date restoration becomes due to restore the area.

The regulations also mandate preparation of a closure plan before any new prospecting or mining licence is

issued by the Commission and the closure plan must be approved by the Commission before a new prospecting or mining licence, is issued by the Commission to an operator.

The reclamation and closure plan is required to include measures for the backfilling of placer mine pits, where applicable and appropriate, the stripping and stockpiling of topsoil for use in reclamation, the replacement of topsoil and vegetation of disturbed lands and the restoration of water courses, where

appropriate. Holders of Prospecting and Mining Licences are required to prepare a contingency and emergency response plan in accordance with the Code of Practice. The contingency and emergency response plans must set out provisions for hazards in mining operations including practical mechanisms to respond to spills of hazardous substances. Any person who contravenes this regulation commits an offence and holders of prospecting and mining licences and medium scale permits are required to ensure that all relevant information of the contingency and emergency response plan are communicated to employees and independent contractors, and shall include information on first person response, notification procedures, location of clean-up equipment, an analysis of potential accidents and responses and materials safety data sheets for all materials which could be spilled.

4.4.1.1.2 General Requirements

The general requirements of the regulations stipulate that the Commissioner shall determine the number of dredges or mining operations which shall be permitted to dredge or mine in any area which may already be or likely to be affected by tailings discharge and to also direct the method of mining permissible in the areas affected or likely to be affected by tailings discharge if necessary. The basis for the commissioner determination is the percentage of clay content found in the overburden or deposit or the total load of clay which may be released in the tailings and shall be made from results of sampling and tests done by officers of the Commission. The regulations also permit The Nephelometric Turbidity Units (NTU) value at the affected area to be stipulated by the Commissioner from time to time and operators of land operations are mandated to discharge tailings into a tailings pond or into a river, creek or stream where the critical turbidity has not exceeded 30 NTU. In addition, operators of river operations are required to discharge tailings into a tailings pond on land or to a river, creek or stream where the critical turbidity has not exceeded 30 NTU or in any other manner as approved by the Commissioner.

Operators are also required to ensure that discharges from tailings ponds or dredges into any river or creek shall not exceed either 100 mg/l of total suspended solids (TSS) or 50 Nephelometric Turbidity Units (NTU). The Commissioner is authorized to stipulate the limits for chemical contamination from time to time. Discharges from tailings ponds and river dredge are required to be released underwater through a conduit at a minimum depth specified by the Commissioner. Where any operation exceeds either of the stipulated limits, the operator shall be cited for such breach and be given twenty-four hours within which to rectify same and operators are required to keep a daily record of the readings of the total suspended solids or Nephelometric Turbidity Units (NTU) in grab samples of the discharge. All readings forming part of the daily record shall be taken approximately twenty four hours after the previous reading.

Where settling ponds are used as parts of the mine drainage system, channels discharging into the river are required to be culverted, and where necessary the slopes must be protected from erosion. Approved devices, chemical procedures or ponds are required to be used to remove settleable solids from tailings discharges from on-land mines. Every settling pond is required to have a minimum water residence time equivalent to the aggregate volume of slurry processed or water used in each sluice box or mine processing device in any continuous two hour period with discharge being in accordance with the effluent limits. Operators are also restricted from disposing of petroleum products or any matter containing tars, oil, grease or any poisonous substances directly on the surface of the land or in a river or creek.

The regulations require that all hazardous waste earmarked for disposal whether recovered from prior workings or from the current operations shall be sealed in barrels which are made of or lined with plastic, marked and sealed and conveyed to an area set aside or facility set up for the disposal of hazardous waste. The accumulated waste shall be brought to the Commissioner's attention for treatment as appropriate and where facilities for disposal are not available, a miner shall burn all waste products including batteries using fuel such as kerosene or similar substances of high flash point in an area set aside for such purposes or, where appropriate shall use the said waste products.

Prior to the commencement of mining in any area, a miner is required, if the miner considers that the area has been environmentally damaged, to request in writing an inspection of such areas by the Commissioner or an officer appointed in writing by the Commissioner.

The regulations require that information in relation to the disposal of effluent shall be provided by the applicant to the Commission on the site of the disposal, the amount of the disposal and the possible effects on the environment.

Among the general requirements is that tailings dam or water retaining dams higher than 16 feet or six metres be inspected annually by a qualified civil, mining or geotechnical engineer registered with the Commission and approved by a recognized engineering body. The reports of such inspections are required to be kept on file and be available for review by inspectors of the Commission and every tailings pond shall be equipped with emergency spillways that pass the flows from the probable maximum flood so as to prevent overtopping of dams under extreme rainfall or runoff rainfall.

The regulations stipulate that no compensation shall be paid to a holder of a permit where the decision to cancel the permit was necessary for the purposes of protecting and conserving the environment, any animal or plant or by reason of an unforeseeable change in circumstances on the basis of which the permit was granted.

4.4.1.1.3 Protected Areas

The Act mandate that no person shall conduct mining and quarrying activities in areas within 20 metres of the low water mark of a river bank except for access of dredges from the river. Mining or quarrying is forbidden in specified nature reserves, parks where resource extraction is prohibited and in buffer areas if not expressly approved by the Commission and all parties likely to be affected by the activity must be notified. In addition, no dry mining or excavation shall be conducted in any watershed without prior permission from the Commissioner.

The Regulations made under The Mining Act (No. 20 of 1989) part XXVII 1 (a) states that there is a restriction to mining and quarrying activities in areas within 20 metres of the low water mark of a river bank except for access of dredges from the river. Restrictions are also placed on mining or quarrying in specified nature reserves and parks where resource extraction is prohibited. Mining can only occur in buffer area if approval is obtained from the Commission and parties likely to be affected by the activity are informed. Additionally, both dry mining and excavation are prohibited in ore or water shed without prior consent from the Commissioner.

4.4.1.1.4 Pollution Control

Environmental effects monitoring shall be conducted for every mine including new mines. Each environmental effects monitoring program shall be submitted to the Commission for approval as part of the Environmental Management Plan.

4.4.1.1.5 Mining Regulations

The regulations contain provisions for the sanitary management of human waste and for burial of animals and any person who expires at the mine. These regulations prohibit the hiring of females, and underage boys and restrict persons permitted to work underground.

The royalty payable on gold is detailed in the regulations in addition to the rights and expectations of lessees and tributors. The regulations places restrictions on individuals eligible to be employed as laborers in mining

districts and mandate that each person, who is not an Amerindian, who works as an employee in a mining district shall be registered. The employer at a mine site is mandated to keep medicines and medical supplies for the use of mine employees and in instances where the number of employees exceed

50 the employer is compelled to employ a sicknurse or dispenser and prohibits employers from punishing employees.

The regulations further mandate the keeping of record of gold, valuable minerals and precious stones, payment of royalty on gold, valuable minerals and precious stones, sale and purchase of gold, valuable minerals and precious stones and on the export of precious Stones.

Part XXII of the regulations applies to the rights, privileges and restriction on Amerindians and the miscellaneous provisions provide for disposal of forfeited gold, valuable minerals and precious stones.

4.4.1.1.6 Environmental Provisions

The environmental provisions of Cap 65:01, as inferred from those regulations, relate to the management of mine operation effluents. The provisions for construction of dams can be interpreted as being related to the construction of tailings, detention and sediment control structures.

In accordance with Part VIII 60 (a) a dam can be constructed on state land as part of a mining operation. There is also a mandate that no one shall deposit any earth, stone, gravel, debris or tailings on a claim held by another person without their consent. This regulation also mandates that any area of water containing poisonous or injurious chemical solutions used in the treatment of gold or other minerals must be fenced to prevent inadvertent access thereto, and notice boards shall be erected in suitable places warning persons not to make use of such water. In addition, in no case shall water containing any poisonous or injurious chemical solutions be permitted by a claim holder or his agents to knowingly escape or enter any river, creek, race, lake, reservoir, or any stagnant water without having been previously rendered innocuous.

Additional provisions of the regulations which are inferred to relate to the utilization and impacts on water resources stipulate that a person may hold at the same time on any water-course which is not navigable, claims extending from the point where such water-course ceases to be navigable to its source and no claim other than a dredging concession or river location shall include the bed of a navigable river or water-course. In addition, no person holding a claim on either bank of a navigable water-course shall prevent free navigation and passage thereon and every holder of a claim shall be entitled to the free use of water naturally flowing through or past his claim, and not already lawfully appropriated in such manner as may, in the opinion of the commissioner or of the mines officer, subject to the approval of the Commissioner, be necessary for the proper working thereof.

Additional regulations related to water resources is a mandate that no person shall back the water of any river, creek or water-course upon any claim or cause any claim to be flooded, either willfully or by neglect through the construction of any dam or stop-off, or in any other way and permits the Minister to grant to any person a licence, with such terms and conditions as he may think proper to take direct and use any water from any river, creek, tributary, stream, lake or pool, situated upon or flowing through any State lands for the purpose of supplying with water any machine or any engine or machinery employed and forming purposes provided that such works shall not interfere with existing rights. Every water-race shall have a point to be specified by the commissioner or mines officer at which water shall be taken from the river, creek, or other source, but in no case shall such river, creek, or other source be included in or form part of any water-race or pipe for or the conveyance of water.

The final water resources provision states that in case any holder of a licence under this regulation fails to make a reasonable use of the advantages allowed to him by his licence or if he takes water in excess of a reasonable quantity or if he wastes water or if he fails to comply with the condition under which his licence was granted the Minister may cancel his licence and every person who willfully or negligently causes the

water of any well or reservoir on or near any claim, or of any creek used for drinking purposes and set apart by the mines officer for that purpose, to become contaminated shall be guilty of a breach of the regulations.

Limits on effluent disposal are covered by the requirement that in no case shall water containing any poisonous or injurious chemical solution be permitted to escape or enter any river, creek, race, lake, reservoir, or any stagnant water without having been previously rendered innocuous.

4.4.1.1.7 Safety Provisions

Health and safety regulations are not explicitly detailed in Cap 65:01. However, the provisions of Part XIII Regulation of Mines can be interpreted as relating to regulating conditions in mines to ensure health and safety. The regulations of Mines details requirements for the employer of a mine manager and places restrictions on persons appointed manager of a mine.

4.4.2 United Nations Declaration on the Rights of Indigenous Peoples, 2007

In 2007, the United Nations adopted the Declaration on the Rights of Indigenous Peoples. A non-binding text, the Declaration sets out the individual and collective rights of indigenous peoples, as well as their rights to culture, identity, language, employment, health, education and other issues. The Declaration emphasizes the rights of indigenous peoples to maintain and strengthen their own institutions, cultures and traditions and to pursue their development in keeping with their own needs and aspirations. It prohibits discrimination against indigenous peoples and promotes their full and effective participation in all matters that concern them, and their right to remain distinct and to pursue their own visions of economic and social development.

4.4.3 Amerindian Act No. 6 of 2006

The Amerindian Act of 2006 was assented to by the President on 14th March, 2006 and came into operation in April 2006. The Act provides for the recognition and protection of the collective rights of Amerindian Villages and Communities, mechanisms for good governance within Amerindian Villages and Communities and the granting of land to these Villages and Communities.

The Act defines words used in the Act such as ‘miner’, ‘mineral’, ‘mining activities’ and ‘traditional mining privilege’. There is a Part of the Act that provides for a number of matters relating to the entry and access to Amerindian Villages and Communities.

Provisions in the act govern how Village lands are acquired and the rights and privileges that are attached to them. Village lands may not be disposed of except as provided in the Act. An existing Amerindian Village may have its Village lands extended on application in writing in accordance with the provisions of the Act. Amerindian Village and Village land status may be accorded an Amerindian Community on Application made, if it has been in existence for at least twenty five (25) years and if at the time of application and for five (5) years immediately preceding its application, it consisted of at least one hundred and fifty (150) persons.

Part V of the Act deals extensively with mining and matters related to mining, including environmental issues relating to lands within the boundaries of Amerindian Villages and proximate thereto. This Part provides for allocation of lands to residents and for lease of lands within the Villages.

Mining is allowed in any river, creek, stream or other source of water within the boundaries of any village subject to prescribed conditions. Anyone who seeks to mine on Village lands without satisfying the prescribed conditions and obligations would commit an offence. One of the conditions for mining on village lands is that a miner must enter a written agreement with the Village Council. That agreement must contain terms that relate to issues such as:

- The offer of employment to residents of the Village at market rates once residents with the required skills are available.
- The purchase of food and materials from the Village once available and at competitive prices

- Compliance by the miner and employees with rules made by the Village council.
- The obligation of miners to take all necessary steps to avoid damage to the environment, pollution of ground water and surface water, interference with agriculture, damage or disruption of flora and fauna and disruption of residents normal activities

The Village and miners may exercise an option to expressly cater for other matters in a written agreement. These matters may include:

- An environmental protection program
- A waste disposal plan
- A mechanism for identifying and resolving conflict
- A health program providing medical supplies to health workers for use in the Villages
- An education program

Another important condition for mining in Villages is the requirements of consent from those present at a Village general meeting.

Where a large scale miner, whether prospecting or mining, is refused consent by the Village he may still be able to prospect or mine for minerals if the Minister with responsibility for mining and the Minister of Amerindian Affairs declare that the mining activities proposed are in the public interest.

The Act provides for the payment of tribute by a miner to the Village for any minerals obtained from Village lands and the Guyana Geology and Mines Commission is mandated to transfer into a fund for that purpose, a prescribed percentage of royalties obtained from mining activities on Village lands. The Guyana Geology and Mines Commission is obligated to notify the Village and be satisfied that the impact of mining on the Village will not be harmful before issuing any permit, licence, concession or permission over or in:

- any part of Village lands
- any land contiguous with Village lands
- any rivers, creeks or water way which pass through Village lands or any lands contiguous with Village lands.

The concession is not located on lands belonging to any Amerindian Village. The mine site will not be accessed by roads through any indigenous people villages. The provisions of the Act relating to miners accessing and passing through Amerindian Villages are not applicable to the project.

4.4.4 Occupational Safety and Health in Mining

The Occupational Safety and Health 1999 contain provisions applicable to the regulation of health and safety in mines. In 2002, a draft Mining Occupational Safety and Health Regulation was proposed by the Ministry of Labour, Human Services and Social Security with the assistance of the International Labor Organization (ILO). The mine will be required to operate in accordance with the Occupational Safety and Health Act 1999.

The OSH Regulation covers duties of employers and self-employed persons, owners of mines, manufacturers and workers. Reporting of dangerous situations and occurrences, administrative requirements such as the preparation, checking and maintenance of mine development plans in advance of mine development, as well as those for mine operations, inspections by mine operators, minimum age of workers and the maximum duration of work shifts, and notice of death or injury are also covered. Other general areas included in the regulation are competency requirements for the supervision of workers at a mine, training for the performance of mining operations, the supervision of work done by competent workers, safe access to and egress from workplaces such as mine openings, ladders, stairways, platforms and open pit workings and general safety for working alone, protective equipment and clothing, protection from falling objects and the prohibition of substance abuse in mines.

Safety requirements for surface operations include emergency procedures and fire prevention and control strategies. The draft Regulation also addresses working environment conditions such as control of specific contaminants, noise and dust limits, vibration and heat stress, ergonomics, sanitary facilities and precautions against exposure to radon and radiation. The safe handling, storage, operation, and transport of explosives are also dealt with. Basic safety procedures for electrical safety in mines, safety requirements for machinery and plant equipment, and the operation of hoisting equipment are detailed as well as miscellaneous provisions regarding the resolution of health and safety issues and the refusal of a worker to work in particular instances.

This extensive draft Regulation has not yet been given legal effect. This mine will have to operate under these regulations after their promulgation.

4.5 Labour Act (1942)

The Labour Act (1942) established the Department of Labour to regulate relationship between employers and employees and to settle differences between these groups. Part I of the act created the positions of Chief, Deputy and Assistant Labour Officer in addition to additional labour officers deemed necessary. Part II details the conciliation process in instances where a difference exists between employer and employees or between different classes of employees. Part III grants authority to the Minister to appoint an advisory committee to investigate the conditions of employment of any occupation and to make recommendations for the minimum wage to be paid to that occupation. The advisory committee must include a representative of both the employer and employee. Parts IV and V of the act respectively detail the right of employees, duties and obligations of employers and payment of wages and deduction from wages. Part VII of the act establishes the right of the Minister to make regulations regarding the hours of work. Collective agreements are covered under Part VII of the act. All aspects of this Act are applicable to this project.

4.6 Labour (Amendment) Act (1994)

This Act amended the Labour Act by the substitution for the words "two hundred and fifty dollars" and "ten dollars" by the words "fifteen thousand, six hundred and twenty-five dollars" and "six hundred and twenty-five dollars", respectively. The amendment further mandated where in any occupation rates of wages have not been prescribed, an employer shall pay wages to the person employed at the rate agreed upon between them, and if the employer fails to do so, he shall be liable on summary conviction to a fine of fifteen thousand six hundred and twenty-five dollars, and on a second or subsequent conviction to a fine of forty-six thousand, eight hundred and seventy-five dollars.

The Amendment also allow for any occupation in which the partial payment of wages in the form of allowances in kind is customary or desirable because of the nature of such occupation, nothing contained in the Amendment shall render illegal a contract with an employee for giving to him food, drink, a house, cottage, tenement or room, or other allowances or privilege in addition to money wages as a remuneration for his services. This part of the Amendment is particularly applicable to this project since the Project Proponent will be required to establish a man camp on site and to provide meals for persons employed on the project.

4.7 Termination of Employment and Severance Pay Act (1997)

This Act provides conditions to govern the termination of employment and grant of redundancy or severance payment to employees. Part II of the Act defines continuity of employment as beginning from and including the first day on which an employee begins to work for an employer and continuing up to and including the date of termination of employment of such employee and establishes conditions that cannot be regarded as interruptions in employment. Part III identifies conditions under which employment can be terminated and identify reasons which do not constitute good or sufficient cause for dismissal or

for imposition of disciplinary action. Part IV of the Act mandates severance and redundancy paid upon termination of employment. These payments are related to the period for which the person has been employed. All aspects of this Act are applicable to this project.

4.8 Holidays with Pay Act (1995)

The Holidays with Pay Act, 1995 provides for the grant and regulation of annual holidays with pay for all categories of workers. The Act mandates that every worker is allowed a period of holidays with pay of not less than one day for each completed month of employment computed from the date of commencement of employment. Every worker who is employed on a half day basis shall have the half day counted as a day and every worker employed on a daily or an hourly basis shall be allowed a period of holidays with pay of not less than one day for every period of 20 (twenty) days or 160 (one hundred and sixty) hours worked.

4.9 Holidays with Pay (Amendment) Act (2009)

The Act repealed and re-enacted section of the Holiday with Pay principal Act which deals with “Offences penalties and court order” and amended Section 11 which deals with the institution of prosecutions by the Chief Labour Officer and replaced the word ‘holidays’ with ‘leave’ throughout the Act.

4.9.1 Wild Birds Protection Act Chapter 71:01

The Act stipulates for the protection of certain wild birds. Wild birds are defined in the schedule of the Act. Certain wild birds are protected absolutely. It is an offence to wound, kill, expose for sale, and offer for sale or export wild birds that are absolutely prohibited. However, there are some wild birds that are not so protected; they receive protection only during a prescribed closed season. However, it is not an offence to wound or kill any wild bird for the purpose of procuring food if done ten miles or more from a plantation.

There are no provisions for the protection of wild birds relative to mining operations however conservation of biological resources is applicable to the project. The company will therefore conform to the provisions of this act.

4.9.2 Town and Country Planning Act Chapter 20:01

Provisions are made in this Act for the orderly and progressive development of land (which is specifically defined), Cities, Towns and other areas be they urban or rural, for their preservation and improvement and for other related matters. The prescribed authority, responsible for effecting the provisions of the Act is the Central Housing and Planning Authority established under the Housing Act Chapter 36:20. *The Central Housing and Planning Authority will consequently be required to provide consent for the development and regulation of any new settlement associated with operations.*

4.10 Wildlife Conservation and Management Act (2016)

This Act provides for the protection, conservation, management, sustainable use, internal and external trade of Guyana’s wildlife. It established and incorporated the Guyana Wildlife Conservation and Management Commission and identifies the power of the Minister to give directions to the Commission. The functions of the Commission and duties of the Commission are detailed in the Act which establishes a Wildlife Scientific Committee and details the functions of Wildlife Scientific Committee. The Act recognizes the Guyana Wildlife Conservation and Management Commission as the CITES Management Authority for Guyana. The mandate of the Commission, according to the act includes development and recommendation of strategies in the field of conservation, management and sustainable use of species of wildlife, consulting with the Wildlife Scientific Committee on the scientific aspects of the conservation, management and sustainable use of species of wildlife, developing, implementing and monitoring collaborative arrangements for the conservation, management and sustainable use of wildlife and coordinating in consultation with stakeholders, the establishment and maintenance of wildlife

conservation and management plans and programs. This project involves no trade in wildlife. The sole aspect of this Act applicable to this project relates to the plans for the management of the biological resources located within the mine site area.

4.10.1 National Biodiversity Action Plan

The National Biodiversity Action Plan (NBAP) was prepared in 1999 to integrate the implementation of the Convention on Biological Diversity into national development. The overall goal of the NBAP was “to promote and achieve the conservation of Guyana’s biodiversity, to use its components in a sustainable way, and to encourage the fair and equitable sharing of benefits arising out of the use of Guyana’s biodiversity’. The stated objectives of the plan were to:

1. Evaluate the state of capacity nationally to achieve the above goal;
2. Identify gaps and needs relating to achieving the above goal;
3. Propose actions to achieve this goal and close the gaps;
4. Develop activities in a number of priority areas relating to the overall goal;
5. Identify the roles and responsibilities of the various stakeholder groups in the implementation of the plan;
6. Increase public awareness of biodiversity.

The plan included a number of program areas partitioned under two phases with various actions for execution. Phase 1 identified foundation programs that are essential for sustainable biodiversity planning and management. This included Human Resources and Institutional Capacity Building. Phase 2 on the other hand, consolidated phase 1 and initiated additional interventions for the second cycle of the plan. The program area for the additional interventions included Planning a Biodiversity Action Plan.

This plan entered its second cycle in 2007 to focus mainly on conservation and sustainable use of biodiversity and sharing of benefits. It retained as its cornerstone the goal and seven objectives from the previous plan. Four thematic natural resource areas are listed as requiring attention. These are:

1. Forests
2. Agriculture
3. Coastal resources
4. Marine resources

The mining operation and access roads will be located in forested areas and impinges on biological diversity. Therefore, according to NBAP 1 consideration should be given to the adoption of the four approaches stated below when planning for management of biodiversity.

The Participatory Approach which recognizes that conservation and responsible use of biodiversity requires commitment and collaboration from agencies, individuals etc that impact/use biodiversity through their activities.

The Cyclical/adaptive Planning Approach which is cyclic in nature and adaptive to change in circumstances and national policy.

The Ecosystem Approach to biodiversity planning and management is based on the linking of the social, economic and environmental aspects of biodiversity management.

The Precautionary Principle which according to the Convention on Biological Diversity is “*where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat.*” This principle has been incorporated into the Environmental Protection Act.

4.10.2 Public Health Act Cap 145

Section 2 of the Public Health Act Cap 145 states that mining districts under the Public Health Act are understood to include mining districts established under section 4 of the Mining Act. Under Section 147, the Minister responsible for Health is enabled to make regulations generally for the sanitary control of mining districts or parts thereof, and the health and welfare of the inhabitants. Revisions to the Public Health Act including draft regulations for mining have been made but not yet promulgated.

The provisions of the Public Health Act will be factored into the employee health and safety plan for the mine site operations.

4.10.3 Low Carbon Development Strategy (LCDS)

The second draft of the Guyana Low Carbon Development Strategy (LCDS), prepared by the Office of Climate Change in the office of the President details a framework for “Transforming Guyana’s Economy While Combating Climate Change”. The draft was prepared based on extensive stakeholder consultations over a four month period in which over 10% of the Guyana population is claimed to have participated.

The LCDS indicates that Guyana “supports international proposals to cut greenhouse gas emissions from deforestation and forest degradation in half by 2020, and make the global forestry sector carbon neutral by 2030 –where emissions from deforestation and forest degradation are balanced by new forest growth.” The LCDS recognizes the Guyana must “Reform existing forest-dependent sectors, including forestry and mining, where necessary, so that these sectors can operate at the standards necessary to sustainably protect Guyana’s forest.”

The LCDS has therefore identified the tasks of the GGMC as “regulating all activities in the mineral sector. It regulates the extraction of minerals from small, medium and large scale mining operations, and provides advice to the Government on appropriate mineral policy matters so that Guyana’s mineral resources can be rationally developed and utilized. ” The LCDS further recognizes that “Mining is one of the major contributors to Guyana’s existing (low) deforestation and degradation rates. The Government has been working with the mining sectors to identify ways to embark on wide-ranging reform of the mining regulations and their enforcement to ensure that mining operations promote higher standards of environmental sustainability alongside economic development. In doing so, possible payments from REDD+ will be factored into policy-making. Where necessary, compensation will be provided to those whose livelihoods have been impacted negatively as a consequence of REDD+-related activities.” It was recently proposed by the GGMC, as a consequence of the LCDS, that the use of mercury in mining be curtailed entirely. A two year period has been identified for enactment of the mercury ban.

Guyana and Norway, subsequent to publication of the initial LCDS document, signed a Memorandum of Understanding related to reduction in emissions thru deforestation and degradation. The agreement indicates that Norway would provide Guyana with result-based payments for forest climate services. Norway payments will total US \$250 million over the period 2010 – 2015 and would be based on performance as related to reductions in deforestation and degradation. “The Governments of Norway and Guyana believe that this can provide the world with a working example of how REDD+ might operate for a High Forest Low Deforestation (HFLD) country.”

4.10.4 Forest Act 2008

This Forest Act 2008, consolidates and amends the law on forests. It governs all activities that are carried out in the forest including mining and associated activities. Under this Act, no person shall engage in the following unless a mineral prospecting or mining licence has been granted under the Mining Act 1989:

- Enter and occupy state forest;

- Cut, damage or take any forest produce or carry on any kind of forest operation;

- Carry out any kind of exploratory operation in a state forest

The Guyana Forestry Commission with the approval of the Minister is vested with the power for carrying out the purposes of the Act. *This project will entail mining within forested areas, the Forest Act 2008 will therefore apply to the operations.*

4.10.5 Guyana Forestry Commission Act 2007

The Guyana Forestry Commission Act 1979 was repealed and replaced by the Guyana Forestry Commission Act 2007. The functions of the Commission as defined in the act include:

- To provide advice on various forest related issues and on formulation of forest policy;
- To prepare plans, codes of practice, and guidelines for the conservation and management of forests;
- To research, collate, analyse, prepare and disseminate data, statistics and other information about forests and all aspects of forestry including forest ecology and the use of forest produce;
- To inspect, certify and accredit services for quality control of forest produce.

The project will entail management and reclamation of forest resources and this act must therefore be adhered to.

4.10.6 Code of Practice for Timber Harvesting 2002

The Code of Practice for Forest Operation was developed by the Guyana forestry Commission (GFC) for Timber Sales Agreement (GFC) and Wood Cutting Lease WCL. It provides guideline and standards on what constitutes satisfactory road building and other related forestry activities. One important component of this project is upgrading an access road to the mine site. This road will at a minimum have to conform to GFC Road Planning as outlined in Chapter five (5) of the Code of Practice.

4.10.7 Convention on the Protection of World Cultural and Natural Heritage, 1972

The Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention) was adopted by the General Conference of UNESCO in 1972. The Convention aims to encourage the identification, protection, and preservation of earth's cultural and natural heritage. It recognizes that nature and culture are complementary and that cultural identity is strongly related to the natural environment in which it develops. The Convention provides for the protection of those cultural and natural 'properties' deemed to be of greatest value to humanity. It is not intended to protect all properties of great interest, importance or value, but rather a select list of the most outstanding of these from an international viewpoint. The Convention recognizes that nations have a duty to ensure the identification, protection, conservation, presentation, and transmission to future generations of their cultural and natural heritage. By adhering to the Convention, nations pledge to conserve not only the World Heritage Site(s) situated within their territories, but also to improve the protection of their national heritage as a whole.

Article 1 and 2 of the convention define cultural and natural heritage as follows:
Cultural Heritage:

- monuments: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;
- groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;

- sites: works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.

Natural Heritage

- natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view;
- geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation;
- natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

In accordance with this convention, The National Trust of Guyana was established to preserve Guyana's Natural/cultural Heritage.

4.11 INTERNATIONAL AND REGIONAL POLICY

4.11.1 Rio Declaration

The Rio Declaration on Environment and Development was one of five (5) documents that resulted from the Earth Summit in Rio de Janeiro in 1992. The other documents that are applicable to this project are:

- Agenda 21
- United Nations Framework Convention on Climate Change
- United Nations Convention on Biological Diversity

The Rio Declaration consisted of 27 principles intended to guide future sustainable development around the world. It confirms the responsibilities of all countries including Guyana to among other principles:

- Use the precautionary approach to prevent environmental degradation (Principle 15)
- Undertake activities having environmental impacts with full public participation (Principle 10)
- Include Indigenous People and their communities in development projects (Principle 22)

Guyana practices sustainable development guided by the Rio Declaration and developed and implemented guidelines for conducting Environmental Impact Assessments, which will be used to guide this project.

4.11.2 Agenda 21

Agenda 21 arose from the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. It outlines a number of environmental policy and management issues for a more sustainable pattern of development in the 21st century. Four major areas of political action were identified in Agenda 21, social and economic development, natural resources, fragile ecosystems, major organizations and groups of people and means of implementation (Selman, 1996). Further, twenty-seven (27) environmental principles for the protection of environmental resources were outlined as the Agenda 21 action programs. *One of its principles which states that environmental impact assessment should be a national instrument, and shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority is*

applicable to this project (Principle 17). This global principle guided the development of a national policy on environmental impact assessment.

The UNCED Conference also initiated global statements on key environmental issues. These included the Framework Convention on Climate Change and the Convention on Biological Diversity which Guyana has

ratified. Guyana must therefore consider these global agreements during environmental impact assessment for developmental projects.

4.11.3 Convention on Biological Diversity

Guyana ratified the Convention on August 12, 1992. It was entered into force on November 12, 1997. The National Focal Point and the Implementing Agency is the Environmental Protection Agency. The objectives of the Convention include: the conservation of biological diversity (defined as the variability among living organisms from all sources including *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexities of which they are part including diversity within species, between species and of ecosystems), the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The provisions of the Convention apply to areas within the limits of national jurisdiction of contracting parties. Contracting parties are required under Article 7 of the Convention, to identify processes and activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity and to monitor their effects through sampling and other techniques. Parties are, also as far as is possible and as appropriate, required to establish protected areas or areas where special measures need to be taken to conserve biological diversity. In areas adjacent to these protected areas environmentally sound and sustainable development should also be promoted. Article 8 requires that degraded ecosystems be rehabilitated and restored and the recovery of threatened species be done through the development and implementation of plans or management strategies. Contracting parties are also required to regulate or manage relevant processes or activities where a significant adverse effect on biological diversity has been determined.

Article 10 of the Convention supports the integration of conservation and sustainable use of biological resources in national decision-making, and the support of local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced. The avoidance or minimizing of adverse transboundary effects is also considered important and should be addressed by the introduction of environmental impact assessments of proposed projects that are likely to have significant adverse impacts on biological diversity. Article 10 also requires the exchange of information and consultation on activities likely to significantly adversely affect the biological diversity of other States and notification to such States of imminent or grave danger to biological diversity within areas under the jurisdiction of such States.

In observance of the Convention, Guyana established the Environmental Protection Agency in 1996, to coordinate and implement a programme for the conservation of biological diversity. A National Biodiversity Action Plan was also developed with stakeholders.

This project could potentially impact the biodiversity of the area to be exploited. The project will consequently be executed to satisfy the objectives of the Convention to conserve biological diversity to ensure sustainable use of the ecosystem components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

4.11.4 Protocol Concerning Pollution from Land-Based Sources and Activities (LBS)

The Protocol requires contracting parties to develop and implement programs, plans and measures to prevent, reduce or control pollution of the Convention areas from land-based sources and activities. Parties are required to address the source categories, activities and pollutants of concern listed in Annex 1 to the Convention. Extractive industries and mining are identified as priority source categories and activities. Heavy metals and compounds, cyanides and fluorides are listed as primary pollutants of concern. Annex II identifies factors to be used to determine effluent and emission limitations and/or management practices.

Possible landbased sources of pollution at the site will include fuel storage tanks and leaks from mining equipment. In accordance with this protocol, the project proponent shall develop and implement programs, plans and measures to prevent, reduce and/or control pollution of the project area from land-based sources and activities.

4.11.5 Protocol Concerning Specially Protected Areas and Wildlife (SPAW)

The SPAW Protocol, used as a means of regionalizing global conventions such as the CBD, utilizes an ecosystem approach to conservation by protecting rare and fragile ecosystems and the endangered speciesit houses. Through its Caribbean Regional Coordinating Unit, assistance is given for the establishment of protected areas to ensure attainment of the objectives of the SPAW Program to significantly increase the number and improve the management of national protected areas and species in the region and assist the Governments of the region, on request, to develop guidelines for the establishment and management of such areas.

The Protocol extends to the Convention Areas as well as water courses extending up to the fresh water limit or watersheds designated by the parties. It urges when necessary, the establishment of protected areasin instances where it is necessary to protect:

1. representative types of coastal and marine ecosystems of adequate size to ensure their long-term viability and to maintain biological and genetic diversity;
2. habitats and their associated ecosystems critical to the survival and recovery of endangered, threatened or endemic species of flora or fauna;
3. the productivity of ecosystems and natural resources that provide economic or social benefits and upon which the welfare of local inhabitants is dependent; and
4. areas of special biological, ecological, educational, scientific, historic, cultural, recreational, archaeological, aesthetic, or economic value, including in particular, areas whose ecological and biological processes are essential to the functioning of the Wider Caribbean ecosystems.

In the application of protection measures, each party is urged to progressively take such measures in accordance with its national laws and international law as are appropriate for:

1. the regulation or prohibition of the dumping or discharge of wastes and other substances that may endanger protected areas;
2. the regulation or prohibition of coastal disposal or discharges causing pollution, emanating from coastal establishments and developments, outfall structures or any other sources within their territories;
3. the regulation or prohibition of fishing, hunting, taking or harvesting of endangered or threatened species of fauna and flora and their parts or products;
4. the prohibition of activities that result in the destruction of endangered or threatened species of fauna or flora and their parts and products, and the regulation of any other activity likely to harm or disturb such species, their habitats or associated ecosystems;
5. the regulation or prohibition of any activity involving a modification of the profile of the soil that could affect watersheds, denudation and other forms of degradation of watersheds, or the exploration or exploitation of the subsoil of the land part of a marine protected area;

6. the regulation or prohibition of industrial activities and of other activities which are not compatible with the uses that have been envisaged for the area by national measures and/or environmental impact assessments pursuant to Article 13;
7. any other measure aimed at conserving, protecting or restoring natural processes, ecosystems or populations for which the protected areas were established.

If any rare or fragile ecosystems are encountered within the area being exploited the ecosystem approach to conservation would be utilized to manage that rare or fragile ecosystem.

4.11.6 Treaty on Cooperation for the Development of the Amazon Basin

The Treaty on Cooperation for the Development of the Amazon Basin was established in 1978 to promote the harmonious development of the Amazon Region and to undertake joint action and efforts to promote the harmonious development of the Amazonian territories in such a way that joint actions produce equitable and mutually beneficially results and also achieve the preservation of the environment, conservation and rational utilization of the natural resources.

Six sub-committees were set up to initiate, implement and address issues as it relates to the implementation of the Amazonian Treaty. These include the following: Health, Transportation, Education, Infrastructure, Tourism, Environment, Science and Technology and Indigenous Affairs.

The area proposed for the development of this project is considered part of the Amazon Basin and this treaty would be applicable to the development. The aforementioned environmental conditions and agreements place emphasis on the Government of Guyana as a signatory to these treaties to put specific measures in place for compliance. The enactment of the Environmental Protection Act and its regulations have established the institutional and regulatory measures for the implementation of the treaty some of which forms part of the environmental impact assessment requirements.

4.11.7 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)

This convention was established in 1972 to control international trade of live and dead animals and plants through the issuing of permits/certificates for such trade. Requirements for the establishment of Scientific and Management authorities; regulation of trade in specific species via permits and certificates and maintenance of records of trade are detailed in the convention. The legal obligation under this convention was established in the Species Protection Regulations of 1999 under the Environmental Protection Act.

The project will not entail capture and trade in endangered species and the company will enforce a policy of no hunting or trapping to ensure its employees do not contravene this convention.

4.11.8 UN Framework Convention on Climate Change (UNFCCC)

UNFCCC was entered into force in 1994 to achieve stabilization of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Further, it required that acceptable levels of greenhouse gas (GHG) should be achieved within a time frame that is sufficient to allow ecosystems to adapt naturally to climate change.

In keeping with the provisions of the Convention, a national climate change committee was established and a national inventory of Greenhouses Gases was prepared for base-year 1994. Aspects related to technology transfer, capacity building requirements, vulnerability assessment and adaptation measures were compiled.

The CO₂ emitted by mining equipment is a greenhouse gas. In addition, clearing of forested areas for mining will reduce the sequestration ability of the forests impacted by that clearing. These quantities of greenhouse gases emitted and the reduction in sequestration will be quantified in the ESIA.

4.11.9 Basel Convention on the Transboundary Movement of Hazardous Waste and their Disposal

The Basel Convention aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. Guyana is a party to this convention which came into force in 1992. It was designed specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). The Convention

is also intended to minimize the amount and toxicity of wastes generated. This ensures

that toxic waste is managed as closely as possible to the source of generation. Examples of hazardous waste as defined by the convention are:

- Wastes from the manufacture, formulation and use of wood preserving chemicals
- Waste pharmaceuticals, drugs and medicines
- Wastes from the production, formulation and use of organic solvents
- Waste mineral oils unfit for their originally intended use
- Waste oils/water, hydrocarbons/water mixtures, emulsions
- Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish

Consequent to this convention Guyana developed regulations on environmental protection. One of these regulations focuses on the management of hazardous wastes.

5.0 EXISTING ENVIRONMENT

Baseline data on the physical environment in the mine site area was compiled over a eight month period to track temporal trends, if any. The periods during which physical data was compiled for the site are as follows:

- November 2015
- May 2016.

Data collection for the physical environment, conducted during each period, focused on surface water hydrology, topography, soils, benthic sediment, climate and meteorology, ambient air quality, and water quality. Data on site geology was compiled from published references. Field surveys conducted during each period included recovery and analysis of surface water samples. Samples of surface water and sediments were obtained from areas containing alluvial deposits. Surface water flow volumes were computed by correlation to runoff areas for each creek and historical data on runoff flows per unit area for the wet and dry seasons.

5.1 Geology, Soil and Topography

The Concession lies within the Precambrian Guiana Shield that extends across northern South America from east of the Andes to northeastern Brazil. Exposures in the mine area are few, due to the thick residual soil cover, often more 180 feet deep. These soils show up most of the rock structures as variations in color and texture of the saprolite. The region of the concession itself is underlain by a metamorphosed series of sediments and intercalated basic rocks dipping steeply to the west. The metasediments are mainly chlorite schists and are commonly referred to as “argillites”. Psammitic metasediments are also present, but the two facies interdigitate at the contact. These psammitic metasediments are known locally as “sandstones”.

Regionally, the geology is complicated. It appears to consist of one or more series of metasedimentary or metavolcanic rocks, locally intruded by granites of at least two varieties. The concession area is underlain by rocks of the Mazaruni Group. These consist of intensely sheared sediments, which strike to the north and dip steeply. Drill-cores in areas in the vicinity of the concession, have shown two rather distinct rock types, pelite and psammite.

Pelite is a siliceous aphanitic rock, often carrying numerous impersistent quartz-feldspar-carbonate bandlets, from 4 to 5 mm across and sometimes more. Foliation is usually contorted. Psammite is a medium grained, dirty quartz-sandstone, with a small clay fraction. When the latter fraction is sufficient, the sandstones may show a close cleavage foliation, at other times it may be shattered, but it always shows a considerable amount of dynamic metamorphism, with more or less associated epidotechlorite.

Granite occurs in some sections of the concession. This granite is locally porphyritic and is generally regarded as the source of hydrothermal solutions, which have caused the mineralization seen at both at Peters’ Mine and at Million Mount. In this district, there are a number of gold alluvial deposits near Mara-Mara mouth. It is probable that all these are genetically related to the Peters’ Mine Granite.

The gold deposits are in Precambrian psammitic and pelitic schist, which is part of the Cuyuni formation of the Mazaruni Group. The concession area is probably within the body of granitic rock and lies within an area of gold mineralization that extends from Million Mount and Mara Mara Creek southward.

The weathered profile within the concession extends to depths from 30 to 60 m. In general, the foliation of the schist strikes a little east of north and dips steeply west or vertically. Locally, especially near some of the

faults, the foliation is much distorted.

Overall, the beds trend west-southwest, with a northerly dip of around 50° . Orientation of the beds is locally variable, however, reflecting not only the boudinage, but also intense shear folding about near-

vertical roughly north-striking axes. The different reaction of the two rock types to this folding largely determines the nature of the ore structures (auriferous quartz veins) within them. The more plastic argillite tends to react to the stress by forming small isoclinal folds in which the quartz forms non-auriferous stringers straggling along and around the hinge line. In contrast, the sandstone, which is more competent than the argillite, forms larger, more open folds and is often fractured along and near the hinge. The quartz in these rocks commonly occurs as wide, well-defined auriferous veins.

The tropical conditions of the study area have produced an environment dominated by chemical weathering. Such an environment is hostile to lithic material, and silica therefore, dominates the sediment composition (quartz). Remnants of lithic materials are in the form of clay clasts and kaolinized sand grains. Generally, bedrock weathers to saprolite, a silty clay material that retains the original bedrock structure. Natural Slopes in the area range from being flat to relatively mild.

The soils within the concession developed in place and consist primarily of residual material derived from weathered acid crystalline rocks (granite, schist, dolerite, granodiorite, and phyllite). There are two soil map units in the Mine Site area, Rp and Rh soils, classified as Class I-II, Class III or Class IV as depicted by Figure 7.

Concession

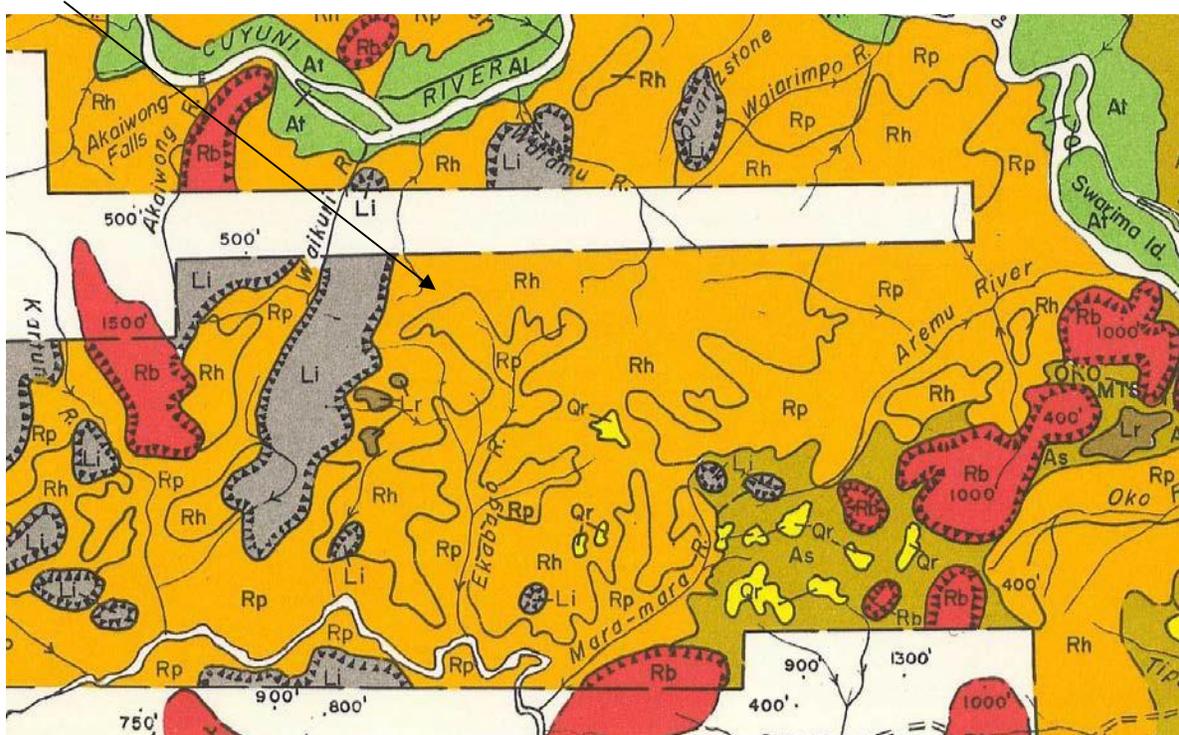


Figure 7 - Soil Map of Project Area (Braun, E.H. G., Derting, J., Suggett, G.R.. Year: 1964.)

Legend:

- Rh Soils – Deep dominantly well drained, yellow and brown, sandy clay loam clay and gravellyclay soils
- Rp soils – Deep dominantly well drained, yellow and brown, sandy clay loam, clay and gravellyclay soils

Rh soils are deep dominantly well drained yellow and brown, sandy clay loam, clay and gravelly clays soils to shallow excessively drained sandy loam and silt loam soils with occasional gravel, relief is hilly to steep residual uplands. Soils are the results of deep weathering of residual, acidic, crystalline rocks such as granite, schist, phyllite and granodiorite.

Rp soils are deep dominantly well drained, yellow and brown, sandy clay loams, clay and gravelly clay soils which also occur as poorly drained silty and clayey soils. These soils occur in rolling sedimentary and residual uplands and resulted from the deposition of unconsolidated sedimentary and alluvial soils and are also reflective of residual materials derived from deeply weathered acid crystalline rocks such as granite schist and phyllite.

Class I-II soils are deep well drained brown, sandy soils of low fertility on gently sloping to rolling topography. Class III soils are dominantly brown sandy clay loams and reddish-brown gravelly clays of low fertility on hilly to steep slopes which makes cultivation difficult and erosion is a likely hazard. Class IV soils are effectively deep sterile, excessively or poorly drained white sand soils on gentle slopes. These areas also contain shallow brown, sandy, sometimes gravelly soils on steep slopes.

5.1.1 Seismic Activity

Seismicity in the northern part of the South America continent is largely controlled by plate boundary events occurring along the southern rim of the Caribbean Basin. Major earthquakes frequently occur along the plate boundary between the South American and Caribbean Plates. Figures 8 and 9 respectively show the distribution of historical deep seated and shallow earthquakes occurring around the Caribbean Basin. These figures demonstrate that earthquake activity is concentrated in a circular pattern around the perimeter of the Caribbean tectonic plate.

Figure 8 - Deep and Intermediate Depth Seismicity, 1901-1993 (from OAS CDMP, 2001)

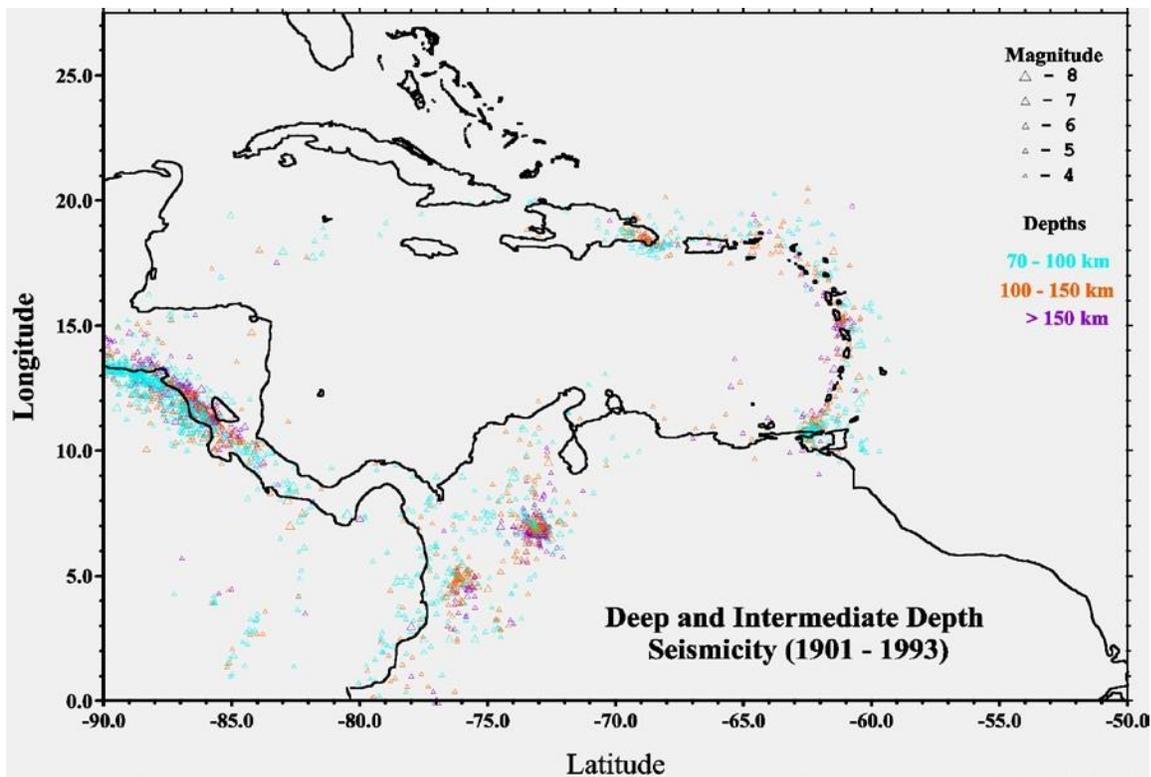
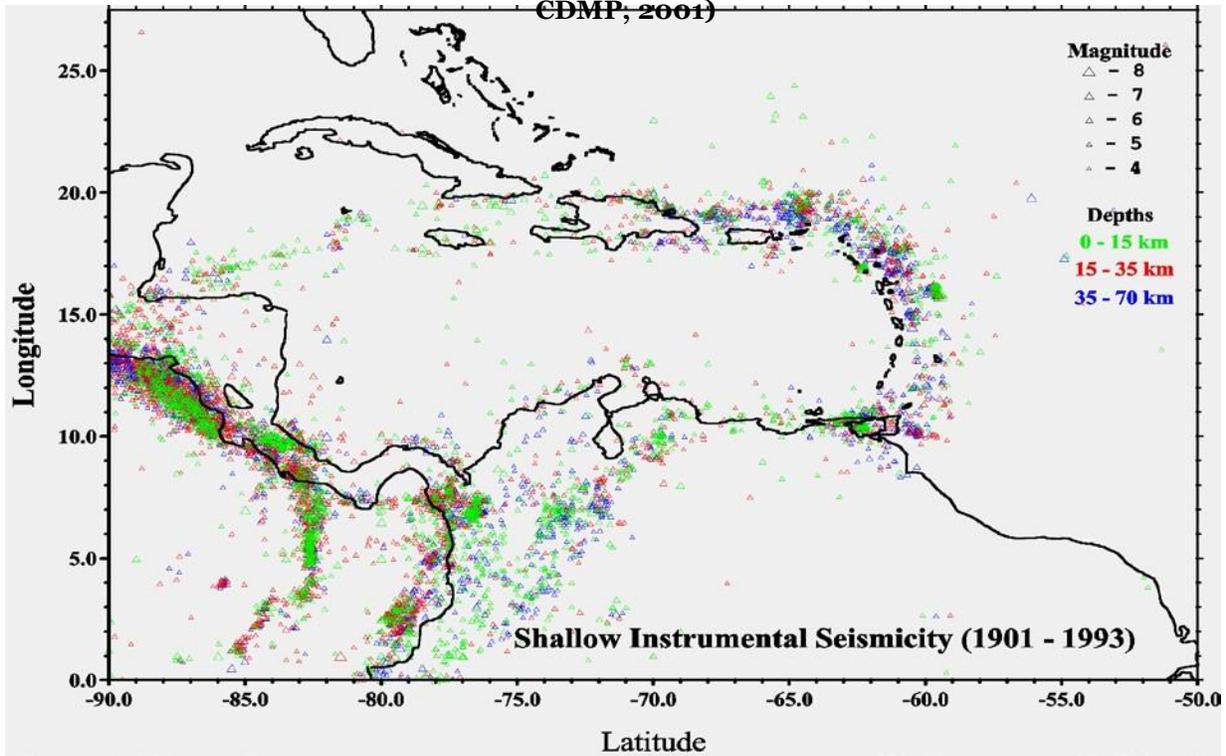


Figure 9 - Shallow Instrumental Seismicity, 1901-1993 (from OAS



Guyana is located within the South American tectonic plate. The project site is located more than 500 km from the Caribbean and South American plate boundary. A search was conducted of the National Oceanic and Atmospheric Administration Earthquake database, which includes data on a half-million earthquakes dating back to 2100 B.C. The results of that search are shown as Figure 10.

Mine Site

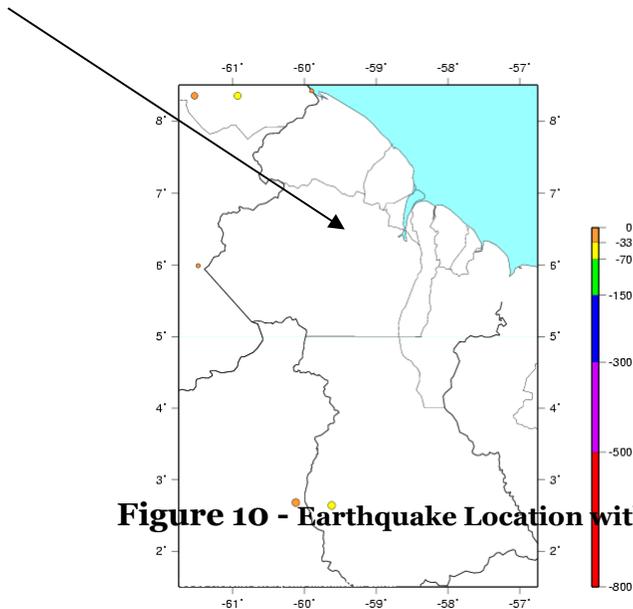


Figure 10 - Earthquake Location within and around Guyana

That search revealed that three events have occurred within recorded history within 400 km of the project area. One of these events occurred in Guyana, in 1964, at a point defined by 2.64° North and 59.62° West at

a depth of 50 km and with a magnitude of 4.50. The second event occurred almost immediately west of that point in Brazil at a point defined by 2.68° North and 60.12° West. The depth of that event was not recorded. The magnitude of that event was reported as being 4.90.

5.2 Climate and Air Quality

Guyana is located in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by the seasonal shifts of the ETZ and its associated rain-bands called the Inter Tropical Convergence Zone (ITCZ). Secondary influences on the climate are of Pacific origin. Formation of El Niño and La Niña can disturb the regular location of the ITCZ which results in higher or lower than normal rainfall. The El Niño/La Niña is primarily responsible for inter-annual variation in rainfall.

Hydro meteorological Service (HMS) has maintained or is maintaining two Meteorological Stations within proximity of the project. These locations are as follows:

- Mazaruni Prisons
- Enachu

The Mazaruni station is at the Mazaruni Prisons near to the confluence of the Mazaruni, Cuyuni and Essequibo Rivers. The data available for this station consist only of daily rainfall recorded for the years 1997 to 2001. No data is available for evaporation and/temperature for this station. Data for Enachu consist of daily recorded rainfall for the years 1962 to 1966. No data is available for evaporation and/temperature for this station.

The maximum daily rainfall recorded over the period of record at the Mazaruni Prisons was approximately 92 millimeters (mm). The minimum daily rainfall recorded was 0 mm. The average yearly rainfall over the period was 2015 mm. Records for Enachu indicate maximum and minimum daily rainfall of 118 and 3 mm respectively. Two corresponding dry periods were noted at both locations:

January - March and
August - October.

The rainfall distribution for the Mazaruni Prisons and Enachu respectively are shown on Figures 11 and

12. No data is available for temperature or evaporation from either location. No records are available for wind speeds in the area. Winds are monitored in the Botanic Gardens in Georgetown. A review of those records reveals that the winds blow primarily from the northeast and east. Winds speeds are highest in March and lowest in July. The average of the higher wind speeds is 7.7 knots. The average of the lower wind speeds is 4.8 knots.

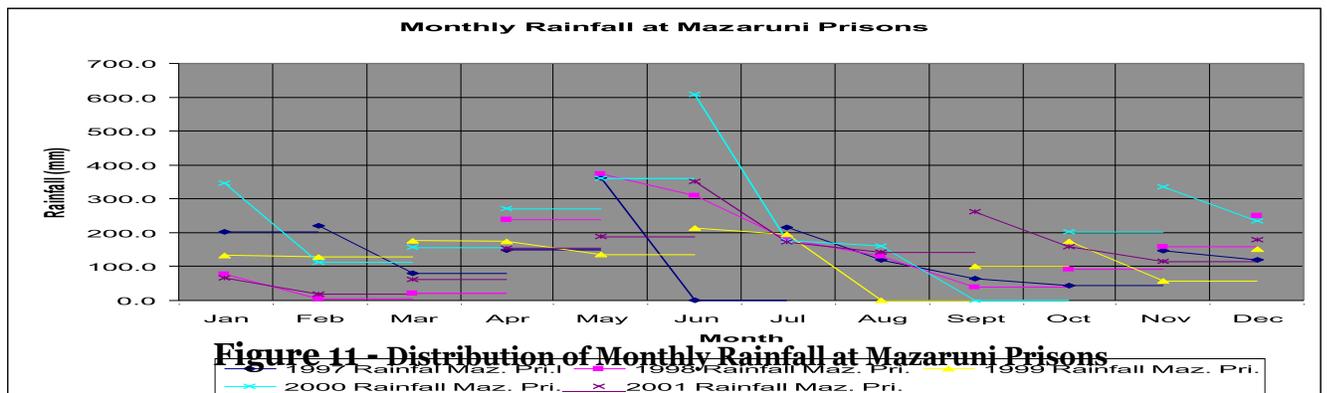


Figure 11 - Distribution of Monthly Rainfall at Mazaruni Prisons

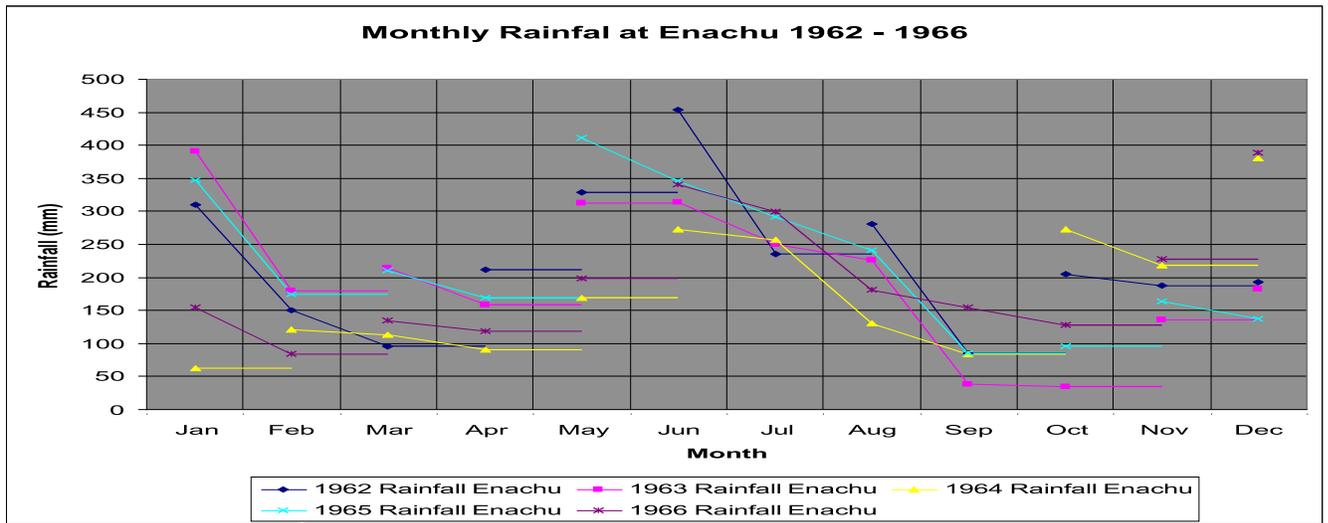


Figure 12 - Distribution of Monthly Rainfall at Enachu

There are no major industries in the area. Aerial emissions in the Project area are directly related to the emission of gases by rotting trees and other vegetative matter. Airborne discharges and particulate matter are not monitored in the area. However, typical (World Bank) guidelines for sulphur emissions specify two levels of allowable emissions. If the region is unpolluted the maximum allowable emissions should not exceed 500 tonnes per day (tpd). If the region is polluted the maximum allowable emissions should not exceed 100 tpd. This criterion is not expected to be exceeded by current aerial emissions.

5.3 Surface Water

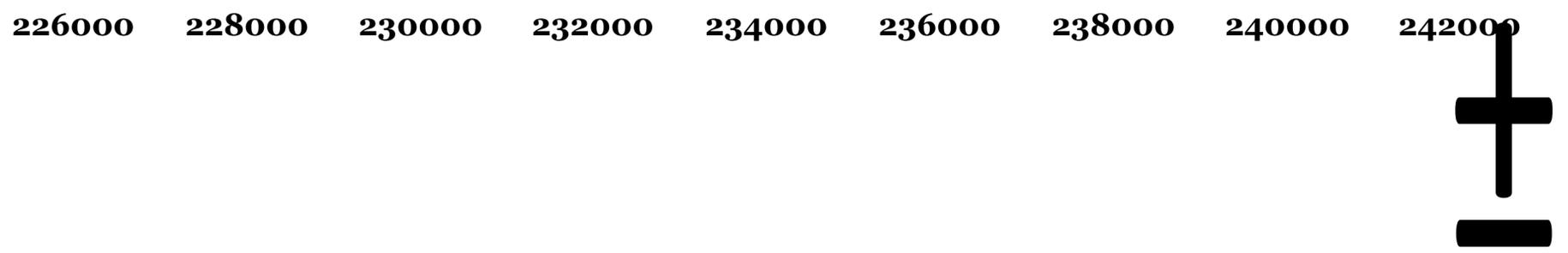
Surface water runoff from the concession discharges to the Puruni River through three tributaries. Two of these tributaries are identified as the Ekabago Creek and the Akwaparu Creek. The location of these creeks and their relationship to the concession is shown on the surface water hydrology map of Figure 13. The Akwaparu and Ekabago creeks extend into the limits of the concession. The Akwaparu Creek has a relatively small watershed and collects surface water primarily from the southwestern section of the concession. The Ekabago Creek collects surface water from the eastern and northern sections of the concession. A third unmaned creek (shown in red on Figure 13) collects surface runoff primarily from the west central sections of the concession.

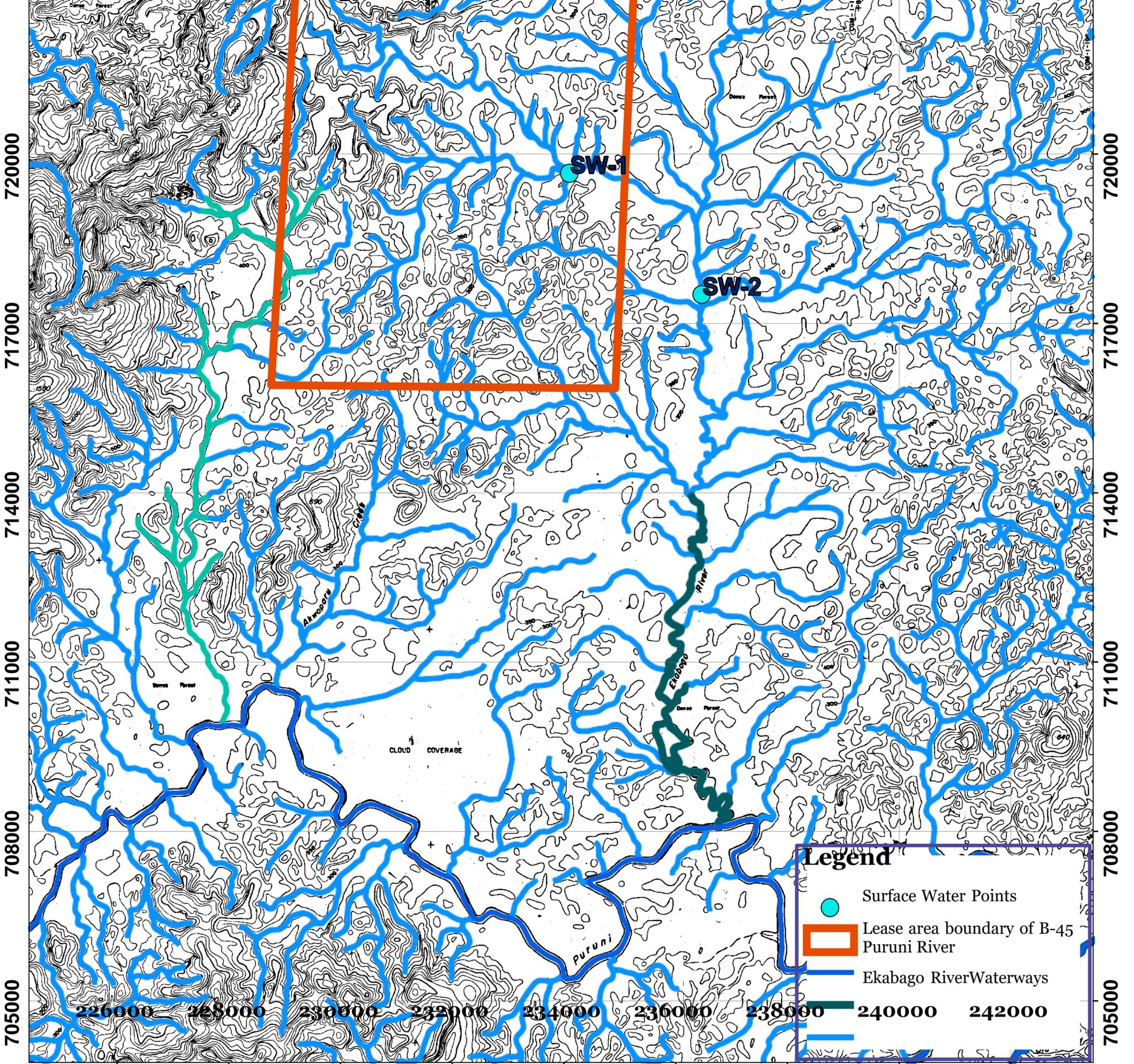
The forest canopy intercepts most of the precipitation in the project area. The soils present at ground surface are a mix of granular and cohesive material. It is highly likely that some of the precipitation incident on the ground surface infiltrates the ground. Flows in the streams and creeks in the site vicinity therefore are probably reflective of groundwater discharge to surface water bodies.

5.3.1 Catchment Area & Flow Volumes

The concession lies within the Puruni River watershed. The total estimated drainage area of the Puruni River is approximately 4170 km². The drainage area of the Puruni River up to Peters Mine is approximately 2610 km². A monitoring station was maintained on the Puruni River at Peters' Mine over the period of September 1977 to September 1982. Summaries of maximum and minimum monthly discharges at Peters Mine based on the period of record are shown on Figures 14 and 15.

Figure 13: Surface Water Hydrology Map showing sampling locations





1 2 4

Kilometers

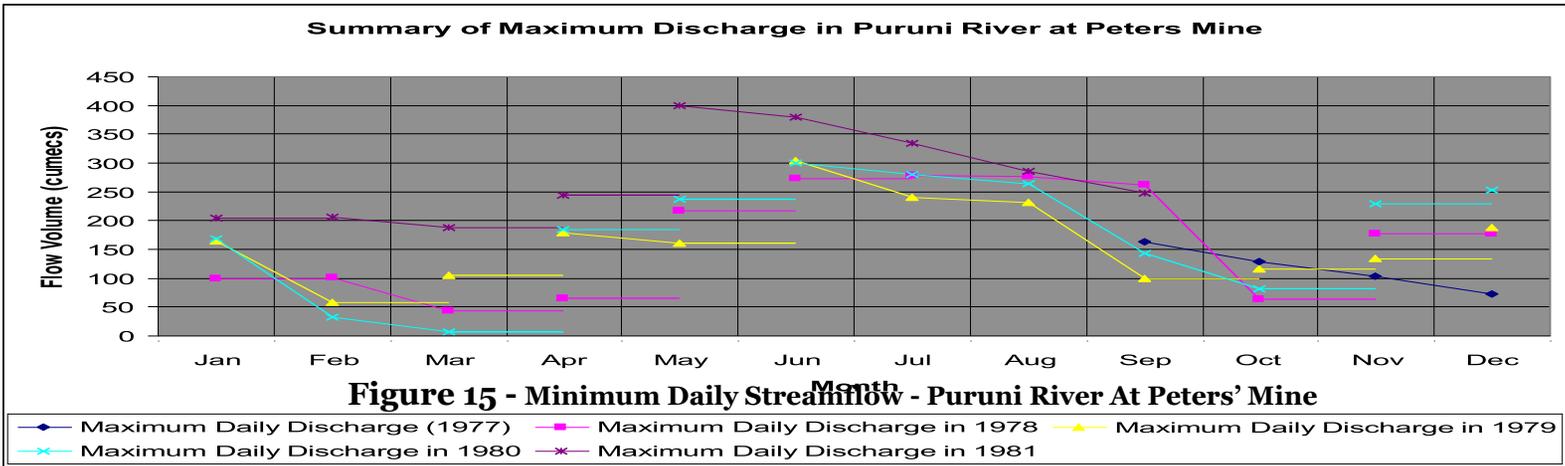


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702000
699000

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Figure 14 - Maximum Daily Streamflow - Puruni River At Peters' Mine



The ratio of the drainage areas of the Ekabago, Akwaparu and unmaned creeks to that of the Puruni River at Peters Mine was used to compute equivalent maximum and minimum discharges on the Ekabago, Akwaparu and unmaned creeks. The inferred maximum and minimum stream flows at the Ekabago, Akwaparu and the unmaned creeks over the period of record are detailed in Table 3. The lowest flows are inferred to occur in the months February – April and the highest flows are inferred to occur in the months of May – August. These flows correlate with the long dry and wet seasons respectively.

Table 3: Streamflows at Ekabago, Akwaparu and unmaned creeks Inferred from Flows at Peters Mine

Maximum Inferred Streamflow at Ekabago, Akwaparu and unmaned creeks for Period of Record (cumecs)												
Ekabago Creek												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977									13.65	10.73	8.57	6.08
1978	8.38	8.45	3.68	5.48	18.18	22.91	23.38	23.23	21.91	5.34	14.83	14.79
1979	13.84	4.87	8.78	15.03	13.43	25.40	20.08	19.34	8.28	9.71	11.23	15.69
1980	14.15	2.78	0.60	15.45	19.85	25.16	23.45	22.10	11.92	6.74	19.20	21.25
1981	17.12	17.30	15.69	20.39	33.47	31.80	28.01	23.98	20.79			
Akwaparu Creek												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977									1.17	0.92	0.73	0.52
1978	0.72	0.72	0.31	0.47	1.55	1.96	2.00	1.99	1.87	0.46	1.27	1.26
1979	1.18	0.42	0.75	1.28	1.15	2.17	1.72	1.65	0.71	0.83	0.96	1.34
1980	1.21	0.24	0.05	1.32	1.70	2.15	2.00	1.89	1.02	0.58	1.64	1.82
1981	1.46	1.48	1.34	1.74	2.86	2.72	2.39	2.05	1.78			
Unmaned Creek												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977									2.17	1.70	1.36	0.97
1978	1.33	1.34	0.58	0.87	2.89	3.64	3.71	3.69	3.48	0.85	2.36	2.35
1979	2.20	0.77	1.39	2.39	2.13	4.03	3.19	3.07	1.32	1.54	1.78	2.49
1980	2.25	0.44	0.09	2.45	3.15	4.00	3.73	3.51	1.89	1.07	3.05	3.37
1981	2.72	2.75	2.49	3.24	5.32	5.05	4.45	3.81	3.30			
Minimum Inferred Streamflow at Ekabago, Akwaparu and unmaned creeks for Period of Record (cumecs)												
Ekabago Creek												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977									5.17	3.16	1.64	2.07
1978	1.87	0.78	0.40	0.31	2.00	14.90	10.02	11.06	4.35	2.64	2.18	5.39
1979	3.20	0.74	0.69	1.93	3.80	15.17	7.83	6.20	3.09	2.75	1.52	5.72
1980	2.21	0.43	0.19	0.22	12.06	15.59	16.02	7.33	3.33	3.02	2.56	4.87
1981	4.75	4.77	1.49	1.42	20.91	23.74	18.73	13.01	6.93			
Akwaparu Creek												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977									0.44	0.27	0.14	0.18
1978	0.16	0.07	0.03	0.03	0.17	1.27	0.86	0.95	0.37	0.23	0.19	0.46
1979	0.27	0.06	0.06	0.16	0.32	1.30	0.67	0.53	0.26	0.24	0.13	0.49
1980	0.19	0.04	0.02	0.02	1.03	1.33	1.37	0.63	0.28	0.26	0.22	0.42
1981	0.41	0.41	0.13	0.12	1.79	2.03	1.60	1.11	0.59			
Unmaned Creek												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

1977									0.82	0.50	0.26	0.33
1978	0.30	0.12	0.06	0.05	0.32	2.37	1.59	1.76	0.69	0.42	0.35	0.86
1979	0.51	0.12	0.11	0.31	0.60	2.41	1.24	0.98	0.49	0.44	0.24	0.91
1980	0.35	0.07	0.03	0.03	1.92	2.48	2.55	1.16	0.53	0.48	0.41	0.77
1981	0.75	0.76	0.24	0.23	3.32	3.77	2.97	2.07	1.10			

5.3.2 Surface Water Quality

To capture baseline surface water quality in the area, surface water samples were recovered from two streams within PL-45 depicted as SW-1 and SW-3 on Figure 13. Surface water and sediment samples were also recovered for analyses from a point, SW-2, outside of PL-45. All samples were sent to ACCUTEST/EXOVA laboratories in Ottawa, Ontario, Canada for analyses to determine the concentration of parameters mandated in the EPA guidelines for Environmental Impact Assessment for the Mining Sector. The results of analytical tests on surface water samples are detailed in Table 4.

Sediment samples were recovered from the creeks concurrently with the surface water samples. Sediment samples were recovered from points immediately below the points at which the surface water samples were recovered. The results of the analyses on sediment samples are detailed in Table 5.

Table 4: Results of Analytical Tests on Surface Water Samples

LAB ID:			1242177	1242178	1242179	143741	143742	143743
Sample Date:			11/15/2015	11/15/2015	11/15/2015	5/16/2016	5/16/2016	5/16/2016
Sample ID:			SW-1	SW-2	SW-3	SW-1	SW-2	SW-3
PARAMETER	UNITS	MRL						
Alkalinity as CaCO3	mg/L	5	23	26	32	17	21	28
Cl	mg/L	1	3	2	2	4	4	4
Conductivity	uS/cm	5	45	55	43	47	52	47
Cyanide (free)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cyanide (total)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
F	mg/L	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
HCO3 as CaCO3	mg/L	1	19	24	26	17	21	28
Ph		1	6.89	7.03	7.01	7.11	7.06	6.85
SO4	mg/L	1	<1	<1	<1	<1	<1	<1
Total Suspended Solids	mg/L	2	312	208	146	286	13	10
N-NH3 (Ammonia)	mg/L	0.02	2.8	3.1	2.4	<0.02	<0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.1	<0.1	0.15	0.21	1.4	0.35	0.87
N-NO3 (Nitrate)	mg/L	0.1	0.35	0.82	0.18	0.11	0.49	0.32
O-PO4 (Ortho-Phosphate)	mg/L	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sulphate	mg/L	1	<1	<1	<1	<1	<1	<1
Total Dissolved Solids (COND - CALC)	mg/L	1	20	33	41	28	47	21
Total Kjeldahl Nitrogen	mg/L	0.8	61.3	49.8	52.7	47.9	35.8	48.7
Phenols	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
K	mg/L	1	<1	2	<1	<1	<1	<1

Be	mg/L	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
B	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Br	mg/L	0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Cu	mg/L	0.001	0.004	0.008	0.005	0.003	0.004	0.003
Hg	mg/L	0.0001	0.0003	0.0001	0.008	0.012	0.16	0.21
Mo	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ni	mg/L	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Si	mg/L	0.1	21.5	13.8	17.6	16.6	23.4	3.9
Ag	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Sr	mg/L	0.001	0.013	0.019	0.021	0.016	0.018	0.023
TI	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Ti	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
V	mg/L	0.001	0.003	0.007	0.002	0.005	0.008	0.004
Hg	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Al (dissolved)	mg/L	0.01	1.87	0.85	0.61	1.22	0.41	0.34
As	mg/L	0.001	< 0.001	<0.001	0.001	0.001	<0.001	0.001
Ca	mg/L	1	3	2	4	2	4	3
Cd	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Co	mg/L	0.0002	0.0043	0.0019	0.0031	0.0026	0.001	0.0022
Cr	mg/L	0.001	0.012	0.006	0.011	0.018	0.004	0.006
Fe	mg/L	0.03	2.43	2.86	1.87	5.29	3.07	3.45
Mg	mg/L	1	2	1	3	1	2	2
Mn	mg/L	0.01	0.1	0.17	0.12	0.14	0.13	0.14
Na	mg/L	2	2	3	3	3	3	2
Pb	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Se	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	mg/L	0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01
Phenols	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Acidity as CaCO ₃	mg/L	5	215	<5	<5	320	<5	<5

Oil & Grease - Mineral	mg/L	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Oil & Grease - Non-mineral	mg/L	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Oil & Grease - Total	mg/L	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Turbidity	NTU	0.1	>100	>100	>100	>100	29.8	17.9

Table 5: Results of Analyses on Sediment Samples Biological Resources

LAB ID:			1242177	1242178	1242179	143741	143742	143743
Sample Date:			11/15/2015	11/15/2015	11/15/2015	5/15/2016	5/15/2016	5/15/2016
Sample ID:			SD-1	SD-2	SD-3	SD-1	SD-2	SD-3
PARAMETER	UNITS	MRL						
Loss on Ignition (@550C)	%	0.1	5.8	4.7	12.1	6.9	7.9	9.3
TOC	%	0.01	0.3	0.27	0.37	0.5	0.58	0.43
Hg	ug/g	0.1	0.4	<0.1	0.18	<0.1	0.2	0.1
Al	ug/g	5	10400	12700	21700	12800	13500	18900
As	ug/g	1	7	8	21	9	9	18
Co	ug/g	1	3	2	36	4	4	40
Cr	ug/g	1	80	96	215	100	104	168
Cu	ug/g	1	34	36	71	21	22	56
Fe	ug/g	5	52300	57400	93500	44200	46900	83900
Mn	ug/g	1	217	241	913	168	170	771
Mo	ug/g	1	<1	<1	<1	<1	<1	<1
Ni	ug/g	1	7	5	23	9	9	30
Pb	ug/g	1	1	3	6	2	2	3
Sb	ug/g	1	<1	<1	<1	<1	<1	<1
Zn	ug/g	2	12	15	61	18	18	57
Ca	ug/g	100	400	400	200	500	300	200
K	ug/g	100	200	300	200	300	200	100
Mg	ug/g	100	300	300	500	400	400	400
Na	ug/g	100	<100	<100	<100	<100	<100	100
Ba	ug/g	1	18	12	11	9	17	6
Cd	ug/g	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Se	ug/g	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Be	ug/g	1	< 1	< 1	< 1	< 1	< 1	< 1
Co	ug/g	1	1	2	1	1	1	1
Mo	ug/g	1	< 1	< 1	< 1	< 1	< 1	< 1
Ni	ug/g	1	3	2	1	4	1	3
Ag	ug/g	0.2	0.5	0.3	< 0.2	0.4	< 0.2	< 0.2
Sr	ug/g	1	< 1	< 1	< 1	< 1	< 1	< 1
Tl	ug/g	1	< 1	< 1	< 1	< 1	< 1	< 1
V	ug/g	100	<100	<100	<100	<100	<100	<100
Oil & Grease - Mineral	ug/g	100	<100	<100	<100	<100	<100	<100
Oil & Grease - Non-mineral	ug/g	100	<100	<100	<100	<100	<100	<100
Oil & Grease - Total	ug/g	100	<100	<100	<100	<100	<100	<100

supplemented by a desk top review of existing baseline data compiled for areas with similar habitat characteristics within the landscape region of the concession.

The dry season field survey was conducted over the period of November 13-19, 2015. A second biodiversity survey, intended to capture biodiversity conditions during the wet season, was conducted over the period of May 08 - 14, 2016. Both surveys captured variations in landscape and habitat types within the concession including topography, forest and vegetation types and the level of disturbance. The objective of each survey was to determine the existence of sensitive species and critical habitat, that is, habitat with high biodiversity. The criteria used to determine potentially sensitive habitat and species are as follows:

- Habitats required for the survival of critically endangered or endangered species (as defined by the IUCN Red List of Threatened Species);
- Areas having special significance for endemic or restricted-range species;
- Sites that are critical for the survival of migratory species;
- Areas supporting globally significant concentrations or numbers of congregatory species; and
- Areas with unique assemblages of species or which are associated with key evolutionary processes.

Species recorded by the surveys were compared with the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species that occur in Guyana, and the Convention on the International Trade of Endangered Species (CITES) to determine and classify species which are endemic, endangered or threatened with extinction.

The IUCN defines species according to their likelihood of extinction and produces a Red List, which includes internationally recognized flora and fauna. CITES produces a list of threatened or endangered animals prohibited from international trade in three appendices based on the level of threat. The criteria for the IUCN and CITES classification are provided in Table 6.

Table 6: IUCN Red List and CITES Classification

IUCN	CITES
Extinct (E) - A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.	CITES Appendix I: includes all species in danger of extinction that are, or that can be affected by trade. The commercial trade of these species is subject to very strict regulations, in order not to endanger survival of the species, and is only authorized under exceptional circumstances.
Extinct in the Wild (EW) - A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.	CITES Appendix II: includes those species that are not currently in danger of extinction, but may become so in the future if their commercial trade is not strictly regulated. Other species not affected by trade are also subject to regulations, in order to allow the effective control of the trade of the species mentioned above.
Critically Endangered (CR) - A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing an extremely high risk of extinction in the wild.	CITES Appendix III: includes species that are subject to jurisdictional regulations anywhere, with the objective of preventing or restricting their exploitation, and requires the cooperation of all districts to control the trade.
Endangered (EN) A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore	

IUCN	CITES
considered to be facing a very high risk of extinction in the wild.	
Vulnerable (VU): A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing a high risk of extinction in the wild.	
Near Threatened (NT): A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.	
Least Concern (LC): A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.	
Data Deficient (DD): A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat.	
Not Evaluated (NE): A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.	

This baseline considers biodiversity at the following levels of scale, listed in increasing order of detail:

- Regions/Biogeographic Provinces
- Landscapes/Ecoregions
- Habitats and Species

5.3.3 Regional and Biogeographic Context

Four main geographical regions can be distinguished within Guyana (FAO, 2015). These are:

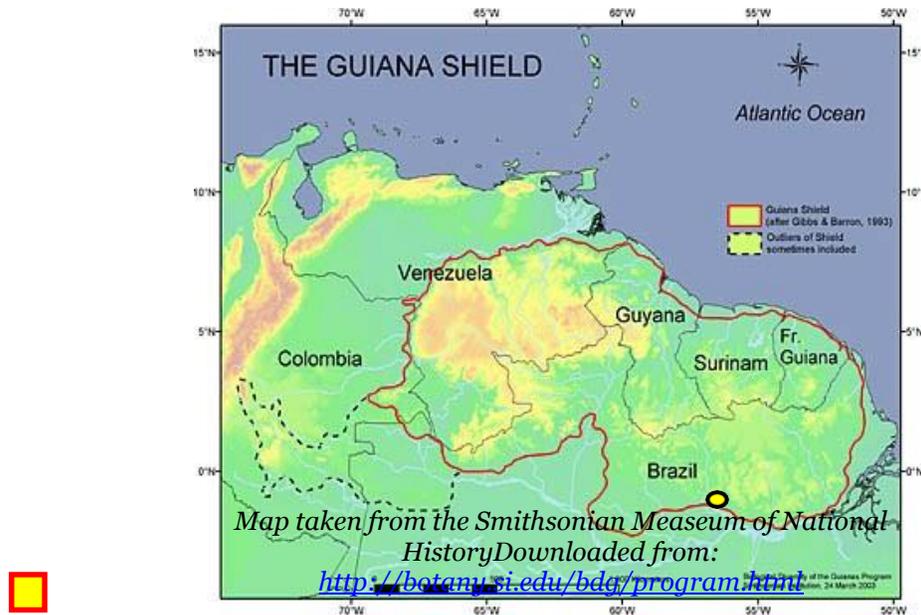
- The northern coastal belt, consisting of low-lying alluvium with a varying width up to a maximum of 65 km in land (in the east);

- The lowland region of undulating forest land covering most of the northern and central parts of the country, generally with an elevation below 150 m;
- The Pakaraima mountain region in the west, an elevated table land of sandstone escarpments between 300 and 1200 m in elevation; and
- The southern uplands consisting of a vast area mostly over 150 m in elevation covered with undulating forest land.

Prospecting License (PL) B-45 is located in the tropical lowland forest region of northwestern Guyana as described in the second division above, some 148 km west-southwest of Georgetown. This low-lying area is considered to be part of the the Guiana Shield region as defined by regional studies by Hollowell and Reynolds (2005). The Guiana Shield is located in northeastern South America. It includes the large mountain systems that form the watershed between the Amazon and Orinoco Rivers. The Guiana Shield

accounts for more than 25 % of tropical forests remaining in the world. Its diverse landscapes have been recognized for their biological endemism, unique ecosystems, pristine forests and cultural diversity. Figure 16 depicts Guyana and the general location of the concession in relation to the Guiana Shield Region.

Figure 16 - General Location Of The Concession In Relation To The Guiana Shield Region



KEY: Guiana Shield Region, Outliers of the Guiana Shield (sometimes included), General area of the concession

The lowlands of the Guiana Shield are biogeographically distinct from the Guiana Shield highlands which include the Tepui formations characterized by relatively high levels of endemisms. Biogeographically, the lowlands of the Guiana Shield are much more closely related to the forested lowlands of the Amazon Basin and are often included under broader definitions of Amazonia due to their overriding similarities. The lowland rainforests on brown sandy soils, loams, or laterites is the major vegetation type of the Amazon Valley and the Guiana Shield (Steege 2000).

The vertebrate faunal diversity of the Guianan lowland forests is comprised largely of widespread species found across the lowland humid forests of the Amazon Basin and the watersheds of the Guiana Shield. In contrast, Guianan vertebrate endemics are generally restricted to the highlands of the Guiana Shield, especially at elevations greater than 1,500 m, or to the savanna and dry forest ecosystems.

The Cuyuni and Mazaruni Rivers are the main drainage conduits of the landscape region of the concession. The Cuyuni and Mazaruni Rivers discharges to the Essequibo River – the Cuyuni River discharging into the lower Mazaruni River, which then discharges into the Essequibo River. The Essequibo River and the seasonally flooded Rupununi savannas of southwestern Guyana serve as biological corridors for aquatic biota, directly linking the Amazon Basin and the watersheds north of the Guiana Shield (Watkins et al., 2004). The Cuyuni and Mazaruni Rivers are therefore connected to the Amazonian aquatic ecosystems via the Essequibo and Rupununi Rivers.

Based on the analyses of large scale forest inventories, Steege and Zondervan (2000) identified five preliminary divisions of the Guianan forest:

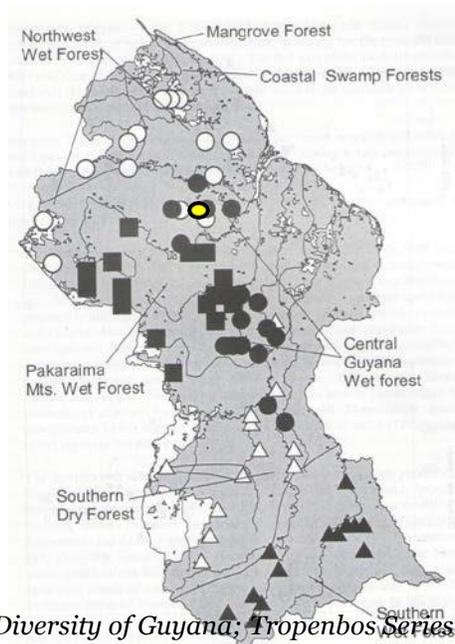
- Forests in the coastal plain (Venezuela – Guyana – Suriname – French Guiana)
- Forest in the North West District of Guyana and lowland Venezuelan Guyana
- Forests of the White Sands Formation (Guyana-Suriname-French Guyana)
- Forests in the Pakaraima-Central Guiana Upland region (Guyana-Venezuela-Brazil)
- Forests of the southern peneplain (Guyana-Suriname-French Guiana-Brazil)

The Cuyuni and Mazaruni River basins lie within the forest in the North West District of Guyana and lowland Venezuelan Guyana. This forest region is found on soils developed on the crystalline shield, consisting of granites and greenstones, as well as on smaller areas covered by Plio-Pleistocene sediments. The forests are characterized by a high abundance of *Eschweilera sagotiana*, *Alexa imperatrix*, *Catostemma emune*, *Licania spp.*, and *Protium decandrum*. Poor monodominant stands of *Mora gonggrijpii* are found on the (probably) more clayey soils between the Cuyuni and Mazaruni Rivers.

5.3.4 Landscapes and Ecosystems

PL B-45 is situated just west of the upper reaches of the Ekabago Creek, a main tributary of the Puruni River, within the lower Mazaruni River Basin, and entirely within the wet forest of northwest Guyana as defined by Steege (2000). Figure 17 shows the location of the concession within the northwest wet forest region of Guyana.

Figure 17 - Map Showing the National Forest Regions of Guyana



Map sourced from; *Plant Diversity of Guyana; Tropenbos Series 18; Edited by Steege (2000)*

LEGEND

- ▲ Southern Wet Forest
- ▲ Northwest Guyana Wet
- Forests Central Guyana Wet
- Forest

■ *Pakaraima Mountains Wet Forests*

△ *Southern Dry Forest; Light grey areas: area under forest cover*

● *General area of the concession*

According to Steege (2000), the northwest Guyana wet forest is characterized by a high abundance and presence of *Eschweilera corrugata*, *Alexa imperaticis*, *Protium decandrum*, *Pentaclethra maculosa*, and *Mora Excelsa*. Extensive marsh forests of *Mora Excelsa* with *Pterocarpus* and *Carapa* are found along the rivers. Mixed forest on dryer ground are dominated by a combination of *Eschweilera corrugate*, *Alexa imperaticis* or

E. corrugate, *Licania spp.* and *Catostemma commune*. In the southern part of the region large monodominant stands of *Mora gonggrijpii* occur. This lowland wet forest region of northwest Guyana is considered part of the Guianas forests region in the North West District of Guyana and lowland Venezuelan as described by Steege and Zondervan (2000).

The concession lies just to the south of the low-lying Cuyuni-Mazaruni watershed divide. The Mazaruni River basin occupies some 36,600 km², almost all entirely within Guyana. The Cuyuni River basin occupies an area of approximately 59,300 km², of which 42,100 km² are within the neighbouring country of Venezuela. These two river basins, approximately 53,800 km², comprise the landscape region for the purposes of this assessment.

The forest ecosystems of the Cuyuni and Mazaruni River basins are dominated by dense forests which are interlocked among aquatic environments in the form of rivers and creeks. Forest ecosystems along the rivers and in the creek valleys are seasonally flooded and provide habitats for aquatic biota during the wet season. The valley slopes, hillslopes, and ridgetops support forests vegetation tolerant to non-seasonally flooded forest conditions.

The river ecosystems are integrated through surface and groundwater hydrological processes. The surface waters of the region are generally considered 'blackwaters' with low pH, high contents of tannins and organic acids from the breakdown of leaf litter, low conductivity and suspended sediments. The Cuyuni and Mazaruni River basins are part of the Essequibo Freshwater Ecoregion (Abell et al., 2008). The rivers serve as a biological corridor directly linking the Amazon Basin and the watersheds north of the Guiana Shield via the Essequibo River. As such, the rivers may have some significance for migratory fishes. The ecosystems support a large diversity of widespread humid forest fauna typical of the neotropics, the Guiana Shield and Amazonia lowlands, and the lowlands forest regions of Guyana.

The Cuyuni and Mazaruni District is known for timber and mineral resources and consists of active mining and logging extraction projects. The concession is surrounded by a number of historic gold producing mines and prospects such as Aurora, Akaiwong, Aranka, Aremu, Peters Mine and Million Mountain. Historical and current mining and logging activities within the Cuyuni-Mazaruni District have disturbed portions of the natural ecosystems.

5.3.5 Habitats and Species

There is no documented biodiversity data collection for the concession. There is, however, some existing baseline information from ESIA studies conducted for mining and forestry projects within the Mazaruni and Cuyuni basins. These projects are situated within areas with similar habitat characteristics to that of PL B-45, that is, lowland wet forest of northwest Guyana. Additionally, the biodiversity of the Guyana Shield Region has been recently studied resulting in checklists for vascular plants (Funk et al., 2007), fish (Vari et al., 2009), and terrestrial vertebrates (Hollowell and Reynolds, 2005). These data provide a valuable baseline on species richness and endemism relevant to this assessment.

Based on the description by Steege and Zondervan (2000), the forest composition of the North West District and eastern Venezuela is characterized by mixed forest vegetation with species belonging to the 'Lowland

Guianas Dominants'. Mixed forest vegetation typically occurs on well-drained soils from the flat plain to broken areas on brown sand, loam or red earth. In the lowland region of Guyana mixed forest vegetation occurs from the Venezuelan border to the Demerara River in the east and from the coastal belt south to the Pakaraima Mountains. This large area is practically covered by the *Eschweilera/Licania* association. The other

association occurring is *Eschweilera/Dicymbe*, which can be considered as a transition between the *Dicymbe* forests of the Pakaraima region and the lowland forests.

Mixed forest vegetation are generally classified as follows: mixed forests on clayey soils; mixed forests on lateritic hills; mixed forests on pleistocene brown sands; extensive riverine forest; and open swamps. A description of each mixed forest type is provided below.

- Mixed forest on clayey soils: These dry land forests of the Northwest District of Guyana and eastern Venezuela are characterized by a high abundance of *Eschweilera sagotiana*, *Alexa imperatricis*, *Catostemma commune*, *Licania* spp. and *Protium decandrum*. These species are found abundantly in almost every dry land forest type in this region;
- Mixed forest on lateritic hills: Common trees are *Eschweilera* spp., *Licania* spp., *Swartzia* spp., *Mora gonggrijpii*, *Chlorocardium rodiei*. A local endemic, *Vouacapoua macropetala*, forms extensive stands with *Eschweilera sagotiana*, *Licania laxiflora*, *Sterculia rugosa*, *Poecilanthe hostmanii* and *Pentaclethra macroloba* on lateritic soils in central Guyana. A low shrubby forest is found on the rocky phase of laterite with Myrtaceae (*Eugenia* spp., *Calycolpes*, *Marlierea*) and Sapotaceae (*Ecclinusa*, *Manilkara*) being dominant at these locations. Pioneers, such as *Cecropia* spp., *Schefflera morototonii*, *Jacaranda copaia* and *Pentaclethra macroloba* are also abundantly present on such sites in central Guyana;
- Mixed rainforests on pleistocene brown sands: These forests on the brown sands of the Berbice formation are almost invariably characterized by species of *Eschweilera* and *Licania* spp. Locally dominant species are *Eschweilera sagotiana*, *E. decolorans*, *E. confertiflora*, *Licania alba*, *L. majuscula*, *L. laxiflora*, *Chlorocardium rodiei*, *Mora gonggrijpii*, *Alexa imperatricis*, *Swartzia schomburgkii*, *S. leiocalycina*, *Catostemma commune*, *Eperua falcata*, *Pouteria guianensis*, *P. cladantha*, *Aspidosperma excelsum* and *Pentaclethra macroloba*. Mono-dominance is common in forests on brown sands in central Guyana and tends to become less in an eastward direction;
- Extensive riverine forest: These are generally found along major rivers, having significant canopy association with species of the Mora forest inclusive of *Eschweilera wachenheimii*, *E. sagotiana*, *Clathrotropis brachypetala*, *C. macrostachya*, *Eperua falcata*, *E. rubiginosa*, *Catostemma* spp, etc.; and
- Open swamps: Herbaceous and grass swamps in brackish and sweet water with *Cyperus*, *Montrichardia*, *Commelina*, *Paspalum* and *Panicum*.

According to the GFC vegetation map obtained for the concession (Figure 18), the concession consists of mixed forest vegetation stratified by topography. The forest strata depicted include: mixed forest on high hills; mixed forest on flat to undulating terrain; and mixed forest on undulating to hilly terrain. These forest types correspond with the forest description of the national wet forest region of northwest Guyana as described by Steege (2000) and the Guianan forest region of the North West District and lowland Venezuelan Guyana as described by Steege and Zondervan (2000), and therefore serve as a basis for the comparison of results derived from this biodiversity survey.

Faunal data of the Cuyuni and Mazaruni landscape region was acquired through a review of ESIA studies for several mining and forestry projects. These projects are situated within the Cuyuni-Mazaruni basins area with similar habitat characteristics to that of the B-45 concession, that is, lowland wet forest of northwest Guyana. The projects include:

- Peter's Mine Concession, situated within the Puruni River and Mazaruni River basins.

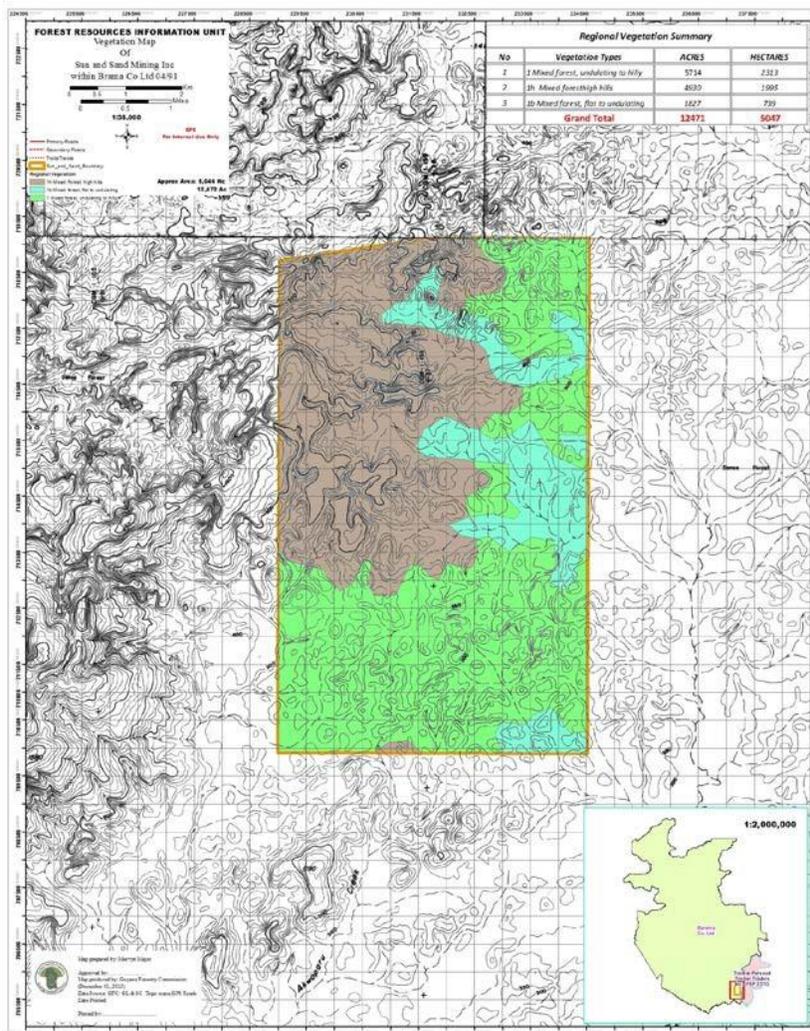
- Garner Forest Concession, situated within the Puruni River and Mazaruni River basins.
- ETK-Sand Springs Resources Mining Concession, situated within the Puruni River and Mazaruni River basins.
- Guyana Goldfields Mining Concession situated within the Cuyuni River basin.

The vertebrate faunal diversity, recorded in studies for the listed projects, comprise of widespread species found across the lowland humid forests of the Amazon Basin and the watersheds of the Guiana Shield. Table 7 provides a summary account of fauna species numbers obtained from the examination of the ESI studies.

Table 7: Species Account For Habitats Within The Cuyuni-Mazaruni Basins

SITE	LOCATION/HABITAT TYPES	NUMBER OF SPECIES RECORDED					
		FISH	MAMMALS	BATS	BIRDS	HERPES	THREATENED SPECIES
Peter's Mine	Puruni River/Lowland Wet Forest NW Guyana	NA	8	NA	18	12 Reptiles 4 Amphibians	None
Garner Forest	Puruni River/Lowland wet Forest NW Guyana	NA	23	13		15 Reptiles 13 Amphibians	Jaguar - <i>Panthera onca</i> (NT) Fawn - <i>Lepus terrestris</i> (NT) White Lipped Peccary - <i>Tayassu pecari</i> (NT)
ETK Sand Springs	Puruni River/Lowland Wet Forest NW Guyana	24 (NA - Not Assessed; NT - Near Threatened)	19 (TUCN Red List)	12	82	13 Reptiles 19 Amphibians	None
Guyana Goldfields	Cuyuni River/Lowland Wet Forest NW Guyana	45	18	3	140	22 Reptiles 23 Amphibians	Harpy Eagle - <i>Harpia harpyja</i> ; (NT)

Figure 18: GFC Map Depicting Mixed Forest Vegetation Types of the Concession

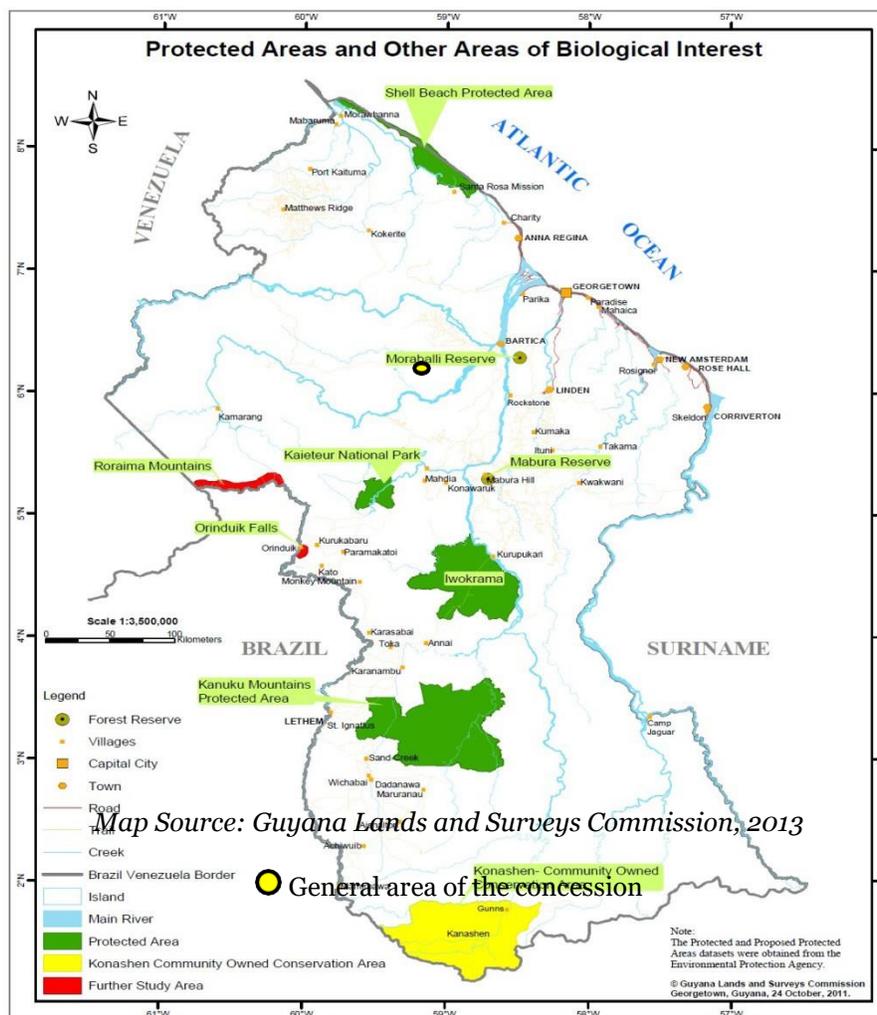


5.3.6 Areas of Recognized Importance to Biodiversity

Areas of biological importance within Guyana include legally protected areas and biodiversity priority areas. The Cuyuni-Mazaruni basins have not been identified by the Government of Guyana (GOG) as a priority for biodiversity conservation. The conservation initiatives in Guyana are largely focused on the larger forested landscapes of central and southern Guyana or in the Rupununi Savannas region.

The national conservation priority sites identified by the GOG include the legally protected areas of the Kanuku Mountains, the Shell Beach Protected Area, the Kaieteur National Park, the Iwokrama Rainforest Reserve, and the Community Owned Conservation Area at Konashen. Other areas of biological interest not legally protected include the Guyana Forestry Commission (GFC) Moraballi and Mabura Reserves, the Orinduik Falls and Roraima Mountains. None of the legally protected areas and other areas of biological interest within Guyana are located within the Cuyuni-Mazaruni basins (see Figure 19).

Figure 19 - Protected Areas and Other Areas of Biological Interest



Eco-regional planning was done at the level of the Guiana Shield Region in April 2002 through the “Guyana Shield Conservation Priority- Setting Workshop”. The workshop identified a series of priority areas for biodiversity and conservation within the Guiana Shield Region. Guyana is included for its importance for areas of high conservation potential, protected areas, and biological priorities for floristics, plant ecology, amphibians and reptiles, mammals, birds, invertebrates, fish and freshwater ecology. Though the biodiversity and conservation priority areas were not bio-geographically defined, a schematic map that identified the Shield’s conservation priority areas was developed.

The priority areas identified for Guyana include the Waini Shell Beach Area, the Cuyuni Area, the White Sand Savanna Belt, the Lower Essequibo Area, the Eastern Upland and Tepui area and the Rupununi Wetlands. Perusal of the workshop schematic map, depicted in Figure 20, shows portions of the Cuyuni Area and the Lower Essequibo Area fall within the Cuyuni-Mazaruni basins. Both of these areas however, fall outside of the concession and the project area of direct influence. The Cuyuni Area is located north-west of the concession and north of the Cuyuni River. The Lower Essequibo Area is situated east, south-east of the concession. The Cuyuni Area is included for its importance for floristics, reptiles, and mammals. The Lower Essequibo Area is included for its importance for plant ecology, invertebrates and fishes and freshwater ecology.

There are no recognized areas of global importance to biodiversity within the Cuyuni-Mazaruni landscape. There are no identified Zero Extinction Sites, proposed or listed Ramsar Wetland Sites or officially designated areas in Guyana identified as Important Bird Areas (IBAs) to date. However, BirdLife International has proposed a total of 10 IBAs for Guyana. Table 8 identifies the proposed IBAs for Guyana. The Pakaraima Mountains are identified as an IBA within Cuyuni-Mazaruni basins. The Pakaraima Mountains are, however, remote from the concession.

Based on the current assessment of the biodiversity recorded within the concession there are no sensitive species and/or habitat classifiable as a critical habitat. Species recorded within the concession are found throughout their ranges in the forest lowlands of Guyana, the Guiana Shield and Amazonia.

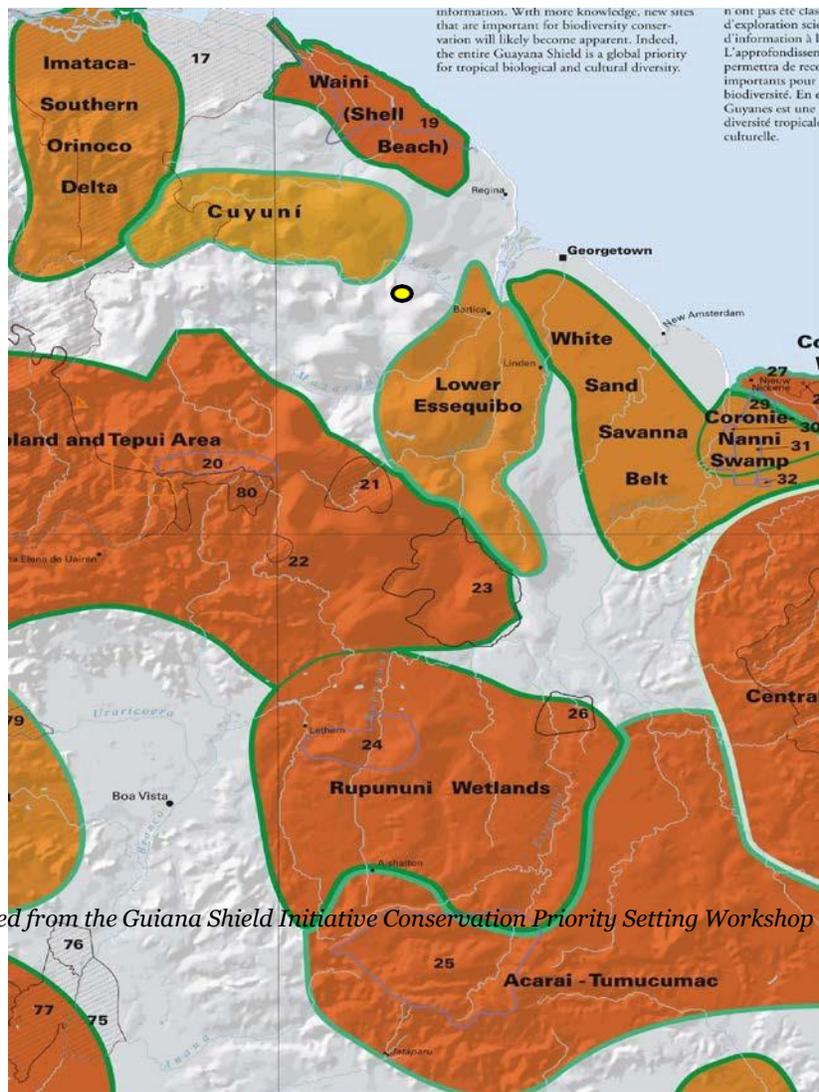
Table 8: Birdlife International IBAS Proposed For Guyana

IBA NAME	ADM UNIT
Shell Beach	Barima-Waini
Karaw/Aruka	Barima-Waini
Ireng River	Upper Takatu-Upper Essequibo
North Rupununi-Karanambu Ranch	Upper Takatu-Upper Essequibo
Mapari-Kanuku Mountain	Upper Takatu-Upper Essequibo
South Central Rupununi	Upper Takatu-Upper Essequibo
Iwokrama	Potaro-Siparuni
Karasabai	Upper Takatu-Upper Essequibo
Pakaraima Mountains	Cuyuni Mazaruni

Data obtained from BirdLife International (2015) Country profile: Guyana.

Website: <http://www.birdlife.org/datazone/country/guyana>. Checked: 2015-12-04

Figure 20 - Guiana Shield Conservation Priority areas within Guyana



(Map extracted from the Guiana Shield Initiative Conservation Priority Setting Workshop Report, 2003)

KEY

- Highest Priority
- Very High Priority

General area of the concession

5.3.7 Biodiversity of the Concession

The dry and wet season surveys were conducted using a system of sample plots and transects. The detailed survey methodology is provided in Appendix C. A general habitat description of the terrestrial and aquatic sample plots is provided in Appendix D. Detailed information on observations recorded by the floral and fauna survey, in addition to the general abundance is provided in Appendix E. The species account of the surveys and an evaluation to identify whether there are any sensitive species of significance to critical habitat are presented in the following sections.

5.3.7.1 Biodiversity Baseline Survey Results

The concession has historically been mined by artisanal miners and has been subject to significant disturbance and habitat degradation. The habitats and biodiversity components within the concession are largely modified habitats. Further, the surveys recorded no sensitive species and/or habitat classifiable as critical habitat. Species recorded within the concession are widespread throughout their ranges within lowland Guyana, the Guiana Shield and Amazonia.

The biomass quantities determined by the surveys were used to estimate carbon stock within the area to conform to requirements of the GFC. Timber volume estimates were determined using the following formula (Adopted from the GFC Metrification Manual for Timber Species, 1999):

- Timber Volume (m³) = 0.7854*D²L*0.0001

Where D = Diameter at Breast Height (DBH)

L = log length

Biomass estimates were developed based on the pan-tropical biomass equation of Chave et al (2005). The Chave et al (2005) biomass allometric model was validated as applicable for use in the Guyana context in Alder and van Kuijk (2009) baseline assessment of forest carbon in Guyana. Biomass estimates were calculated strictly for trees with DBH greater than 5 cm and for saplings with DBH less than 5 cm. Carbon accounting estimates were expressed both in tonnes carbon per ha, (tC ha⁻¹) or tonnes of carbon dioxide-equivalent per ha, (tCO₂-e ha⁻¹). The IPCC (2006) recommended conversion factor of 0.5 for biomass to carbon was used. The CO₂-equivalent, tonnes of carbon was determined by multiplying by the ratio of 44/12, which is the ratio of the atomic weights of Carbon Dioxide (CO₂) to Carbon (C).

The Chave et al (2005) model is as follows:

- AGB = wood density (g/cm³) x exp(-1.499 + 2.148ln(DBH) + 0.207(ln(DBH))² - 0.0281(ln(DBH))³)

Wood densities were derived species by species from the database of Zanne et al (2009). These are available for 134 Guyanese species, including all common forest trees. For species with unknown wood density a weighted average wood density of 0.66 g/cm³ was utilized as recommended by ter Steege (2001).

Below ground tree (root) biomass was calculated as a root:shoot (R:S) ratio relative to above ground biomass. This method is implicit in the IPCC (2006) equations for forest biomass calculations. The following root:shoot ratios adopted from Steege (2001) were utilized for the forest types encountered within this concession:

- Mixed Forest R:S ratio = 0.220

Necromass (dead wood and litter) was approximately estimated using an expansion factor of 8.6 % (adopted from Steege (2001)) relative to tree biomass. Both above ground and below ground (roots) tree biomass were determined for the areas sampled. A small increase in forest seedlings and saplings biomass was recorded, from 5.77 tC/ha in the dry season to 6.06 tC/ha in the wet season. The increase in seedlings and saplings biomass over the dry and wet seasons is as a result of preferential growth conditions and increased germination during the wet season. The mean biomass, that is, above and below ground tree biomass, saplings, and leaf litter for the sampled areas is provided in Table 9.

Table 9: BIOMASS PER HECTARE FOR SAMPLED AREAS

	ABOVE GROUND TREE BIOMASS (tC/Ha)	BELOW GROUND TREE BIOMASS(tC/Ha)	SAPLING S (tC/Ha)	LITTER (tC/Ha)	SUM CARBON POOLS (tC/Ha)
Dry Season	119.23	28.02	5.77	12.66	165.69
Wet Season	119.23	28.02	6.06	12.66	165.97

There was no significant difference recorded in the floral composition and carbon stock in the dry and wet season surveys. The dry and wet season surveys documented a total of 60 plant species within 32 families.

The concession is dominated by mixed forests on clayey soils characteristic of forest of the Northwest District as described by Steege and Zondervan (2000). Two True Guyana endemics, Wamara (*Swartzia leiocalycina*) and Marishiballi (*Licania buxifolia*) and 6 Guiana Shield endemic species, the Common Baromalli, *Catostemma commune*, the Black Kakaralli, *Eschweilera sagotiana*, Mora, *Mora Excelsa*, Morabukea, *Mora gonggrijpii*, Ituri Wallaba, *Eperua grandiflora*, and Soft Wallaba, *Eperua falcata* were recorded during the surveys. The surveys did not record any critically endangered or endangered floral species. The Kereti Silverballi, *Ocotea puberula*, is listed as Least Concern by the IUCN Red List. The flora species recorded during the surveys are presented in Table 10.

Sixteen species of non-volant mammals representing 12 families, and 3 species of volant mammals (bats) representing 2 families were documented during the dry season survey. The wet season survey documented 10 species of non-volant mammals representing 9 families, and 8 species of bats representing 3 families. No critically endangered or endangered species, migratory or endemic mammalian species were recorded during the surveys.

The herpetofauna survey during the dry season recorded a total of 17 amphibian species representing 6 families and 10 reptilian species representing 6 families. The wet season survey recorded a total of 19 amphibian species representing 6 families and 10 reptilian species representing 7 families. None of the herpetofauna species documented are endemic or is listed by the IUCN Red List.

Fifty nine species of birds belonging to 18 families were recorded during the dry season survey and a total of 43 species from 20 families were recorded during the wet season survey. No critically endangered or endangered bird species were recorded. One nearctic migrant *Coccyzus americanus* (Yellow-billed Cuckoo) was recorded during the dry season. Three species encountered are Guiana Shield endemics: *Myrmeciza athrothorax* (Black Throated Antbird); *Myrmotherula gutturalis* (Brown Bellied Antwren); and *Crax alector* (Black Curassow).

A total of 16 taxonomic orders of terrestrial macro-invertebrates were recorded during the dry season survey, and a total of 14 orders were documented during the wet season survey. Decapoda and Gastropoda were the only two taxonomic orders of benthic macro-invertebrates recorded during the dry and wet season surveys.

Eighteen species of fish representing 11 families were documented during the dry season survey. The wet season survey documented 21 species representing 13 families. No endemic or migratory fish species were recorded during the wet and dry season surveys.

5.3.7.1.1 Flora

The dry and wet season surveys documented a total of 60 plant species within 32 families. The concession is dominated by mixed forests on clayey soils characteristic of forest of the Northwest District as described by Steege and Zondervan (2000).

The families Caesalpiniaceae and Lecythidaceae were dominant with *Eschweilera sagotiana* (Lecythidaceae) being the most dominant species recorded. Other species recorded for the Lecythidaceae family included *Eschweilera wachenheinii*, and *Eschweilera decolorans*. The family Caesalpiniaceae was the most species rich and included species such as *Eperua grandiflora*, *Eperua falcate*, *Swartzia leiocalycina*, *Mora excels* and *Mora gonggripii*. *Mora excels* and *Mora gonggripii* were abundant. The family Burseraceae was occasional.

The surveys recorded 2 true Guyana endemics, Wamara (*Swartzia leiocalycina*) and Marishiballi (*Licania buxifolia*) both species ranked as rare. Six Guiana Shield endemic species were recorded: the Common Baromalli, *Catostemma commune*, ranked as rare; the Black Kakaralli, *Eschweilera sagotiana*, ranked as dominant; Mora, *Mora Excelsa*, ranked as abundant; Morabukea, *Mora gonggripii*, ranked as occasional; Ituri Wallaba, *Eperua grandiflora*, ranked as rare; and Soft Wallaba, *Eperua falcata* ranked as rare.

The floral survey did not record critically endangered or endangered species. The Kereti Silverballi, *Ocotea puberula*, is listed as Least Concern by the IUCN Red List. The flora species recorded during the surveys are presented in Table 10.

Table 10: Floral Species Recorded Within The Concession

VENACULAR NAME	SPECIES	FAMILY	Recorded in Dry Season	Recorded in Wet Season
Adebero	<i>Paypayrola guianensis & longifolia</i>	Violaceae	Yes	Yes
Arara broad leaf	<i>Unonopsis spp.</i>	Annonaceae	Yes	Yes
Arara rough skin	<i>Unonopsis glaucopetala</i>	Annonaceae	Yes	Yes
Aromata	<i>Clathrotropis brachypetala</i>	Papilionaceae	Yes	Yes
Awasokule	<i>Tovomita schomburgkii</i>	Guttiferae	Yes	Yes
Baromalli	<i>Catostemma altsonii</i>	Bombacaceae	Yes	Yes
Baromalli common	<i>Catostemma commune</i>	Bombacaceae	Yes	Yes
Burada	<i>Parinari campestris</i>	Rosaceae	Yes	Yes
Coffee mortar	<i>Terminalia dichotoma</i>	Combretaceae	Yes	Yes
Corkwood	<i>Pterocarpus officinalis</i>	Papilionaceae	Yes	Yes
Gamma cherry	<i>Cordia Tetrandra</i>	Boraginaceae	Yes	Yes
Haiawa	<i>Protium guianensis</i>	Burseraceae	Yes	Yes
Haiawaballi	<i>Protium beglectum & Tenuifolium</i>	Burseraceae	Yes	Yes
Itikiboroballi	<i>Swartzia benthamiana & bannia</i>	Caesalpiniaceae	Yes	Yes
Kairiballi	<i>Licania spp.</i>	Rosaceae	Yes	Yes
Kakaralli black	<i>Eschweilera sagotiana</i>	Lecythidaceae	Yes	Yes
Kakaralli fine leaf	<i>Eschweilera wachenheinii</i>	Lecythidaceae	Yes	Yes
Kakaralli smooth leaf	<i>Eschweilera decolorans</i>	Lecythidaceae	Yes	Yes
Kanakudiballi	<i>Cochlospermum orinocense</i>	Cochlospermaceae	Yes	Yes
Kauta	<i>Licania guianensis</i>	Rosaceae	Yes	Yes
Kautaballi	<i>Licania majuscula</i>	Rosaceae	Yes	Yes
Kwako	<i>Marlierea montana</i>	Myrtaceae	Yes	Yes
Maho	<i>Sterculia spp.</i>	Sterculiaceae	Yes	Yes
Maho black	<i>Sterculia guianensis</i>	Sterculiaceae	Yes	Yes
Marishiballi	<i>Licania buxifolia & micrantha & mollis</i>	Rosaceae	Yes	Yes
Mora	<i>Mora excels</i>	Caesalpiniaceae	Yes	Yes
Morabukea	<i>Mora gonggripii</i>	Caesalpiniaceae	Yes	Yes
Okokonshi	<i>Quiina obovata</i>	Quiinaceae	Yes	Yes
Parakusan	<i>Swartzia genmanii & arborescens</i>	Caesalpiniaceae	Yes	Yes
Shibadan	<i>Aspidosperma album</i>	Hugoniaceae	Yes	Yes

VENACULAR NAME	SPECIE S	FAMILY	Recorded in Dry Season	Recorded in Wet Season
Silverballi kereti	<i>Ocotea puberula</i>	Lauraceae	Yes	Yes
Simarupa	<i>Simaruba amara</i>	Simaroubaceae	Yes	Yes
Suradan	<i>Hieronyma laxiflora</i>	Euphorbiaceae	Yes	Yes
Sweetheart	<i>Talisia elephantipes</i>	Sapindaceae	Yes	Yes
Trysil	<i>Pentaclethra macroloba</i>	Mimosaceae	Yes	Yes
Turu Palm	<i>Jessenia bataua</i>	Palmae	Yes	Yes
Unknown	-	-	Yes	Yes
Waiaballi	<i>Hebepetalum humiriifolium</i>	Linaceae	Yes	Yes
Waiaballi	<i>Tapura guianensis</i>	Chailletiaceae	Yes	Yes
Wallaba ituri	<i>Eperua grandiflora</i>	Caesalpiniaceae	Yes	Yes
Wallaba soft	<i>Eperua falcate</i>	Caesalpiniaceae	Yes	Yes
Wamara	<i>Swartzia leiocalycina</i>	Caesalpiniaceae	Yes	Yes
Warakosa	<i>Inga alba</i>	Mimosaceae	Yes	Yes
Wild Cherry	<i>Eugenia patrisii</i>	Myrtaceae	Yes	Yes
Yarri Yarri	<i>Duguetia spp.</i>	Annonaceae	Yes	Yes
NON WOODY PLANTS				
Kapadula	<i>Tetracera volubilis</i>	Dilleniaceae	Yes	Yes
Devildoer	<i>Strychnos sp.</i>	Loganiaceae	Yes	Yes
Nibbi	<i>Heteropisis flexuosa</i>	Cyclanthaceae	Yes	Yes
Turu palms	<i>Jessenia bataua (Mart.)Burret</i>	Palmae	Yes	Yes
Monkey ladder	<i>Bauhinia guianensis</i>	Leguminosae- caesalp.	Yes	Yes
Monkey Plum	-Unknown	-	Yes	Yes
Kufa	<i>Clusia grandiflora</i>	Guttiferae	Yes	Yes

Turtle Ladder	<i>-Unknown</i>	-	Yes	Yes
Manicole	<i>Euterpe oleracea</i>	Palmae	Yes	Yes
Granny back bone	<i>Curarea candicans</i>	Menispermaceae	Yes	Yes
Acia palm	<i>Euterpe oleracea</i>	Palmae	Yes	Yes
Monkey syrup	<i>Trichilia rubra</i>	Meliaceae	Yes	Yes
Ferns	<i>Pityrogramma spp</i>	Pteridaceae.	Yes	Yes
Bitter tally	<i>Mikania micrantha</i>	Compositae	Yes	Yes
Congo Pump (White)	<i>Cecropia spp</i>	Cecropiaceae	Yes	Yes

5.3.7.1.2 Fauna

5.3.7.1.2.1 Non- Volant Mammals

Sixteen (16) species of non-volant mammals representing 25 individuals from 7 orders and 12 families were documented during the dry season survey. Ten species of non-volant mammals representing 13 individuals from 7 orders and 9 families were documented during the wet season survey.

The most abundant families recorded during the dry season survey were Cervidae, Cebidae and Scuridae, each represented by 2 species. The most abundant species were *Dasyprocta leporine* with 8 individuals, followed by *Potos flavus* with 6 individuals, *Tapirus terrestris* with 3 individuals and *Mazama americana* and *Puma concolor* each with 2 individuals. Five species namely, *Mazama gouazoupira*, *Bradypus tridactylus*, *Cuniculus paca*, *Sciurus aestuans* and *Sciurillus puscillus* were each represented by 1 individual.

The most abundant family recorded during the wet season survey was Cebidae represented by 2 species.

The most abundant species was *Mazama americana* with 4 individuals followed by *Cuniculus paca* with 3 individuals, and *apirus terrestris* and *Pithecia pithecia*, each with 2 individuals. *Dasyopus sp* (armadillo) and *Potos flavus* (kinkajou) were each represented by 1 individual.

The species encountered within the concession are widespread within the lowland forest of the Guiana Shield and Amazonia. The *Tapirus terrestris* (Brazilian Tapir) is listed as Vulnerable by the IUCN Red List. No critically endangered or endangered species, migratory or endemic mammals were recorded. The non-volant mammalian species recorded during the surveys are presented in Table 11.

Table 11: Non-Volant Mammals Recorded Within The Concession

FAMILY	SCIENTIFIC NAME	COMMON NAMES	Recorded in Dry Season	Recorded in Wet Season
Mustelidae	<i>Eira Barbara</i>	Tyra	No	Yes
Cebidae	<i>Aloutta sinclus</i>	Red Howler Monkey	Yes	Yes
Bradypodidae	<i>Bradypus tridactylus</i>	Pale-throated Three-toed Sloth	Yes	No
Megalonychidae	<i>Choloepus didactylus</i>	Two-Toed Sloth	Yes	No
Cebidae	<i>Saimari sciureus</i>	Common Squirrel Monkey	Yes	No
Cebidae	<i>Cebus olivaceus</i>	Wedge-Capped Capuchin	Yes	No
Cebidae	<i>Pithecia pithecia</i>	White-faced Saki	No	Yes
Cervidae	<i>Mazama Americana</i>	Red Brocket Deer	Yes	Yes
Cervidae	<i>Mazama gouazoupira</i>	Amazonian Brown Brocket Deer	Yes	No
Agoutidae	<i>Agouti paca</i>	Labba/Paca	Yes	Yes
Dasyopodidae	<i>Dasyopus sp</i>	Armadillo	Yes	Yes
Dasyproctidae	<i>Dasyprocta leporine</i>	Red-rumped Agouti	Yes	Yes
Felidae	<i>Puma concolor</i>	Puma	Yes	No
Procyonidae	<i>Potos flavus</i>	Kinkajou	Yes	Yes
Scuridae	<i>Sciurus aestuans</i>	Guianan Squirrel	Yes	No
Scuridae	<i>Sciurillus pusillus</i>	Neotropical Pygmy Squirrel	Yes	No
Tapiridae	<i>Tapirus terrestris</i>	Brazilian Tapir	Yes	Yes
Tayassuidae	<i>Unkuaygu</i>	Peccary	Yes	Yes

Three species of bats representing 3 individuals from 2 families, Mormopidae with 1 individual, and Phyllostomidae with 2 individuals, were recorded during the dry season survey. The wet season survey recorded a total of 27 individuals representing 8 species from 3 families – Mormoopidae with 1 species and 2 individuals; Phyllostomidae – Stenodermatinae with 2 species and 2 individuals, Phyllostomidae - Lonchophyllinae with 1 species and 3 individuals, and Phyllostomidae - Carrollinae with 3 species and 14 individuals; and Molossidae with 1 species and 6 individuals.

The family Phyllostomidae was represented by the following sub-families in the dry season survey: Stenodermatinae with 1 individual; and Lonchophyllinae with 1 individual. The species recorded were *Artibeus obscurus* (Sooty fruit eating bat), *Lonchophylla thomasi* (Thomas's nectar bat) and *Pteronotus parnellii* (Greater moustached bat). In the wet season survey the family Phyllostomidae was represented by three sub-families: Lonchophyllinae; Stenodermatinae and Carrollinae. The bat species recorded during the surveys are presented in Table 12.

Table 12: Bat species recorded within the Concession

SPECIES	COMMON NAME	Recorded in Dry Season	Recorded in wet Season
Family: Phyllostomidae			
Sub-Family: Stenodermatinae			
<i>Artibeus obscurus</i>	Sooty fruit eating bat	Yes	Yes
<i>Sturnira lilium</i>	Little yellow shouldered bat	No	Yes
Sub-Family: Lonchophyllinae			
<i>Lonchophylla thomasi</i>	Thomas's nectar bat	Yes	Yes
Sub-Family: Corallinae			
<i>Carollia brevicauda</i>	Silky short tailed bat	No	Yes
<i>Carollia perspicillata</i>	Seba's short tailed bat	No	Yes
<i>Rhinophylla pumilio</i>	Dwarf little fruit bat	No	Yes
Family: Molossidae			
<i>Molossus molossus</i>	Palla's mastiff bat	No	Yes
Family: Mormoopidae			
<i>Pteronotus parnellii</i>	Greater moustached bat	Yes	Yes

5.3.7.1.2.3 Birds

Fifty nine species of birds with 532 individuals belonging to 18 families were recorded during the dry season survey. The wet season survey recorded 43 species with 211 individuals belonging to 20 families. The most species rich and abundant family recorded in the dry season was the Thamnophilidae (antbirds, antshrikes and antwrens) with 20 species representing 117 individuals, followed by Tyrannidae with 8 species and 54 individuals and Psittacidae (parrots, parakeets) with 5 species and 81 individuals.

The most species rich and abundant family recorded during the wet season survey was Thamnophilidae with 16 species representing 61 individuals, followed by the families of Psittacidae with 4 species and 69 individuals, Pipridae with 4 species and 18 individuals, and Tyrannidae with 4 species and 7 individuals.

No critically endangered or endangered bird species were recorded. Two nearctic migrants, the *Coccyzus americanus* (Yellow-billed Cuckoo) and the *Bubulcus ibis* (Cattle Egret), were recorded within the concession. Three species encountered are Guiana Shield endemics: *Myrmeciza athrothorax* (Black Throated Antbird); *Myrmotherula gutturalis* (Brown Bellied Antwren); and *Crax alector* (Black Curassow). The bird species recorded during the survey are presented in Table 13.

Table 13: Bird species recorded within the concession

FAMILY	SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
Accipitridae	<i>Buteo magnirostris</i>	Roadside Hawk	Yes	Yes
Falconidae	<i>Ibycter americanus</i>	Red Throated Caracara	Yes	Yes
Columbridae	<i>Columba plumbea</i>	Plumbeous Pigeon	Yes	Yes
	<i>Patagioenas cayennensis</i>	Pale-vented Pigeon	Yes	Yes
Cotingidae	<i>Lipaugus vociferans</i>	Screaming Piha	Yes	Yes
Cuculidae	<i>Coccyzus americanus</i>	Yellow-Billed Cuckoo	Yes	No
Dendrocolapitidae	<i>Xiphorynchus guttatus</i>	Buff Throated Woodcreeper	Yes	Yes
	<i>Glyphorhynchus spirurus</i>	Wedge-billed Woodcreeper	Yes	Yes
Apodidae	<i>Chaetura spinicaudus</i>	Band-rumped Swift	Yes	Yes

FAMILY	SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
Picidae	<i>Campephilus rubricollis</i>	Red-necked Woodpecker	Yes	Yes
	<i>Celeus elegans</i>	Chestnut Woodpecker	Yes	Yes
Pipridae	<i>Schiffornis turdina</i>	Thrush-like Schiffornis	Yes	Yes
	<i>Lepidothrix coronate</i>	Blue-Crowned Manakin	Yes	Yes
	<i>Pipra erythrocephala</i>	Golden-Headed Manakin	Yes	No
	<i>Corapipo gutturalis</i>	White-Throated Manakin	Yes	Yes
	<i>Dixiphia pipra</i>	White-crowned Manakin	Yes	Yes
Psittacidae	<i>Amazona amazonica</i>	Orange-Wing Parrot	Yes	Yes
	<i>Pionus menstruus</i>	Blue-headed Parrot	Yes	Yes
	<i>Ara macao</i>	Scarlet Macaw	No	Yes
	<i>Brotogeris chrysoptera</i>	Golden-winged Parakeet	Yes	Yes
Cracidae	<i>Crax alector</i>	Black Curassow	Yes	Yes
Ardeidae	<i>Bubulcus ibis</i>	Cattle Egret	No	Yes
Psophiidae	<i>Psophia crepitans</i>	Gray Winged Trumpeteer	Yes	No
Strigidae	<i>Pulsatrix perspicillata</i>	Spectacled Owl	Yes	Yes
Thamnophilidae	<i>Cercomacra cinerascens</i>	Gray Antbird	Yes	No
	<i>Myrmoborus leucophrys</i>	White Browed Antbird	Yes	Yes
	<i>Hypocnemis cantator</i>	Warbling Antbird	Yes	Yes
	<i>Hypocnemoides melanopogon</i>	Black Chinned Antbird	Yes	Yes
	<i>Pithys albifrons</i>	White Plumed Antbird	Yes	Yes
	<i>Myrmeciza longipes</i>	White Bellied Antbird	Yes	Yes
	<i>Myrmornis torquata</i>	Wing Banded Antbird	Yes	No
	<i>Chamaeza campanisona</i>	Short Tailed Anthrush	Yes	Yes
	<i>Grallaricula nana</i>	Slate Crowned Antpitta	Yes	Yes
	<i>Myrmeciza ferruginea</i>	Ferruginous Back Antbird	Yes	Yes

	<i>Thamnomanes caesius</i>	Cinereous Antshrike	Yes	No
	<i>Cercomacra tyrannina</i>	Dusky Antbird	Yes	No
	<i>Hylophylax poecilonota</i>	Rufous-throated Antbird	Yes	Yes
	<i>Dichrozona cinta</i>	Scale-backed Antbird	Yes	Yes
	<i>Myrmeciza athrothorax</i>	Black Throated Antbird	Yes	Yes
	<i>Myrmotherula gutturalis</i>	Brown Bellied Antwren	Yes	Yes
	<i>Myrmotherula schisticolor</i>		Yes	Yes
	<i>Thamnomanes ardesiacus</i>		Yes	Yes
	<i>Thamnophilus murinus</i>		Yes	Yes
	<i>Thamnophilus amazonicus</i>	Amazonian Antshrike	Yes	Yes
Thraupidae	<i>Euphonia violacea</i>	Violeceous Euphonia	Yes	No
	<i>Cyanerpes caeruleus</i>	Purple Honeycreeper	Yes	No
Trochilidae	<i>Phaethornis superciliosus</i>	Long Tailed Woodnymph	Yes	No
	<i>Thalurania furcate</i>	Fork-tailed Woodnymph	Yes	No
	<i>Campylopterus largipennis</i>	Gray Breasted Sabrewing	Yes	Yes
Trogonidae	<i>Trogon rufus</i>	Black-throated Trogon	Yes	Yes
Tyrannidae	<i>Lophotriccus galeatus</i>	Zimmer's Flycatcher	Yes	Yes
	<i>Tolmomyias assimilis</i>	Olivaceous Flatbill	Yes	No
	<i>Rhynchocyclus olivaceus</i>	Whiskered Flycatcher	Yes	No
	<i>Myiobius barbatus</i>	McConnell's Flycatcher	Yes	Yes
	<i>Mionectes macconnelli</i>	White-throated Spadebill	Yes	No
	<i>Mionectes oleagineus</i>	Ochre Bellied Flycatcher	Yes	No
	<i>Euscarthmus meloryphus</i>	Tawny Crowned Pgymy Tyrant	Yes	Yes

FAMILY	SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
	<i>Platyrinchus mystaceus</i>	Yellow-throated Flycatcher	Yes	No

	<i>Knipolegus poecilurus</i>	Rufous Tailed Tyrant	No	Yes
Vireonidae	<i>Hylophilus sp</i>	Greenlet	Yes	No
	<i>Hylophilus muscicapinus</i>	Buff-cheeked Greenlet	Yes	No
Furnariidae	<i>Xenops minutus</i>	Plain Xenops	Yes	No
Cardinalidae	<i>Cyanocopsa cyanooides</i>	Blue-Black Grosbeak	No	Yes
Galbulidae	<i>Galbula albirostris</i>	Yellow-Billed Jacamar	Yes	Yes

5.3.7.1.2.4 Herpetofauna

Seventeen species of amphibians represented by 321 individuals from 6 families were recorded during the dry season survey. The wet season survey recorded a total of nineteen species represented by 632 individuals from 6 families. *Scinax ruber* (Red Snouted Treefrog) was the most abundant species recorded during the dry season with 123 individuals, followed by *Dendrosophus marmoratus* with 44 individuals and *Pseudis paradoxa* with 37 individuals. *Phyllomedusa trinitatis* with 1 individual was the least abundant recorded species followed by *Osteocephalus buckleyi*, *Ctenophryne geayi*, *Ameerega trivittata* each with 2 individuals recorded. *T.resinifictrix* was recorded calling from arboreal bromeliads on trees, and *L. petersii* from the edges of puddles on open roads.

The dominant species recorded during the wet season survey were *Scinax ruber* (214 individuals), and *Hypsiboas crepitans* (82 individuals) of the family Hylidae and *Rhinella marina* (160 individuals) of the family Bufonidae. *Osteocephalus buckleyi* with 1 individual, *Osteocephalus taurinus* with 2 individuals, *Scinax nebulosus* with 2 individuals, and *Ctenophryne geayi* with 2 individuals were the least abundant species recorded during the wet season survey.

The families Hylidae and Leptodactylidae were the most species rich families recorded in the dry season with 9 and 3 species respectively, while the least species rich families were Mircohylidae and Aromobatidae each with 1 species. The families Hylidae and Leptodactylidae were also the most species rich families recorded in the wet season with 9 and 3 species respectively, while the least species rich families were Mircohylidae, Dendrobatidae and Aromobatidae, each with 1 species.

The species assemblage encountered within the concession is typical of the lowland wet forest of Guyana and the wider Guiana Shield and Amazonian lowland forest regions. None of the amphibian species documented are endemic or listed by IUCN Red List. The amphibian species recorded within the concession are presented in Table 14.

Table 14: Amphibians Recorded within the concession

	SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
	AROMOBATIDAE			
	<i>Allobates femoralis</i>	Brilliant-thighed Poison Frog	Yes	Yes
	BUFONIDAE			
	<i>Rhaebo guttatus</i>	Smooth Side Toad	Yes	Yes
	<i>Rhinella marina</i>	Giant Marine Toad	Yes	Yes
	<i>Rhaebo nasicus</i>	Werner's Toad	No	Yes
86	DENDROBATIDAE			
	<i>Ameerega trivittata</i>	Three-striped Poison Arrow Frog	Yes	Yes
	HYLIDAE			
	<i>Hypsiboas boans</i>	Giant Gladiator	Yes	Yes

SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
<i>Hypsiboas crepitans</i>	Rattle-voiced Treefrog	Yes	Yes
<i>Osteocephalus buckleyi</i>		Yes	Yes
<i>Osteocephalus taurinus</i>	Manaus Slender- legged Treefrog	Yes	Yes
<i>Phyllomedusa trinitatis</i>		Yes	Yes
<i>Phyllomedusa bicolor</i>		No	Yes
<i>Pseudis paradoxa</i>	Paradox Frog	Yes	Yes
<i>Scinax nebulosus</i>	Spix's Snouted Treefrog	No	Yes
<i>Scinax ruber</i>	Red Snouted Treefrog	Yes	Yes
<i>Trachycephalus resinifictrix</i>	Cacique-Headed Treefrog	Yes	Yes
<i>Dendropsophus marmoratus</i>	Marbled Treefrog	Yes	Yes
LEPTODACTYLIDAE			
<i>Leptodactylus petersii</i>	Peter's Thin- Toed Frog	Yes	No
<i>Leptodactylus knudensi</i>	Knudsen's Thin-toed Frog	Yes	Yes
<i>Leptodactylus mystaceus</i>	Amazon Basin White-lipped Frog	Yes	Yes
MICROHYLIDAE			
<i>Ctenophryne geayi</i>		Yes	Yes

Ten species of reptiles represented by 61 individuals from 6 families were recorded during the dry season survey. During the wet season survey, 10 species represented by 59 individuals from 7 families were encountered.

Ameiva ameiva (South American Ground Lizard) was the most abundant species recorded in the dry season with 32 individuals followed by *Kentropyx calcarata* with 18 individuals. *Anolis fuscoauratus*, *Gonotodes humeralis*, *Lepasoma sp.*, *Liophis miliaris* and *Paleosuchus palpebrosus* were the least abundant species, each with 1 individual. The families of Polychrotidae, Teiidae and Gekkonidae were the most species rich, each represented by 2 species followed by the families of Alligatoridae, Colubridae and Gymnophthalmidae with 1 species. Interviews with employees at the concession indicated the presence of *Epicrates cenchria*, *Bothrops atrox*, *Micrurus surinamensis* and *Lachesis muta*. These species were not verified by encounters during the dry season survey.

Kentropyx calcarata with 23 individuals was the most abundant species recorded during the wet season survey, followed by *Ameiva ameiva* with 18 individuals. *Anolis fuscoauratus*, *Gonotodes humeralis*, *Thecadactylus rapicauda* and *Pseudoboa coronata* were the least abundant species, each represented by 1 individual. The families of Colubridae, Teiidae and Gekkonidae were the most species rich, each represented by 2 species, followed by the families of Alligatoridae, Scincidae, Viperidae and Polychrotidae, each represented by 1 species.

Paleosuchus palpebrosus is listed as Least Concern by the IUCN Red List. No endemic reptiles were recorded during the survey. The reptilian species recorded within the concession are presented in Table 15.

Table 15: Reptiles Recorded Within the Concession

SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
POLYCHROTIDAE			
<i>Anolis chrysolepis</i>	Goldenscale Anole	Yes	No
<i>Anolis fuscoauratus</i>	Slender Anole	Yes	Yes
TEIIDAE			
<i>Kentropyx calcarata</i>	Striped Forest Whiptail	Yes	Yes
<i>Ameiva ameiva</i>	South American Ground Lizard	Yes	Yes

GEKKONIDAE			
<i>Gonotodes humeralis</i>		Yes	Yes
<i>Thecadactylus rapicauda</i>	Turnip-tailed Gecko	Yes	Yes
GYMNOPHTHALIMIDAE			
<i>Lepasoma sp</i>		Yes	No
SCINCIDAE			
<i>Copeoglossum nigropunctatum</i>	Black Spotted Skink	No	Yes
COLUBRIDAE			
<i>Pseudoboa coronate</i>	Crowned False Boa	No	Yes
<i>Siphlophus compressus</i>	Tropical Flat Snake	No	Yes
<i>Leptophis ahaetulla</i>	Parrot Snake	No	Yes
<i>Liophis miliaris</i>	Common Water Snake	Yes	No
ALLIGATORIDAE			
<i>Paleosuchus palpebrosus</i>	Cuvier's Dwarf Caiman	Yes	Yes
VIPERIDAE			
<i>Bothrops atrox</i>	Labaria	Yes	Yes
<i>Lachesis muta</i>	Bush Master	Yes	Yes
ELAPIDAE			
<i>Micrurus surinamensis</i>	Aquatic coral snake	Yes	No

5.3.7.1.2.5 Macro-Invertebrates

Macro invertebrates were classified to the Order taxa, due to the difficulty of identifying and classifying invertebrates to the species level.

A total of 16 orders of terrestrial macro-invertebrates were recorded during the dry season survey. The most abundant orders, during the dry session, were Acari, Blattidea, Diptera, Hymenoptera, Isoptera, Lepidoptera, Odonata and Orthopterans. The Mantodea, Phasmidae, Hemiptera, Annelida and Lithobiomorpha were the least abundant orders recorded. Decapoda and Gastropoda were the only two orders of benthic macro-invertebrates recorded during the dry and wet season surveys.

A total of 14 taxonomic Orders of macro-invertebrates were recorded during the wet season survey. The

most abundant orders were the Blattidea, Hymenoptera, Diptera, Orthoptera and Isoptera. A significant number of individuals of the Orders Lepidoptera, Acari, Aranea and Callipodida were also recorded during the wet season survey. The macro-invertebrates recorded within the concession are presented in Table 16.

Table 16: Macro-Invertebrates Recorded within the Concession

VERNACULAR NAME	ORDERS	Recorded in Dry Season	Recorded in Wet Season
TERRESTRIAL MACRO-INVERTEBRATES			
Mites and Ticks	Acari	Yes	Yes
Segmented Worms	Annelida	Yes	Yes
Spiders	Araneae	Yes	Yes
Cockroaches	Blattidea	Yes	Yes
Centipedes	Lithobiomorpha	Yes	No
Beetles	Coleoptera	Yes	Yes
Millipedes	Callipodida	Yes	Yes
True Flies	Diptera	Yes	Yes
True Bugs	Hemiptera	Yes	Yes
Bees, Wasp and Ants	Hymenoptera	Yes	Yes

VERNACULAR NAME	ORDERS	Recorded in Dry Season	Recorded in Wet Season
TERRESTRIAL MACRO-INVERTEBRATES			
Termites	Isoptera	Yes	Yes
Butterflies, moths and skippers	Lepidoptera	Yes	Yes
Praying Mantis	Mantodea	Yes	No
Dragon and Damselflies	Odonata	Yes	Yes
Crasshoppers, locusts, crickets and katydids	Orthoptera	Yes	Yes
Stick Insects	Phasmidae	Yes	Yes
BENTHIC MACRO-INVERTEBRATES			
Shrimp and Crabs	Decapoda	Yes	Yes
Snails	Gastropoda	Yes	Yes

5.3.7.1.2.6 Fish

Eighteen species of fish with 72 individuals from 11 families were documented during the dry season survey. The most abundant species were *Astyanax bimaculatus* (Characiformes: Characidae) with 11 individuals, *Pimelodella cristata* (Siluriformes: Pimelodidae) with 11 individuals and *Cichlasoma amazonarum* (Perciformes: Cichlidae) with 10 individuals. These were followed by *Hypostomus sp.* (Siluriformes: Loricariidae) with 7 individuals, *Guianacara cuyunii* (Perciformes: Cichlidae) with 6 individuals and *Hopliasspp.* (Characiformes: Erythrinidae) with 5 individuals.

The least abundant species recorded in the dry season were *Prochilodus nigricans*, *Leporinus spp.*, *Hoplerythrinus unitaeniatus* and *Pimelodus ornatus* each with 1 individual recorded. These were followed by *Callichthys sp.*, *Rineloricaria sp.*, *Crenicichla alta*, *Bryconops sp* and *Roeboides descavadensis* each with 2 individuals recorded. The families Cichlidae and Characidae were the most species rich documented in the dry season with 3 species respectively, followed by the Erythrinidae with 2 species. The orders Characiformes with 29 individuals, Siluriformes with 25 individuals and Perciformes with 18 were the most abundant.

The wet season survey documented a total of 21 species of fish with 89 individuals from 13 families. The most abundant species were *Apistogramma sp.* (Perciformes: Cichlidae) with 14 individuals, *Bryconops colaroja* (Characiformes: Characidae) with 10 individuals, and *Moenkhausia sp* (Characiformes: Characidae) with 13 individuals, followed by *Thoracocharax stellatus* (Characiformes: Gasteropelecidae) with 8 individuals, *Eigenmannia virescens* (Gymnotiformes; Sternopygidae) with 7 individuals, and *Aequidens tetramerus* (Perciformes: Cichlidae) with 4 individuals.

The least abundant species recorded during the wet season survey were *Henonemus taxistigmus*, *Ituglanis cf metae*, *Synbranchus marmaratus*, *Rineloricaria sp*, *Prochilodus sp*, *Poecilia reticulata* and *Phenacogaster sp*, each with 1 individual recorded. These were followed by *Ancistrus leucostictus*, *Moenkhausia chysargyrea*, *Charax gibbous* and *Leporinus sp*, each with 2 individuals recorded.

The families Chiichthysidae with 8 species and Characidae with 5 species were the most species rich documented in the wet season survey, followed by the family Erythrinidae with 3 species. The orders Characiformes with 47 individuals, Siluriformes with 15 individuals, Perciformes with 18 individuals, and Gymnotiformes with 7 individuals were the most abundant documented in the wet season survey.

The fish species recorded have some economic, socio-cultural and ecological value. Several species are aquarium fishes, for example, *Gasteropelecus sternicla*, *Roeboides descalvadensis*, *Prochilodus nigricans* and

Moenkhausia sanctaefilomenae while others like the *Cichlasoma amazonarum* *Guianacara cuyunii* and *Crenicichla alta* are a source of food. Some also assist in ecological functions such as seed dispersal. No endemic or migratory fish species were recorded during the surveys. The fish species recorded in the concession are presented in Table 17.

Table 17: Fish Species Recorded within the Concession

FAMILY	SCIENTIFIC NAME	COMMON NAME	Recorded in Dry Season	Recorded in Wet Season
Characidae	<i>Moenkhausia sanctaefilomenae</i>	Serebe	Yes	Yes
	<i>Roeboides descalvadensis</i>	Scale Eater	Yes	Yes
	<i>Astyanax bimaculatus</i>	Serebe	Yes	Yes
	<i>Moenkhausia</i> sp.	Serebe	No	Yes
	<i>Phenlcoaster</i> sp.	Cacabelly	No	Yes
	<i>Charax gibbous</i>	Broke Neck	No	Yes
	<i>Bryconops colaroja</i>	Cacabelly	No	Yes
	<i>Moenkhausia chysargyrea</i>	Serebe	No	Yes
Curimatidae	<i>Cyphocharax spilurus</i>	Cacabelly	No	Yes
Prochilodontidae	<i>Prochilodus nigricans</i>	Silverfish	Yes	No
	<i>Prochilodus</i> sp.	Silverfish	No	Yes
Iguanodectidae	<i>Bryconops</i> sp.	Red Tail Tetra	Yes	No
Anostomidae	<i>Leporinus</i> sp.	Daray	Yes	Yes
Gasteropelecidae	<i>Gasteropelecus sternicla</i>	Hatchet fish	Yes	No
	<i>Thoracocharax stellatus</i>	Hatchet Fish	No	Yes
Erythrinidae	<i>Hoplias</i> sp.	Huri	Yes	Yes
	<i>Hoplerythrinus unitaeniatus</i>	Yarrow	Yes	No
	<i>Hoplias malabaricus</i>	Huri	No	Yes
Poeciliidae	<i>Poecilia reticulata</i>	Goupy	No	Yes
Sternopygidae	<i>Eigenmannia virescens</i>	Night fish	No	Yes
Cichlidae	<i>Cichlasoma amazonarum</i>	Patwa	Yes	No
	<i>Guianacara cuyunii</i>	Patwa	Yes	No
	<i>Crenicichla alta</i>	Sun fish	Yes	No
	<i>Aequidens tetramerus</i>	Patwa	No	Yes
	<i>Apistogramma</i> sp.	Patwa	No	Yes
Loricariidae	<i>Rineloricaria</i> sp.	Whip tail Catfish	Yes	Yes
	<i>Hypostomus</i> sp.	Smoke Hassa	Yes	No
	<i>Ancistrus leucostictus</i>	Spotted black hassa	No	Yes
Pimelodidae	<i>Pimelodella cristata</i>	Kassie	Yes	No
	<i>Pimelodus ornatus</i>	Ornate Pim Catfish	Yes	No
Heptapteridae	<i>Rhamdia quelen</i>	Kassie	Yes	No
	<i>Pimelodilla</i> sp.	Ornate Pim Catfish	No	Yes
Callichthyidae	<i>Callichthys</i> sp.	Hassa	Yes	No
	<i>Megalechis thoracata</i>	Hassa	No	Yes
Trichomycteridae	<i>Henonemus taxistigmus</i>	Soft Body Catfish	No	Yes
	<i>Ituglanis</i> cf <i>metae</i>	Vandilia	No	Yes
Synbranchidae	<i>Synbranchus marmaratus</i>	Eel	No	Yes

5.3.8 Identification of Potentially Critical Habitat

Species recorded were evaluated to identify whether there are any sensitive species of significance to critical habitat. The five criteria for the assessment of whether a given habitat may be considered a critical habitat are as follows:

- Criterion 1: areas that meet the criteria of the IUCN classification, including habitats required for the survival of critically endangered and/or endangered species (as defined by the IUCN Red List of Threatened Species or National Legislation);
- Criterion 2: areas having special significance for endemic and/or restricted-range species;
- Criterion 3: sites that are critical for the survival of migratory and/or congregatory species;
- Criterion 4: areas with highly threatened and/or unique ecosystems; and
- Criterion 5: areas associated with key evolutionary processes.

For the first three critical habitat criteria numerical thresholds are defined to facilitate decision making. The thresholds form the basis of a tiered approach, in that numerical thresholds are used to assign Criteria 1 through 3 to a Tier 1 or a Tier 2 critical habitat designation. A summary of the tiers with respect to the thresholds for each criterion is provided in Table 18.

Table 18: Quantitative Thresholds for Tiers 1 and 2

CRITERIA	TIER 1	TIER 2
1. Critically Endangered (CR)/Endangered (EN) Species	<p>(a). Habitat required to sustain ≥ 10 percent of the global population of CR or EN species/subspecies where there are known, regular occurrences of the species, and where the habitat could be considered a discrete management unit for that species.</p> <p>(b). Habitat with known, regular occurrences of CR or EN species where the habitat is one of 10 or fewer discrete management sites globally for that species.</p>	<p>(c). Habitat that supports the regular occurrence of a single individual of CR species and/or habitat containing regionally-important concentrations of a Red-listed EN species where that habitat could be considered a discrete management unit for that species/subspecies.</p> <p>(d). Habitat of significant importance to CR/EN species that are wide ranging and/or whose population distribution is not well understood and where the loss of such habitat could potentially impact the long term survivability of the species.</p> <p>(e). As appropriate, habitat containing nationally/regionaly important concentrations of an EN, CR or equivalent national/regional listing.</p>
2. Endemic/ restricted range Species	<p>(a). Habitat known to sustain ≥ 95 percent of the global population of endemic or restricted range species where that habitat could be considered a discrete management unit for that species.</p>	<p>(b). Habitat known to sustain \geq percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment.</p>
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CRITERIA	TIER 1	TIER 2
3. Migratory/Congregatory Species	(a). Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species' lifecycle where that habitat could be considered a discrete management unit for that species.	<p>(b). Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent but < 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for the species, where adequate data are available and/or based on expert judgement.</p> <p>(c). For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for identifying Wetlands of International importance.</p> <p>(d). For species with large but clumped distributions, a provisional threshold is set at ≥ 5 percent of the global population for both terrestrial and marine species.</p> <p>(e). Source sites that contribute ≥ 1 percent of the global population recruits.</p>

For criteria 1 through 3, the Sun and Sand Mining Resources Inc B-45 concession with an area of approximately 50.6 km², depicted in Figure 3, is the “discrete management unit” which defines the area of habitat considered for the critical habitat assessment. According to the criteria, the discrete management unit is the area with a definable boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas.

The B-45 concession is situated just west of the upper reaches of the Ekabago Creek, a main tributary of the Puruni River, within the lower Mazaruni River Basin, and entirely within the wet forest of northwest Guyana as defined by Steege (2000). The concession lies just to the south of the low-lying Cuyuni-Mazaruni watershed divide.

Information and analyses on the status, trends and threats to species of international conservation concern recorded in the concession was taken from the IUCN Red List of Threatened Species. Version 2015-4. (<www.iucnredlist.org>. Downloaded on 02 June 2016).

5.3.9 Critically Endangered (CR)/Endangered Species (EN)

The local conservation status of species within Guyana is set out in the First Schedule of the Wild Life Management and Conservation Regulations, 2013. The First Schedule of the Regulations classifies wild life as Vulnerable, Endangered and Critically Endangered, as guided by the criteria of the IUCN Red List of Threatened Species occurring in Guyana. The IUCN Red List species was therefore used in this analysis. The species of international concern recorded within the concession are provided in Table 19.

Table 19: Species of International Concern Recorded within the Concession

SPECIES	COMMON NAMES	IUCN	CITES
MAMMALS			
<i>Mazama Americana</i>	Red Brocket	DD	II
<i>Tapirus terrestris</i>	Brazilian Tapir	V	I
<i>Aloutta senciculus</i>	Red Howler Monkey	LC	II
<i>Saimiri sciureus</i>	Common Squirrel Monkey	LC	II
<i>Cebus olivaceus</i>	Wedged-capped Monkey	LC	II
<i>Puma concolor</i>	Puma	LC	II
<i>Pteronotus parnellii</i>	Greater moustached bat	LC	-
<i>Lonchophylla thomasi</i>	Thomas's nectar bat	LC	-
<i>Artibeus obscurus</i>	Sooty fruit eating bat	LC	-
BIRDS			
<i>Buteo magnirostris</i>	Roadside Hawk	LC	II
<i>Amazona amazonica</i>	Orange-Wing Parrot	LC	II
<i>Pionus menstruus</i>	Blue-headed Parrot	LC	II
<i>Brotogeris chrysoptera</i>	Golden-winged Parakeet	LC	II
<i>Pulsatrix perspicillata</i>	Spectacled Owl	LC	II
<i>Crax alector</i>	Black Curassow	V	-
<i>Psophia crepitans</i>	Gray Winged Trumpeteer	NT	-
<i>Hypocnemis cantator</i>	Warbling Antbird	NT	-
<i>Myrmornis torquata</i>	Wing Banded Antbird	NT	-
<i>Myrmotherula gutturalis</i>	Brown Bellied Antwren	NT	-
<i>Campylopterus largipennis</i>	Gray Breasted Sabrewing	LC	II
HERPTOFAUNA			
<i>Allobates femoralis</i>	Brilliant-thighed Poison Frog	LC	II
<i>Ameerega trivittata</i>	Three-striped Poison Arrow Frog	LC	II
<i>Hypsiboas boans</i>	Giant Gladiator	LC	II
<i>Paleosuchus palpebrosus</i>	Cuvier's Dwarf Caiman	LC	II
FISH			
<i>Pimelodella cristata</i>	Barbudo	LC	-
PLANTS			
<i>Kereu Silverball</i>		LC	
<i>Ocotea puberula</i>		LC	

PLANTS I: Includes all species in danger of extinction that are, or that can be affected by trade; **CITES II:** species that are not currently in danger of extinction, but may become so in the future. **IUCN Red List:** V – Vulnerable; LC – Least Concern; NT – Near Threatened; DD – Data Deficient

None of the floral species recorded within the concession is listed as endangered or critically endangered by the IUCN Red List. The only endangered or critically endangered plant species listed by the IUCN Red List for Guyana are: *Trichilia surumuensis* (EN), *Aniba rosaedora* (EN), *Viola surinmensis* (EN), and *Vouacapoua Americana* (CR). These species are widespread within their ranges in forest lands of Guyana. *Trichilia surumuensis* is restricted to the Roraima Highlands; the *Aniba* genera occurs widely in Wallaba forest and in mixed forest on white and brown sand; the *Vouacapoua* genera is locally common in mixed forest in the near interior growing in reefs on rocky hills or sandy clay, and in swamp forests on alluvial flats in southeastern Guyana; *Viola surinamensis* are widely distributed and are abundant to frequent in marsh forest, Mora forest and swamp forest. These plant species are not known to occur within the concession.

No critically endangered mammals are known to occur in Guyana. The only endangered mammal listed by the IUCN Red List for Guyana is the giant otter (*Pteronura brasiliensis*). According to Duplaix (1980), the giant otter prefers slow flowing clear black water creeks and rivers, particularly during the dry season, and rivers with low levels of human activity. Low sloping banks with good forest cover and close access to prime fishing areas are preferred by otters. These conditions are not met within the concession. The creeks within the concession appear to have historically been subjected to degradation and contamination from artisanal and small scale mining. *Pteronura brasiliensis* was not recorded during the survey and is not known to occur within the concession.

P. Brasiliensis is endemic to the rainforests and wetlands of South America. The northern extent of its range occurs near, but does not include, the Caribbean Sea, and the southern extent of its range reaches Argentina. The majority of the animals are found in the Brazilian Amazon and the regions immediately bordering this area. In Guyana, there are a number of known localities with stable giant otter populations in the Rupununi Region such as; the Bat Creek, Lower Rewa River, Upper Rewa River, Karanambo, Upper Rupununi River (Duplaix, 2002). Consequently there are far more than 10 discrete management units for the giant otter.

Tapirus terrestris (Brazilian Tapir) is found in lowland regions of northern and central South America, from Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, and Venezuela. This species is considered to be Vulnerable due to an ongoing population reduction as a result of habitat loss, illegal hunting and competition with livestock. Lowland tapir populations seem unlikely to persist anywhere humans occur at densities any greater than 1/km². Even where habitat remains, populations are reduced and dispersed due to the effects of hunting. This is greatly amplified around increasing human populations and settlements within its habitat range.

The only endangered birds species listed in Guyana are: Sun parakeet (*Aratinga solstitialis*); Hoary-throated spinetail (*Synallaxis kollari*); and the Red siskin (*Carduelis cucullata*). All of these birds are associated primarily with savanna or dry forest landscapes (i.e., Rupununi and Sipalawini savannas within Guyana). None of these birds were recorded during the survey and are not known to occur within the landscape region of the project.

Crax alector is listed as Vulnerable by the IUCN Red List. Based on a model of future deforestation in the Amazon basin, and its susceptibility to hunting and trapping, it is suspected that the population of this species will decline rapidly over the next three generations, and it has therefore been uplisted to Vulnerable. The *Crax alector* is widely distributed in the north-central South America.

The bird species *Psophia crepitans* (Gray Winged Trumpeteer), *Hypocnemis cantator* (Warbling Antbird), *Myrmornis torquata* (Wing Banded Antbird), and *Myrmotherula gutturalis* (Brown Bellied Antwren) recorded during the survey of the concession are listed as Near Threatened by the IUCN Red List. Based on a model of future deforestation in the Amazon basin, it is suspected that the population of these bird species will decline rapidly over the next three generations, and have therefore been listed as Near Threatened. These birds are wide ranging and fairly common within their ranges.

P. crepitans is widespread and occurs through Brazil north of the Amazon, west to the Rio Negro, through the Guianan shield forests (French Guiana, Suriname and Guyana), South West Venezuela and just into extreme South East Colombia. *H. cantator* occurs in the Guiana Shield of northern South America, and is generally fairly common. Its distribution just reaches extreme east-central Venezuela, where it is found in north-western Bolívar. It ranges from there through Suriname, Guyana and French Guiana, being especially frequent in the latter two, to north-east Amazonian Brazil, where it ranges from the lower Rio Negro eastwards to Amapá. *M. torquata* occurs in the eastern foothills of the Andes and in Amazonia in southern

Colombia, North East Ecuador, Peru north of the Amazon, South East Venezuela, Guyana, Suriname, French Guiana, and in Brazil. *M. gutturalis* occurs across the Guiana Shield region of northern South America, and is fairly common throughout its range.

The only fish and non-avian reptiles listed as endangered or critically endangered by the IUCN Red List for Guyana are marine species that are not present within the Cuyuni-Mazaruni Basin. No endangered or critically endangered amphibians are known to occur in Guyana.

5.3.10 Endemic/Restricted Range Species

There is no clear picture of endemism in Guyana. Guyana is no phylogeographic entity in itself but is part of the Guiana Shield. Local plant endemism is often associated with such habitats as white sands, serpentine rock, swamps, igapo, verzea, rock outcrops and cloud forest (Gentry, 1992). As such, concentrations of endemics in Guyana can be expected in the white sands area and the Pakarima Highlands (Steege, 2000).

The concession is located in the tropical lowland wet forest of northwest Guyana with elevations ranging between 10 m – 400 m. According to Steege (2003), the lowland rain forest on brown sandy soils, loams, or laterites is the major vegetation type of the Amazon Valley and the Guiana Shield. The lowland eco-region is biogeographically distinct from the Guiana Shield Highland centers of endemism.

True Guyana endemics Wamara (*Swartzia leiocalycina*) and Marishiballi (*Licania buxifolia*), and the Guiana Shield endemics the Common Baromalli (*Catostemma commune*), the Black Kakaralli (*Eschweilera sagotiana*), Mora (*Mora excelsa*), Morabukea (*Mora gonggrijpii*), Ituri Wallaba (*Eperua grandiflora*) and Soft Wallaba (*Eperua falcate*) were recorded within the concession.

Swartzia, *Licania*, *Eschweilera* are typical Guianan lowland genera and are common throughout the lowland forest of Guyana. *Swartzia* is more common in central to east Guyana (Steege 1998). According to Huber (1995), the dry land forest of the Northwest District of Guyana and eastern Venezuela are characterized by a high abundance of *Catostemma commune* and other species such as *Eschweilera sagotiana*. Upland forest dominated by *Eschweilera*, *Licania* and *Catostemma* continue far into Venezuela (Huber, 1995). *C. commune* is also reported to be frequent to abundant in mixed forest and mora forest occurring in the Essequibo and Cuyuni River Basins (Steyermark, 1987). Poor Mono-dominant stands of *Mora gonggrijpii* are found on the more clayey soils between the Cuyuni and Mazaruni. *Mora gonggrijpii* dominated stands are also found in the eastern parts of Venezuelan Guyana. *Mora excelsa* also have a uniquely high dominance within clayey soils (Steege, 2000).

The Tier 1 sub-criteria for critical habitat for endemic or restricted range species is that the habitat is known to sustain at least 95% of the global population of the species. None of the endemic species recorded qualify the concession as a Tier 1 Critical Habitat under Criterion 2.

The Tier 2 critical habitat sub-criterion for endemic species is that the habitat includes at least 1 percent of the global population of the species in question. The concession is approximately 50.6 km², which would require that the extent of occurrence of the endemic species recorded in the area does not exceed 5,060 km². Based on available information, the distribution of the endemic species recorded is likely to be far greater than 53,800 km² (approximate area of the Cuyuni-Mazaruni basin), and therefore does not qualify the concession as Tier 2 Critical Habitat for endemic plants.

The Guiana Shield has a variety of landscapes scattered throughout the region and includes sandstone tepuis, granite inselbergs, white sands, seasonally flooded tropical savannas, lowlands with numerous rivers, isolated mountain ranges, and coastal swamps, each supporting a characteristic vegetation (Huber et al., 1995, Huber, 1995b). The highlands of the Shield have flora and fauna with numerous endemic species. Some tepui endemic species occur at elevations as low as 300 m, with increasing numbers at elevation of 1500 m to 1800 m, and fully developed communities occurring above elevation 2000 m (Funk

and Berry, in press).

According to Lim et al (2005), there are fifteen mammalian lowland endemic species of the Guiana Shield Region, five of which have restricted distribution occurring in areas outside of Guyana. The other lowland endemics of the Guiana Shield are more widely distributed and include *Lasiurus atratus*, *Ateles paniscus*, *Pithecia pithecia*, *Neacomys dubosti*, and *Isothrix sinnamariensis*. Nine species are endemic to, but found throughout, the Guiana Shield: *Didelphis imperfecta*, *Monodelphis brevicaudata*, *Lophostoma schulzi*, *Neacomys guianae*, *N. paracou*, *Oecomys auyantepui*, *O. rex*, *O. rutilus*, and *Sphiggurus melanura*. One endemic species (*Proechimys hoplomyoides*) is restricted to lowland and highland regions of the western Guiana Shield. There are five endemic marsupials; *Didelphis imperfecta*, *Marmosa tyleriana*, *Monodelphis brevicaudata*, *Monodelphis reigi*, and *Philander* sp.; and two primates, *Ateles paniscus* and *Pithecia pithecia*. None of these species were recorded within the concession during the survey.

The Checklist of the Terrestrial Vertebrates of the Guiana Shield identified six species of bats endemic to the Guiana Shield; *Artibeus* spp. (unidentified), *Lonchorhina fernandezi*, *Lophostoma schulzi*, *Lasiurus atratus*, *Molossus barnesi*, and *Platyrrhinus aurarius* (Hollowell and Reynolds, 2005). *Artibeus obscurus* was recorded in the concession. This species is listed as Least Concern by the IUCN Red List due to its wide distribution, presumed large population, and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category.

Artibeus obscurus is found east of the Andes in southern Colombia and Venezuela, eastern Ecuador, Peru, Bolivia, and into the adjacent portions of the Guianas and most of Brazil even to Santa Catarina state. The B-45 concession does not qualify as a Tier 2 Critical Habitat for the species *Artibeus obscurus* since the range for the species extends far beyond the Cuyuni-Mazaruni Basin which is approximately 53,800 km². Under IFC PS 6, a restricted-range terrestrial vertebrate species is defined as species which have an extent of occurrence of 50,000 km² or less.

Based on Braun's (2000) endemism classification system, 3 bird species encountered within the concession are Guiana Shield endemics: *Myrmeciza athrothorax*, Black Throated Antbird; *Myrmotherula gutturalis*, Brown Bellied Antwren; and *Crax alector*, Black Curassow. The concession does not qualify as a Tier 2 Critical Habitat for the endemic birds recorded since the range for the species extends far beyond the Cuyuni-Mazaruni Basin which is approximately 53,800 km².

Most of the Guianas endemic amphibians are largely restricted to the Guiana Shield highlands, generally closely associated with the Tepui formations (Senaris and Mac Culloch, 2005). Some amphibian endemic species occur at relatively low elevations, and these tend to have wider distributions than do highland endemics. Amphibian species endemic to the Guyana lowlands are; *Stefania evansi*, endemic to Guyana at 20-890 m elevations; and *Anomaloglossus kaiei*, endemic to Guyana at 150-900 m elevation. None of these species were recorded in the concession.

As is the case with other vertebrate fauna, most of the endemic reptiles are restricted to highland areas (Senaris and Mac Culloch, 2005). A list of Guiana Shield reptiles (De Avila-Pires, 2005) provides the species considered endemic. Perusal of the list revealed the following Guyana endemics:

- *Amphisbaena stejnegeri* – known only to occur in Demerara, Vreed-en-Rust;
- *Arthrosaura guianensis* – known only to occur in Mount Ayanganna, and Pakaraima Mountains; and
- *Echinosaura sulcarostrum* – known only from Baramita.

These three reptilian species are Not Evaluated (NE) by the IUCN Red List and were not recorded in the

concession.

According to an updated List of freshwater fish species endemic to Guyana by Vari et al, (2009), a total of eighty four (84) freshwater fish species are endemic to Guyana. The majority of the listed species are found

in the highlands of the Guiana Shield, especially in the Potaro River basin, or in the Rupununi Savannas region. Review of this list against the fish species recorded in the concession revealed no endemic fish species.

The biodiversity of the invertebrate communities of the Guiana Shield region is extremely poorly known (Lavelle, 2003). The invertebrate Orders Hymenoptera (Family-Formicidae, ants); Lepidoptera (butterflies); and Opisthoptora (earthworms) are estimated to have high endemism within the Guiana Shield region (Lavelle, 2003). Earthworms were estimated to exhibit a very high degree of endemism as depicted in Table

20. According to Lavelle (2003), many species of the invertebrates groups exhibiting extremely high rates of endemism are likely to disappear from areas as deforestation progresses and endemic species are largely eliminated.

Table 20: Estimated Species Richness In Eight Groups Of Invertebrates In The Guiana Shield Region.

Adopted from Lavelle. (2003).

ND – No Data

TAXA	WORLD	GUIANA SHIELD (EXPECTED)	ENDEMIC (ESTIMATED)	ENDANGERED
Order Lepidoptera: Family Sphingidae (hawkmoths)		95	16	ND
Family Apidae: Genus Meliponinae (Stingless bees)	500	90	10	ND
Order Hymenoptera: Family Vespidae (Social Wasps)	1000	200	12	ND
Order Isoptera (Termites)	400	225	10	ND
Order Hymenoptera: Family Formicidae (ants)	7000	1500	300	ND
Order Lepidoptera (Butterflies)	15000	1500	150	20
Order Odonata (Dragon Flies)	5600	240	ND	ND
Order Opisthoptora (Earthworms)	7000?	2000	1900	Many

Restricted terrestrial vertebrates are species with an extent of occurrence of 50,000 km² or less. While there are a number of terrestrial vertebrate species that are broadly endemic to the Guiana Shield region, none of the Guiana Shield endemics or the Guyana lowland endemics known to occur in the concession have ranges that can be considered restricted.

5.3.11 Migratory and Congregatory Species

The interior lowlands of Guyana are not known to be critical habitats for migratory or congregatory species. Unlike the Atlantic Coastline of the North West District of Guyana (Shell Beach Area), which supports the nesting and foraging grounds of migratory sea turtles and birds such as the Scarlet Ibis (*Eudocimus ruber*), the B-45 concession does not include any significant habitat areas known to assemble congregatory or migratory terrestrial species. Two nearctic migrants, the *Coccyzus americanus* (Yellow-billed Cuckoo) and the *Bubulcus ibis* (Cattle Egret), were recorded within the concession. The conservation status of these birds is listed as Least Concern by the IUCN Red List.

The Puruni River serves as the major drainage conduit of the concession area. The Puruni River forms part of the river system of the Mazaruni River Basin that drains to the Essequibo River. The Essequibo River

drainage basin is seasonally linked to the Amazon drainage when the flooded savannas of the Rupununi form a continuous expanse of water between the tributaries of the Rio Branco and the Rupununi River (Watkins et al, 2004). The Puruni and Mazaruni River Basins therefore connect the Amazonia aquatic

systems via the Essequibo River, thereby serving as biological corridors linking to the Amazon Basin. There are however, no known studies or records of migratory species from the Puruni River.

5.3.12 Unique Assemblage of Species and Key Evolutionary Processes

The concession forms part of the lowland forest ecosystems typical of the lowland forests habitats of Guyana, and is part of the lowland forests of the Guiana Shield Region and the Amazon Basin. Even though these lowland forests may have heterogeneity in the nature of soils, they are present across the lowland forests of Guyana and therefore do not have significant transitional habitats that may have potential importance for key evolutionary processes such as speciation.

Unlike the Guiana Shield Highlands centres of endemism occurring at elevations of 1500 m or more, the lowland forests habitat of the concession are characterized by biota that is widespread throughout lowland forest habitats of Guyana, the Guiana Shield and Amazonia. As a result, there are no ecological features/functions or ecosystem services characteristic of the concession which are not replicated across the Guiana Shield, Amazonia and Guyana lowland forests.

6.0 DESCRIPTION OF THE SOCIAL ENVIRONMENT

A zone of influence or study area for the project was determined that took into consideration all possible interactions and impacts due to the project even if they are to relatively far away communities. The Zone of Influence has been thus defined as the physical radius to which the project footprints or impacts may potentially extend.

There are no formal or established communities or settlements in the immediate vicinity of the proposed Project site, and no established communities in proximity to associated project components. Hence, due to its remote location, the Project does not involve the types of direct socio-economic effects characteristic of most mining projects.

Given the lack of communities in the area of direct influence of the project, the social baseline was developed looking at a broader area where possible interactions and impacts of the Project on formal settlements/communities were likely to occur, even if relatively far from the main Project components. The zone of indirect influence for the socio-economic baseline study was determined using this logic. For example, there are certain communities which are likely to serve as entry points to the Mine site for project logistics and for the transport of goods, services and workers. Hence, Itaballi and Bartica were considered to be in the area of indirect influence. Potentially vulnerable communities, such as the Amerindian communities in the Middle Mazaruni area, were not included, since there are no direct links between the Project access road and these communities.

The socioeconomic baseline was conducted to establish: (i) dominant uses of land and other resources for subsistence and livelihood activities, such as farming, fishing, hunting and mining practices; (ii) presence of infrastructure such as schools, medical facilities, communications network/transport networks and markets; (iii) public health issues in terms of health risks and diseases; (iv) local institutional capabilities;

(v) land ownership patterns; (vi) identification and characterization of community cohesion and management; and (vii) identification of existing and proposed development plans for the study area. Consultations and field work were done with the relevant stakeholders to compile the baseline.

To achieve these objectives the following four data collection methods were employed:

- review and update of secondary data (reports, legislation, etc.);
- visit and consultations with the communities/villages of Itaballi, Kartabo and Bartica.

The socioeconomic baseline was compiled based on a review of documents available in the public domain coupled to community specific data obtained by visits to communities within the Project Area of Influence. A questionnaire was administered to residents of potentially impacted communities during site visits to enhance data obtained during public consultation meetings. The questionnaire was designed to capture socio-economic and socio-cultural information for the communities within the Project Area of Influence. It also sought to acquire data on dominant land uses and utilization of other resources for subsistence and livelihood activities in each community. Data was also compiled to determine individuals who have constantly lived in the area, people who recently moved into the area and people who enter the area periodically for work and other purposes.

The visit to each community was also used to confirm social infrastructure such as schools, medical facilities, communications/transport networks and markets available in each community. Public health issues, relevant to each community as evidenced by anecdotal information acquired by the field visits were also noted. The status of each community and the local administrative and institutional capacity, land

ownership patterns and identification and characterization of community cohesion and management were also established. Discussions with communities also identified the attachment of the communities to the proposed mining development.

Demographic and other data compiled by the Guyana Bureau of Statistics were reviewed for Region 7. The information available at the Bureau of Statistics was compiled based on surveys done in 2002 and 2012. While published data is available for both surveys, the 2012 results are indicative of the aggregated report released. The percentage increase between the time of the 2002 census and the end of 20012 was used to infer population increases in the communities which serve as way stations to the mine site and in other communities within proximity of the proposed mine site.

6.1 Mine Site

The Project Site is located in Region 7. There are no established and/or traditional villages within the project area. Employees of Sun and Sand are present at the site. Transient miners infrequently pass through the area.

6.1.1 Access Roads and Project Roads

The proposed mine is accessible both by road and by air. The road to the site originates at Itaballi on the west bank of the Mazaruni River and passes thru Aremu on its way to the mine site. The mine site is also accessible by air from Ogle. Way station communities to the mine site are consequently Bartica and Itaballi in Region 7. There are several roads within the project area which were constructed during previous mining operations and for current exploration activities.

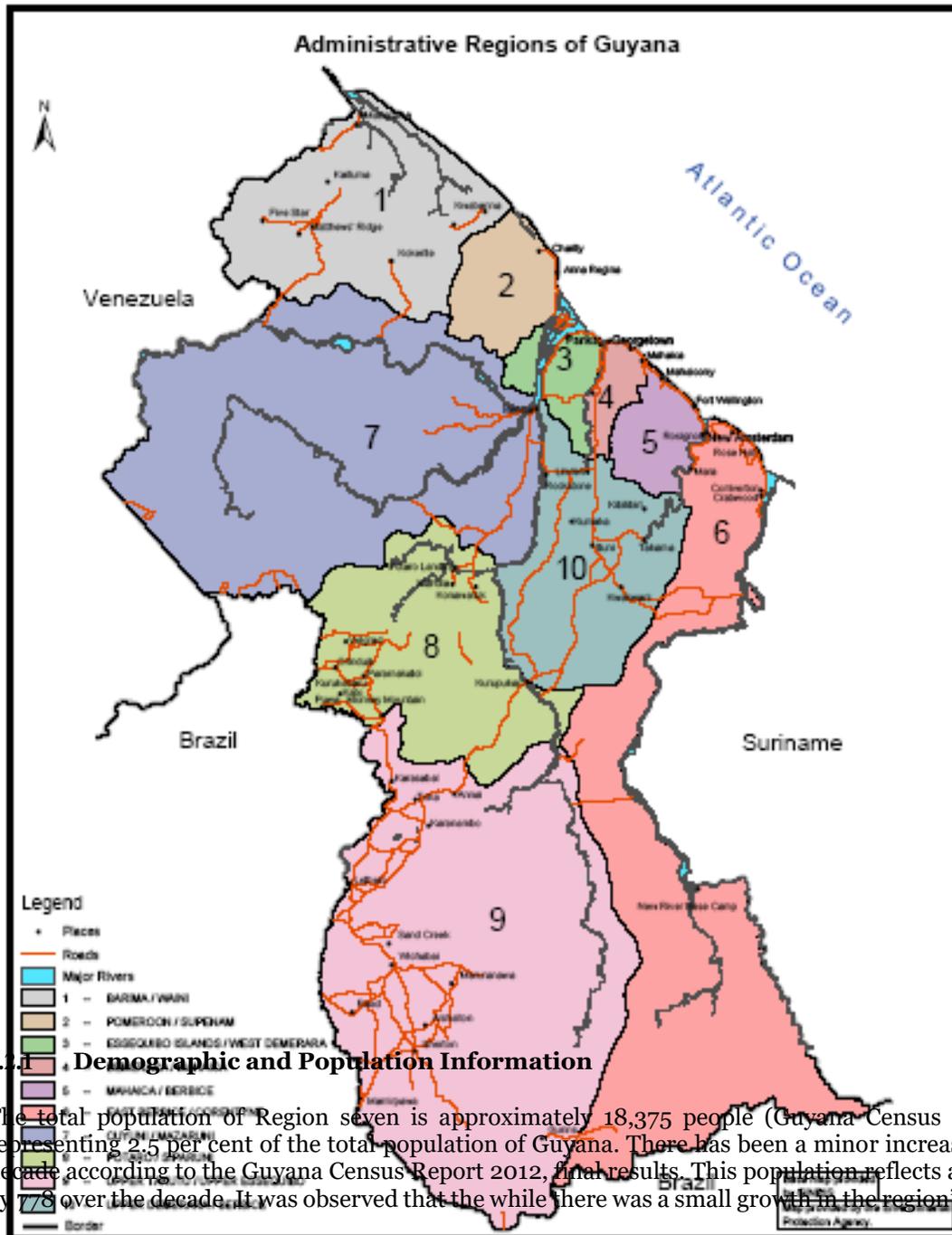
6.2 Profile of Region 7 Cuyuni-Mazaruni

Guyana has ten administrative regions (Figure 27). Each of Guyana's ten administrative regions has a Regional Democratic Council (RDC) and a regional chairman. This system of local government is designed to decentralize government functions and to provide each region with administrative responsibilities to serve the interest of that region. In Region 7, the RDC is located in Bartica, which is not easily accessible by most indigenous communities. As a result, the RDC has three sub-regions; Upper, Middle and Lower Mazaruni Sub-regions. The project area of influence lies within the Middle Mazaruni Sub-region. The mine site is located within the Middle Mazaruni Sub-region with a District Administrative Centre located at Kamarang.

Region 7 is well known for its gold mining activities. Gold mining has always been an economic pillar for Guyana, even though Region 7 has seen little of this gold wealth re-distributed in local communities. As such, subsistence farming, fishing, hunting, and employment in logging and mining businesses are the main sources of livelihoods in the Region. Generally, cost of living in this Region is extraordinarily high, and is estimated to be almost one and a half times that on the coast (Guyana Living Standards Survey, 1999).

One of the root causes of the high cost of living is the high freight costs associated with the relative geographic isolation of the area, compounded by the difficulty in traversing the terrain. This high cost of living has negatively impacted the availability of government officers (teachers, health workers, nurses, etc.). Most government employees are not adequately compensated to remain for long periods in the area. Generally, Amerindian subsistence economies are gradually integrated into cash economies through mining and logging activities.

Figure 27 - Administrative Regions of Guyana



6.2.1 Demographic and Population Information

The total population of Region seven is approximately 18,375 people (Guyana Census Report, 2012), representing 2.5 per cent of the total population of Guyana. There has been a minor increase over the last decade according to the Guyana Census Report 2012, final results. This population reflects a minor growth by 778 over the decade. It was observed that the while there was a small growth in the region's population,

the male gender continues to increase significantly over the females reflecting a ratio of 53:47(Guyana Census Report 2012, final result).

Amerindians are the fourth largest ethnic group in Guyana and make up about 10.5% of the total Guyanese population. Amerindians account for 37.2 per cent of the Region 7 population. Between 1980 and 2012, the Amerindian population of Guyana grew from 40,343 to 78,492. This represents an increase of 94.6 per cent. The population of Region 7 rose modestly by 4.4 per cent between 1980 and 2012. The population density is estimated at 0.4 persons per square kilometer, compared to the national average of approximately 3 to

3.5 persons per square kilometer, which suggests that the land area in Region 7 is sparsely populated (Guyana Census Report, 2012).

Based on information obtained from the Ministry of Indigenous Peoples Affairs, there are twenty-three (23) Amerindian communities in Region 7. These communities are scattered throughout the three sub-regions of Upper, Middle and Lower Mazaruni. The communities are identified in Table 21 below, which provides additional information on the estimated population of each community.

In addition to the Amerindian communities identified in Table 21, additional communities in Region 7 include mixed communities at Kartabo and Itaballi. Both are located on or within proximity of the access road to the mine site. The populations of Itaballi and Kartabo are 262 and 250 persons respectively.

Table 21: Amerindian Communities in Region 7

(Source: Bureau of Statistics, 2007)

NAME OF COMMUNITY	POPULATION	STATUS
Arau	125	Titled
Chinoweing	286	Titled
Jawalla	1023	Titled
Kaburi	250	Titled
Kurutuku	114	Titled
Mosapai/Kaikan, Upper Mazaruni	227	Titled
Warawatta	152	Titled
Pauima	432	Titled
Phillipai	182	Titled
Waramadong	648	Titled
Isseneru, Middle Mazaruni	122	Titled
Karrau Creek, Essequibo River	190	Untitled
Tassarene	79	Untitled
Kambaru, near Imbaimadai - Upper Mazaruni	87	Untitled
Wax Creek	142	Untitled
Warrawatta	152	Untitled
Serenamu-Pashenamu, Middle Mazaruni	131	Untitled
Tashareng/Issano, Middle Mazaruni	62	Titled
Enachu	30	Untitled
Kurupung	319	Untitled
Oranapai	1	Untitled

Information for Region 7 indicates that of the 5,021 households, 78.6 % are headed by males. In communities identifiable as indigenous communities, approximately 90 percent of households are headed by males. In excess of 62 percent of the head of households of Region 7 has been educated to above secondary school

level compared to approximately 47.5 percent of the indigenous head of household population of that region. A summary of the highest qualification level and of the number of head of households attaining that level in Region 7 is detailed in Table 22.

Table 22: Qualification Level Attained by Head of Household – Region 7

Educational Level	Attained by Number of Head of Households
None	2419
Primary	374
Junior Cambridge	20
GCE O' Level/CXC	177
GCE A' Level/CAPE	5
Higher School Certificate	2
Cert/Dip (Tertiary)	422
Bachelor's	19
Post Graduate	2
Other	13

The breakdown of Region 7 population by age is detailed in Table 23. The projection of the population data to the end of 2012 is also detailed in the Table 23. The percentage of school age individual (4 – 24 years old) attending school in Region 7 is approximately 62.3 percent. In indigenous communities the percentage of school age individuals actually attending school is approximately 65.3 percent. Employment levels reported in 2002 for Region 7 are relatively high when compared to the national average. In excess of 90 percent of the labor force in Region 7 was employed at the time of the survey. In the indigenous communities employment levels were reported to be approximately 88.5 percent in 2002.

Table 23: Breakdown of Region 7 Population by Age Range.

Age Range (Years)	Population 2002 Census	Population 2012 Census
Under 10	4975	4408
10 - 19	3292	3911
20 - 29	2684	3059
30 - 39	2326	2509
40 - 49	1554	2044
50 - 59	805	1373
60 - 64	392	353

The major industry groups in Region 7 and the number of individuals employed by the respective industry group are detailed in Table 24. These numbers are reflective of numbers provided in the 2002 Census. Similar information is not available for the 2012 Census.

Table 24: Industry Group and Persons Employed in Region 7

Industry	No. of Persons Employed
Agriculture, Hunting & Forestry	1,528
Fishing, Operators of Fish hatchery & Fish farms	25
Mining and Quarrying	1,410
Manufacturing	293
Electricity, Gas, Steam & Hot Water Supply	36
Construction	214
Wholesale & Retail Trade; Repair of Vehicles	633
Hotel and Restaurants	171
Transport Storage and Communication	311
Financial Intermediation	21
Real Estate, Renting & Business Activities	61
Public Admin & Defense; Compulsory Soc Sec	250

Education	285
Health & social work	115
Other Community, Soc & Personal Activities	223
Private Households with Employment	98
Extra-Territorial Organization & Bodies	0

The Bureau of Statistics also compiled data on the employment categories in Region 7. A breakdown of the employment categories for 2002 is detailed in Table 25. Similar data for 2012 is not available from the 2012 Census.

Table 25: Employment Category Region 7 - 2002

Employment Group	No. of Individuals
Legislators , Senior Officials & Managers	134
Professionals	41
Technicians & Associate Professionals	351
Clerks	174
Service Workers, Shop & Market Sales Workers	724
Skilled Agricultural & Fishery Workers/Farmers	1,346
Craft and Related Trades Workers	929
Plant & Machine Operators & Assembler	447
Elementary Occupation	1,532

The compilation of health data indicating disease occurrences in Region 7 for 2013 – April 2016 is detailed in Table 26 below. This information is based on cases that have been referred to the Bartica Hospital from nearby villages. The data above indicates that Skin infections followed by malaria are the most prevalent disease in Region 7 over the past two and a half years.

Table 26: Occurrences of Illnesses in Region 7

(Source: Regional Hospital – Region 7 Bartica)

DISEASES	Summary of Occurrences						
	ALL AGES	UNDER 5	5 - 14	15-19	20 - 44	45-64	65+
Diabetic	3510	-	-	-	920	1490	1100
Hypertension	3994	-	-	-	1548	1326	1120
Malaria	4633	-	120	920	1120	1999	474
Arthritis Rheumatism	139	-	-	-	-	118	21
Skin Infections	545	1246	1575	1820	670	490	

The communities in the project area of influence are Bartica, Itabali and Kartabo. Bartica has been a major hub for providing services for the interior since the 1880's. It is also the home of the Regional Democratic Council office, responsible for carrying out legislative and community services to Region 7. Itabali, located approximately six miles from Bartica on the West Bank of the Mazaruni River, serves as an access point to the proposed mine site. Kartabo, on the lower side of the Mazaruni is a small village approximately 6 miles from Bartica.

6.3.1 Bartica

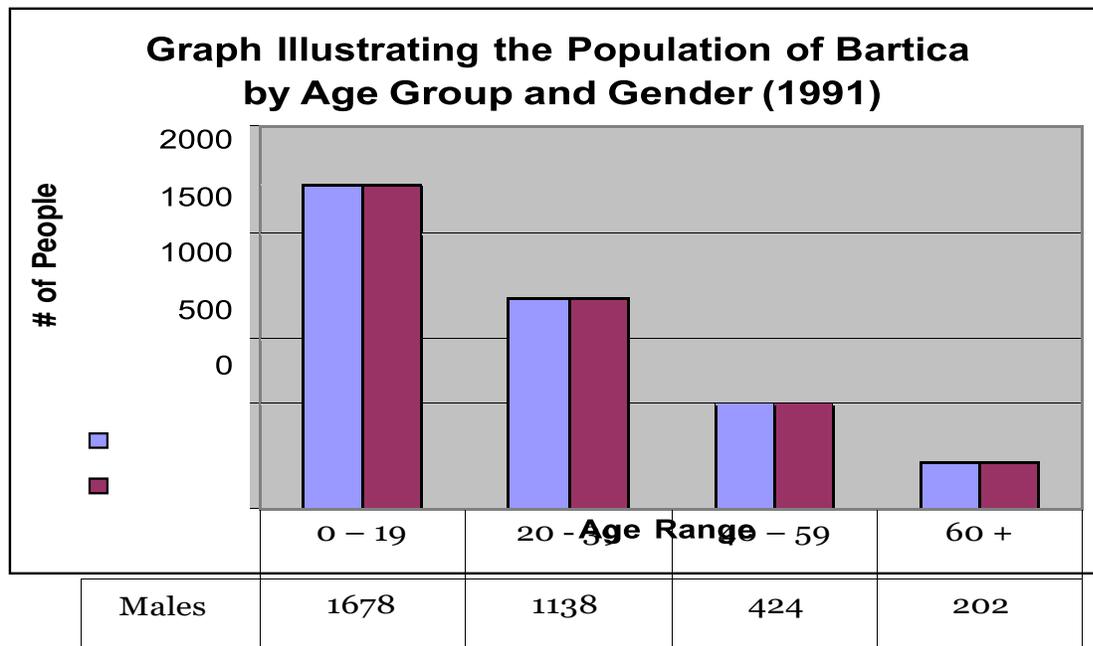
Bartica is located on the right bank of the Essequibo River approximately 160 km northeast of the proposed mine site. Bartica sits on the site of the old “Vryheid” Dutch Plantation that was established in 1678 by the Dutch West India Company. The first permanent structure, in Bartica, was established in 1829 by the Church Missionary Society. However because of the unsuitability of the soil for agriculture, the mission moved eastwards for about a mile to a place called Bartica Grove (the current site of Bartica), at the confluence of the Essequibo, Mazaruni and Cuyuni Rivers.

In 1887, the land was repossessed with permission from the Court of Policy to lay the foundation for a future town in the hinterland and several lots were laid out and sold at a public auction. However, it was the rise of the gold industry in the 1880s which really give impetus to the development and growth of Bartica as it was an ideal location in terms of accessibility to Georgetown, as well as the gold fields and the timber grants. Bartica also served as a major recruitment point for laborers and a number of service oriented businesses sprang up in the town to cater for the needs of the miners and woodcutters. Finally, government departments were established to monitor and control the gold industry.

Bartica is central to the development of Region 7, not only because of its antiquity but because of its economy. On May 7th, 2016, Bartica was officially given Township Status and the rights accorded thereto including subsequent election of a mayor and town councilors. Bartica has also been identified to serve as a model for implementation of concepts related to the development of a green economy.

6.3.2 Population

Based on information compiled by the 2002 census, Bartica has a total population of 7458 persons compared to a population of 6908 in 1991. Amerindians accounted for approximately 4.1 per cent of Bartica population in 2002. Based on the projections of the Bureau of Statistics, the population of Bartica at the end of 2006 equated to approximately 7600 persons. The average household size was 5. As Figure 28 indicates, Bartica has a very young population, with approximately 50 percent below twenty years old, and about 33 percent between the ages of twenty and thirty-nine years.



Females	1743	1109	431	183
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Figure 28 - Population of Bartica

Bartica's population comprises four major ethnic groups, namely, Mixed (59.2%), African/Black (20.4%) East Indian (15.9%) and Amerindian (4.1%) as illustrated in Figure 29. In addition, a sizeable portion of Brazilians reside at Bartica and are allowed to operate a number of establishments (shops and restaurants).

In excess of 72 percent of the head of households of Bartica have been educated to above secondary school level. A summary of the highest qualification level and of the number of head of households attaining that level in Bartica is detailed in Table 27.

Table 27: Qualification Level Attained by Head of Household – Bartica

Educational Level	Attained by Number of Head of Households
None	1141
Primary	141
Junior Cambridge	16
GCE O'Level/CXC	115
GCE A'Level/CAPE	2
Higher School Certificate	1
Cert/Dip (Tertiary)	98
Bachelor's	12
Post Graduate	2

The breakdown of Bartica population by age is detailed in Table 28. The projection of the population data to the end of 2006 is also detailed in the Table 28. The percentage of school age individuals (4 – 24 years) attending school in Bartica is approximately 66.4 percent.

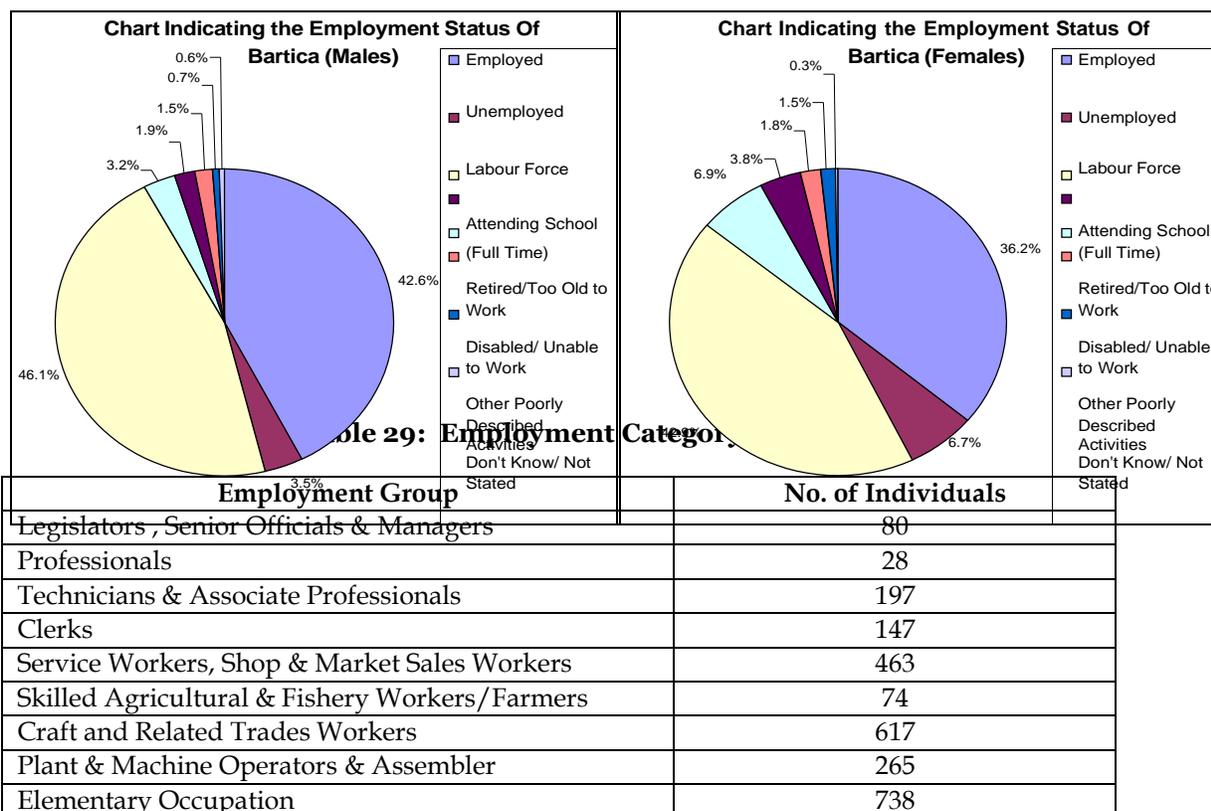
Table 28: Breakdown of Bartica Population by Age Range.

Age Range (Years)	Population	Projected Population end of 2006
Under 10	1932	1969
10 - 19	1506	1535
20 - 29	1294	1319
30 - 39	1127	1148
40 - 49	748	762
50 - 59	336	342
60 - 69	263	268
70 - 79	166	169
80 +	69	70

Employment levels reported in 2002 for Bartica are relatively high when compared to the national average. In excess of 89.5 percent of the labor force in Bartica was employed at the time of 2002 survey. The unemployment rate in Bartica is approximately 7.6 % for males and 15.6 % for females. Figure 29 provides more details of employment levels by gender for Bartica.

The Bureau of Statistics also compiled data on the employment categories in Bartica. A breakdown of the employment categories for 2002 is detailed in Table 29.

Figure 29 - Gender Employment Levels in Bartica



The major industry groups in Bartica and the number of individuals employed by the respective industry groups are detailed in Table 30.

Table 30: Industry Group and Persons Employed in Bartica

Industry	No. of Persons Employed
Agriculture, Hunting & Forestry	98
Fishing, Operators of Fish hatchery & Fish farms	5
Mining and Quarrying	618
Manufacturing	166
Electricity, Gas, Steam & Hot Water Supply	34
Construction	192
Wholesale & Retail Trade; Repair of Vehicles	441
Hotel and Restaurants	135
Transport Storage and Communication	237
Financial Intermediation	21
Real Estate, Renting & Business Activities	49
Public Admin & Defense; Compulsory Soc Sec	171
Education	155
Health & social work	80
Other Community, Soc & Personal Activities	143

Private Households with Employment	60
Extra-Territorial Organization & Bodies	0

6.3.3 Economic Activities

Review of Table 30 indicates dominant economic activities for males in Bartica are related to craft and related trades, elementary occupation, plant and machine operators and assemblers, and service and market sales workers and shops, respectively. On the other hand, most females are engaged in economic activities in areas such as service and market sales, workers and shops, elementary occupation, technicians and associate professionals, and clerks.

6.3.4 Social Infrastructure

Currently, Bartica has the following social amenities:

- one secondary school;
- three primary schools;
- several nursery schools;
- a community centre;
- a police station;
- a library; and
- a hospital

Others social amenities include:

- a regional transportation workshop;
- the office of the Regional Democratic Council of Region 7;
- two commercial banks; and,
- several places of worship

The Hope Foundation, an HIV/AIDS NGO operates in Bartica and provides education and public awareness on HIV/AIDS and related issues. Bartica has historically been considered as low crime community, with crimes in the area being predominantly petty crimes (for examples, stealing) with few isolated cases of rape and murder. The relative calm was however shattered on the evening of February 16th 2008 when Bartica was invaded by a heavily-armed gang. The invasion resulted in the death of twelve persons, including three policemen.

Brazilians who reside at Bartica are allowed to operate a number of establishments. The Brazilian culture has been adopted by many of the youths of Bartica and this has led to both positive and negative changes in the local culture.

6.3.5 Education Infrastructure

The sole secondary school at Bartica has 1133 students and 52 teachers. Thirty one (31) of the teachers are trained. The pupil to teacher ratio is approximately 22:1. Bartica has three primary schools with the largest of these being St. John's the Baptist Primary with 635 students and 27 teachers of which fourteen (14) teachers are trained. The second largest primary school at Bartica is St Anthony's with 532 students and 21 teachers of which twelve (12) teachers are trained. Two Miles Primary with 174 students is the primary school with the least capacity. It has ten (10) teachers of which six (6) are trained. The nursery school population at Bartica consists of 952 students and 23 teachers. There are no private schools or skills training institutions in Bartica.

6.3.6 Security

The Bartica Police Station serves as the security administrative center of Region 7. There are several community policing groups scattered throughout Region 7 and Toshias of Amerindian villages are sworn rural constables. A community policing group typically consists of several individuals who have been sworn in as rural constables and who have authority to enforce the law and make arrests in specific communities.

6.3.7 Utilities

Bartica is provided with electricity by the Guyana Power and Light Company (GPL). Individual households in the communities are required to pay a security deposit to the power company prior to being connected to the grid. Potable water is provided by Guyana Water Inc (GWI). Some households complement their public water supply by collecting rainwater. Both land line and cellular telephones are available to residents of Bartica.

6.3.8 Access

Bartica is accessible by water, land or air. A ferry service operates from Parika on the Essequibo Coast to Bartica on a daily basis. This is the major source for moving goods from the coast to Bartica. Additionally, fast boats constantly move passengers from Parika to Bartica. Goods are also moved to Bartica by road. The typical road trip to Bartica consists of passage over the Soesdyke-Linden Highway to a crossing at Rockstone on the Essequibo River and thence to Bartica along the Bartica-Potaro Road. Bartica also has an airstrip with the capacity to land 13-seater planes. The community of Bartica itself has several paved and unpaved roads.

6.4 Itaballi

Itaballi is located on the West Bank of the Mazaruni River, approximately six miles upstream of Bartica and 154 km from the proposed mine site. This community serves as the last stop for miners heading to the gold and diamond fields on the Mazaruni and Cuyuni Rivers. Information from the Bureau of Statistics, (D. Seelochan August 23, 2007), indicates that the population is approximately 262 individuals consisting of 127 males and 135 females. Itaballi has a total housing stock of 65 houses. There seems to have been a gradual increase in the population in recent years which is likely attributable to the growth of the mining/logging industry.

Physical observation of the population indicates that approximately 55 percent¹ of the individuals are below 18 years of age. The significant youth population has probably resulted in the initiation of a Youth Initiative Group (YIG) in June of 2006. At July 2007 the YIG had a membership of approximately seventy

(70) persons. The YIG, headed by the headmistress of the school at Itaballi has been involved in cleaning the Health Centre compound and providing food hampers for the elderly in the community. Observation of the Itaballi population indicates approximately 70 percent is mixed race. The other ethnic groups in the community are Amerindians, Indo-Guyanese and Afro-Guyanese (each approximately 10% of the population)².

Several individuals at Itaballi are engaged in businesses to satisfy community needs and the need of miners and other operators in the region.

¹ The 2002 census indicates that 53 percent of Itaballi's population is below the age of 18 and 2.5% above age 65.

² The 2002 Census report suggest the ethnic composition as follows: Amerindian 13%, Mixed 67%, Afro-Guyanese 11% and Indo-Guyanese 8.5%

6.4.1 Social Infrastructure

Itaballi has the following social infrastructure:

- a community centre;
- a library;
- a primary school;
- a recently constructed health centre/post;
- two churches; and
- a play field and pavilion.

Itaballi has no secondary school, however, children from the community can and have, over the years, accessed secondary education in Bartica. A recently constructed health facility provides the community with basic health services, such as medical supplies, medical checks and testing for hypertension. Malaria smears are sent to be analyzed at the Bartica Regional Hospital.

There are a number of shops which cater to the needs of miners. There are also a number of fuel depots which supply fuel to vehicles heading to the interior. In 2003, a security check-point was established at Itaballi with the aim of reducing the high incidence of crime at interior locations. Two officers of the Guyana Police Force and two GGMC mining officers are stationed at the check-point. These officers monitor persons and vehicles entering and leaving the mining district.

6.4.2 Health Infrastructure

The Itaballi Health Center offers basic health services including hypertension checks, dressing of wounds and inoculations. No midwife/medex/doctor is attached to the health centre. A nurse is required to travel from Bartica daily to run the centre, but this does not occur since traveling between Bartica and Itaballi can be sometimes difficult.

6.4.3 Education Infrastructure

The school at Itaballi has both primary and nursery divisions. At the end of July 2007 the enrollment consisted of 107 primary students and 38 nursery students. Fourteen (14) students graduated from the nursery department at the end of the last school year.

6.4.4 Security

A police outpost at Itaballi was removed at the end of July 2007. There is consequently no police presence at Itaballi.

6.4.5 Utilities

Itaballi is not provided with electricity by the Guyana Power and Light Company (GPL). Several households in the communities use generators for electricity generation however several homes are lit by lamps. Potable water is not provided to the community. Individual households obtain water from either the Mazaruni River or by trapping rainwater in cisterns and drums. Cellular telephones are available to residents of Itaballi. The service is however intermittent due to problems with signal reception.

6.4.6 Access

Itaballi is accessible by water, land or air. Fast boats move passengers from Bartica to Itaballi. Goods are moved to Itaballi by road both from Bartica and from Georgetown. Trucks from Bartica travel along the

Bartica-Potaro Road and cross the Mazaruni River by barge at Teperu. The typical road trip from Georgetown consists of passage over the Soesdyke-Linden Highway to a crossing at Rockstone on the Essequibo River and thence to Teperu along the Bartica-Potaro Road and then across the Mazaruni River to Itaballi. Itaballi can also be accessed by an airstrip located at Kwappow. The community of Itaballi has several unpaved roads.

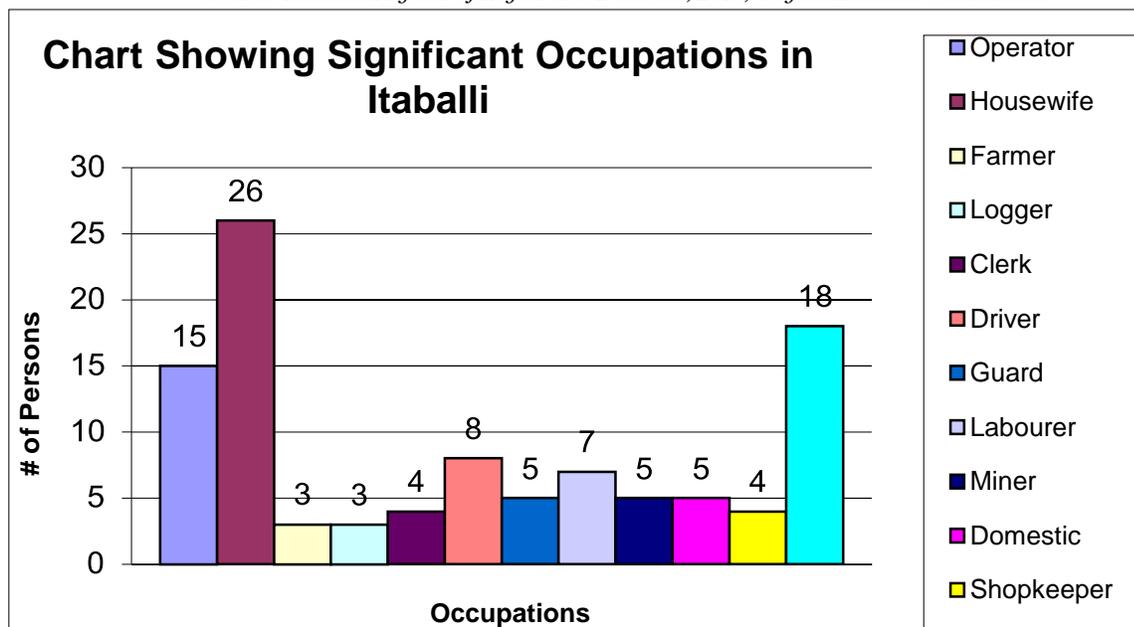
6.4.7 Economic Activity

Itaballi is primarily a farming community, with bananas, pears, and ground provisions being the main produce. Subsistence farming appears to be the main non-income household activity, while the major economic activities are gold/diamond mining, shop keeping, logging and farming. Other forms of income generation are:

- Cash crop farming;
- Small scale gold processing;
- Selling timber; and
- Wildlife trapping and selling

Figure 30 - Occupations in Itaballi

Source: National Register of Registrants Database, 2010; Guyana Elections Commission



6.5 Kartabo Village

Kartabo Point, also known as Kartabo is a village in the Cuyuni-Mazaruni Region number 7 of Guyana. Kartabo is located on the lower Mazaruni River, approximately 6 miles from Bartica. Its population is approximately 250 persons. Residents are involved in fishing, cash crop farming, boat-building and logging to a smaller extent, most of which is done on a subsistence basis. Kartabo is a predominately Amerindian community, however there is the presence of African and other mixed individuals from the coast.

There is no security in the village, however, security and other disputes are arbitrated and settled by the

Village Toshao and councillors. There is a primary school in the community with three teachers. The registered population is 70. There is a community health worker dedicated to providing continuous service

to the community. The community is visited twice monthly by medical officers from Bartica. Medical service is provided by these officers at a newly constructed health post. Acute renal illness, diabetes and high blood pressure are the illnesses most reported to occur in the community. Kartabo was recently identified, based on a need assessment, as the recipient of a solar power driven groundwater well.

6.6 Puruni Village

Puruni is located on the right bank of the Puruni River approximately 76 km southeast of the proposed mine site along the Itaballi/Puruni Road. This community is an in-transit point for miners and vehicles crossing to and from mining concessions and other operations. Field survey indicates that Puruni is a predominantly mixed community with a population of approximately 50 individuals. Economic life in the community is centered on mining, shop keeping and the provision of accommodation for sex workers. Residents also farm, fish and hunt on a subsistence basis. The cost of living is relatively high in the community primarily attributable to the high costs of transportation of goods.

There is no public utility service in Puruni. Several households in the community use generators to generate electricity while, several other homes are lit by lamps. Water is sourced from the Puruni River for domestic purposes while water for consumption is stored in black tanks from rainfall. There are no social health infrastructures in Puruni. The nearest Police Outpost is approximately 91 km away at the MMC Toll Station in Itaballi. The only Administrative presence in the area is a Mines Office which is staffed by a Mines Officer and a Mines Warden. They are tasked with monitoring the mining operations within the district.

6.7 Results of Socio-Economic and Socio-Cultural Surveys

Ten percent of the population of Itaballi and Kartabo was randomly sampled. Employment within the communities is dominated by mining, farming and individual sole proprietorship activities. In general all individual farms were less than 4 acres in size. Most respondents reported that their average monthly income ranges being between G\$ 20,000 to G\$35,000. All individuals practiced some form of religious activities with the Christian faith being dominant. Almost one-half of the residents surveyed fished at least twice weekly. All residents fished at least once weekly. The primary source of fish for residents was the Mazaruni River.

Approximately 20 percent of the respondents indicated that they would hunt for food. Animals typically hunted were the wild cow/wild hog, labba, powis and acquiri. Hunting activities were confined to within 5 km of the respondents' community as a rule. A large percent of the respondents harboured no ill concerns relative to people from the coast moving into their communities.

6.8 Land-uses within the area of influence of the project

There are significant forested areas in Region 7. Timber harvesting has consequently been the primary economic activity in the Itaballi-Kartabo area. The GFC map shows forest concession both north and south of the Puruni River and Kartabo-Itaballi road (see Figure 31). Timber sales agreements (TSAs) account for the majority of land allocated for forestry/logging within the area of influence of the project. Small scale forest permissions (SFPs) are allocated to a lesser extent. TSA is a large scale forestry concession which covers an area of more than 20,000 hectares and grant permission for the exploitation of timber for a duration of more than 20 years. SFPs are only valid for two years, and are non-exclusive. SFP permit holders are therefore only allowed to remove a certain quota of timber from the concession.

The SFPs are located north east of the Kartuba-Puruni road between Willems Timber & Trading Co. TSAs and the Essequibo and Cuyuni Rivers. The SFPs concessionaires within the area of influence are; Custom

Wood Tech Engineering, RL Sukram, Boodhoo's General Store, Aurora Small Loggers Association, M&S Bisson Sawmill, Lakram Singh Harriidat Sawmill, Rockcliffe Parris and Lloyd Mahabir.

The TSAs that intersect the area of influence are owned and operated by the following logging companies:

- The Garner Forest Inc;
- Timber Traders Ltd;
- A Mazaharally and Sons Company and
- Willems Timber Ltd.

All of the SFPs and TSAs are currently operational. Timber is harvested and removed from the concessions via the Itaballi-Puruni Road and the Essequibo and Cuyuni Rivers.

Mining, in the area of influence, has progressed over the years from the traditional pork knocker operations to small and medium scale artisanal and large scale mining operations. Prospecting permits medium scale (PPMS) and medium scale mining permits (MPs) accounts for the majority of land allocated for mining within the area of influence (see Figure 32 below). ETK Inc., Peter's Mine and Guyana Goldfields Inc. are the current holders of prospecting licenses (PLs) and Mining Licenses in Region 7 within the area of influence of the project.

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940000⁰⁰⁰
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970000⁰⁰⁰⁰⁰⁰



Cuyuni River

ETK PROPERTY

Puruni River

CUYUNI RIVER

ESSEQUIBO RIVER

760000⁰⁰⁰⁰⁰⁰

730000⁰⁰⁰⁰⁰⁰

700000⁰⁰⁰⁰⁰⁰

MAZARUNI RIVER

670000.000000

640000.000000

Legend

- River network
- ETK Property
- ETK Project Area of Influence
- Prospecting permit medium scale (PPMS)
- Mining permit (MP)
- Prospecting licence (PL)

Mazaruni River

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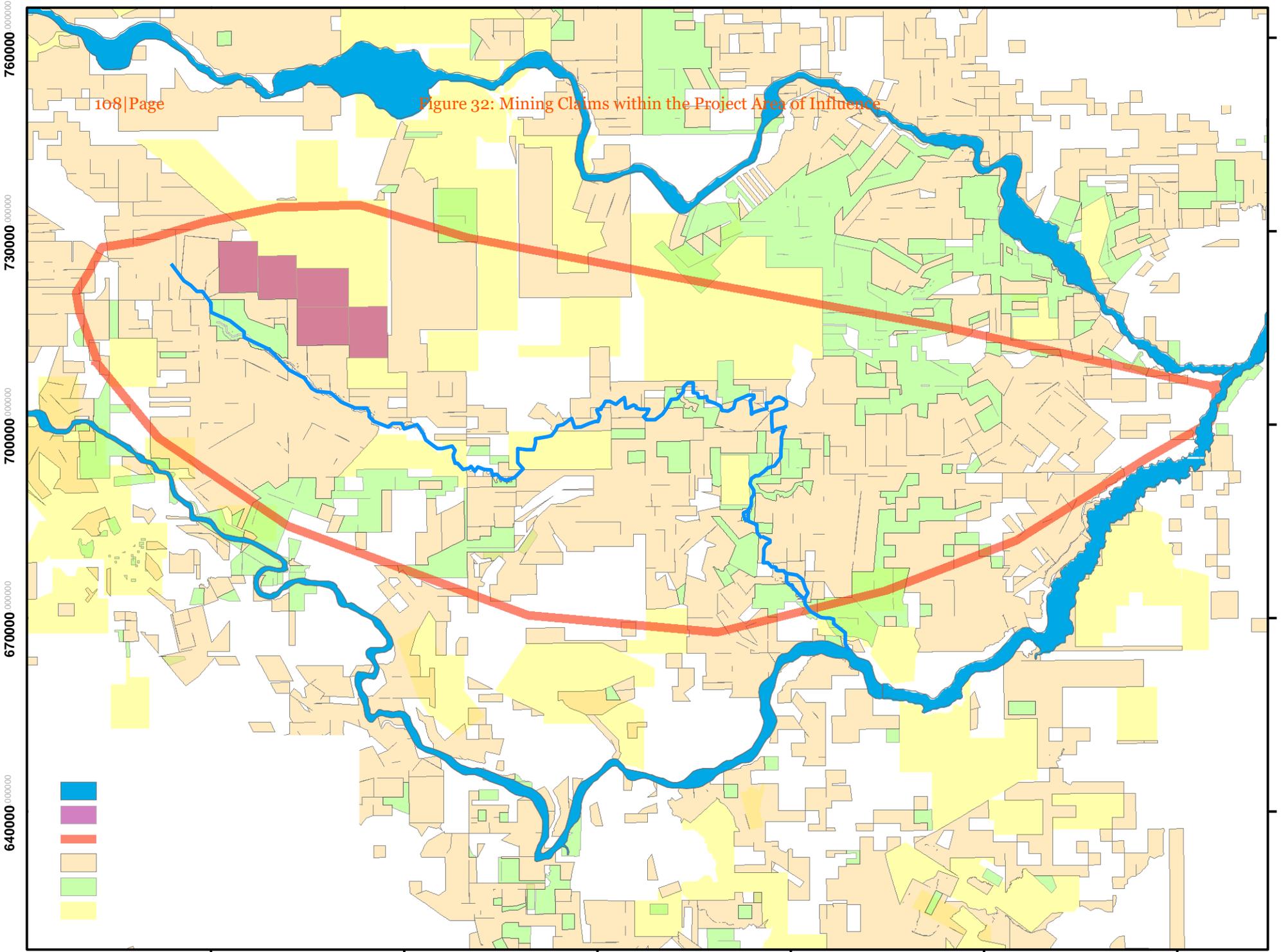
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Figure 32: Mining Claims within the Project Area of Influence



7.0 PHYSICAL ENVIRONMENTAL IMPACTS AND RISKS OF PROPOSED ACTION

This section analyses the potential positive and negative consequences of the construction and operation of the proposed Project and describes the recommended mitigation measures to avoid, minimize, or mitigate potential negative impacts and enhance potential positive effects. The resource-specific impact discussions include the design, construction, operation and closure phases of the Project as well as potential impacts during transitional stages, non-routine events, and impacts due to Project uncertainties.

7.1 IMPACT ASSESSMENT METHODOLOGY

Information on potential impacts from the construction and operation of the Project was obtained from various sources, including consultation with the EPA, the public consultations process, ESIA for similar projects in Guyana and worldwide, literature, research, and independent modeling and analysis.

To identify potential and assess impacts associated with or resulting from Project activities, the Project team used professional judgment, fieldwork, and desk-top analysis to identify potential impacts and their interactions. The significance of potential impacts that may result from the proposed Project was determined to assist the EPA in preparing recommendations for evaluation of the proposed Project.

The methodology that was used to identify and assess the potential physical and social impacts of the proposed Project is described in the following sections.

7.1.1 Steps of Impact Assessment

Impact Assessment takes place as follows:

1. Characterize the baseline – the existing conditions before the Project is undertaken and any effects are generated (see Sections 5.0 and 6.0);
2. Identify sources of impacts and the impacts themselves that are generated by any aspect of the Project;
3. Rate impacts before any mitigation (for negative impacts) or enhancement (for positive impacts) is implemented;
4. Recommend mitigation and enhancement measures to address the impact; and
5. Rate impacts after mitigation to produce a “residual” impact rating.

7.1.2 Why a System of Rating Impacts?

It is standard practice in ESIA processes to “rate” potential impacts to:

- Provide a basis for prioritization of impacts to be dealt with;
- Provide a method of assessing the effectiveness of proposed mitigation measures; and
- Provide a scale which shows the level of impact both before and after a proposed mitigation measure has been applied.

For this ESIA, a consistent system for rating impacts was used in order to apply analytical rigor to the assessment and rating process. It must be remembered, however, that any outcome with regard to reducing major negative impacts or enhancing positive impacts is dependent on the selection, applicability, implementation and effectiveness of mitigation measures for the proposed Project.

Table 31: Severity Criteria: Negative Social/Health and Environmental Impacts

Severity	Negative Social/Health Impacts					Negative Environmental Impacts
	Duration	Geographic Extent	Ability to Adapt	Socio-Cultural Effectys	Health Effects	
Low	Short-term < 1 year Low Frequency	Individual/Household	Those affected will be able to adapt to the changes with relative ease, and maintain pre-impact livelihoods, culture, quality of life and health.	Inconvenience but with no consequence on long-term livelihood, culture, quality of life, resources, infrastructure and services.	Event resulting in annoyance, minor injury or illness that does not require hospitalization.	Affects environmental conditions, species and habitats over a short period of time, is localized and reversible.
Medium	Medium-term 1-6 years Medium to Intermittent Frequency	Small Number of Households	Those affected will be able to adapt to the change with some difficulty and, and maintain pre- impact livelihoods, culture, quality of life and health but only with a degree of support.	Primary and secondary impacts on livelihoods, culture, quality of life, resources, infrastructure and services.	Event resulting in moderate injuries or illness, which may require hospitalization.	Affects environmental conditions, species and habitats in short and medium-term. Ecosystem integrity will not be adversely affected in the long-term, but the effect is likely to be significant in the short or medium term to some species or receptors. The area/region may be able to recover through natural regeneration and restoration.
High	Long-term/Irreversible > 6 years Constant Frequency	Large part of/Full settlement	Those affected will not be able to adapt to the changes and maintain pre-impact livelihood.	Widespread and diverse primary and secondary impacts likely to be impossible to reverse or compensate for.	Catastrophic event resulting in loss of life, severe injuries or chronic illness requiring hospitalization.	Affects Environment conditions, species and habitats for the long-term (over the life of the project) may substantially alter the local and regional ecosystem and natural resources, and may affect sustainability. Regeneration to its former state would not occur without intervention. Affects environmental conditions or media over the long-term, has local and regional affects and/or is irreversible.

Table 32: Enhancement Criteria: Positive Social/ Health and Environmental

Enhancement	Positive Social/Health Impacts				Positive Environmental Impacts			
	Duration	Extent	Degree of Change	Focus/Sensitivity	Duration	Extent	Degree of Change	Focus/Sensitivity
High Level of enhancement	Benefits will be lasting and sustained over the long-term i.e. > 7 years	Benefits throughout the local community and beyond to State/National Level.	Direct benefits to individuals and communities will provide significant opportunities for leveraging secondary benefits and significantly improving livelihoods for themselves and others.	Benefits will pertain to vulnerable groups and those that would have otherwise been 'losers' as a result of the project.	Benefits will be sustained over the long-term.	Benefits will extend beyond local environment (i.e., linkage of fragmented habitat, e.g., regional corridor)	Direct benefits to species or resources will provide significant opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that are degraded or are sensitive, rare or in need of protection.
Medium Level of enhancement	Benefits will be felt for a medium period of time (1 to 7 years) or be intermittent over the longer term.	Benefits to many individuals and households in the local community and beyond.	Moderate benefits to individuals and communities which will provide some opportunities for furthering themselves and improving livelihoods.	Benefits will possibly pertain to vulnerable groups and those that would have otherwise been 'losers' as a result of the project.	Benefits will be measurable in the short-term and possibly longer.	Benefits to many species, habitats and natural resources in the local environment and beyond.	Direct benefits to species, habitats and natural resources that may provide some opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that have some level of degradation, sensitivity or rarity.
Low Level of enhancement	Benefits will be short-term (up to one year).	Benefits to a few individuals and households either in the local area and/or further afield	Some benefits to individuals and communities potentially improving opportunities for furthering themselves and improving livelihoods.	Benefits will not pertain to vulnerable groups and will only benefit those that would have otherwise benefited from the project.	Benefits will be short-term.	Benefits to a few species associated with the habitat and resources in the local environment.	Benefits to a few species, habitats and natural resources that may provide minor opportunities for sustainability.	Benefits will pertain to species, habitats and natural resources that are not sensitive or rare.

7.1.3 Criteria for Rating the Impacts

An impact rating is the product of two elements: (1) the severity of the potential impact and (2) the likelihood of the “event” occurring.

7.1.3.1 Severity and Enhancement Criteria

The severity or enhancement of each impact will be rated using the criteria identified in Tables 31 and 32. Note that colors are used to assist the reader in reviewing the impacts and their relative magnitude.

7.1.3.1.1 Likelihood Criteria

Likelihood of the event occurring is comprised of the following categories:

- Low likelihood – Extremely rare;
- Medium likelihood – Uncommon; and
- High likelihood – Common

7.1.3.1.2 Determining the Rating

The overall rating of the impacts will be determined by using the following matrix (Table 33). It should be noted that these matrices act as a guide and there may be situations where rigid application is inappropriate and where stakeholder perceptions and feedback have a significant role to play. For specific impacts where this is the case, the rating is clearly explained in the evaluation of the impact.

Table 33: Rating Matrix

Severity/Enhancement	Likelihood		
	Low	Medium	High
High Level of enhancement	Moderate	Major	Major
Medium Level of enhancement	Minor	Moderate	Major
Low level of enhancement	Insignificant	Minor	Moderate
Low Severity	Insignificant	Minor	Moderate
Medium Severity	Minor	Moderate	Major
High Impacts were also	Moderate	Major	Major

severity/enhancement and likelihood criteria detailed in the impact rating matrix but was mandated by the Guyana Environmental Protection Agency as one of the assessment criterion to be considered by the impact assessment.

7.2 Physical Resources

7.2.1 Design Impacts

The excavation depths are limited to less than 3.0 m. The project will consequently entail no detailed engineering designs. Work prior to the commencement of operation is limited to the exploration work initially undertaken to determine the viability of the resource present in the alluvial/colluvium deposits at the site. The project will therefore result in no design impacts. No mitigation measures would be required.

7.2.2 Soils

7.2.2.1 Construction Phase

Potential impacts to soil could result from maintenance/widening of the access road to the site, from clearance of areas to be mined and from excavation for creek diversions. Soil is a complex ecosystem. A single cubic meter of soil may contain millions of living things, including small rodents, insects, worms, algae, fungi, and bacteria. These organisms are important for mixing and aerating the soil particles. They also help release or convert nutrients in soils into forms that are useful for plants. These soils, developed on highly leached bedrock, are nutrient poor and have low fertility. The development and maintenance of the terrestrial ecosystems, in the project area, nevertheless depend upon the surficial soils as basic components of the system. Interactions between physical and biochemical processes have operated over variable time scales (hundreds to thousands of years) and space (from less than 1 km² to thousands of square kilometers) to produce the soil which provide support to complex ecosystems. In addition, continued weathering of minerals in soils at the site continues to release chemicals which are used by a variety of organisms, including plants to build soils.

Construction activities will result in soil degradation since minerals necessary to support the ecosystem may be depleted construction activities. These are moderate irreversible (medium severity; medium likelihood). These impacts will be mitigated by confining clearing and excavation activities only to those areas required for execution of the project. The mitigation measures will result in minor irreversible impacts (low severity, medium likelihood).

During the constructional phase, the risk of erosion is present due to removal of vegetation and exposure of soil. Roads and other transport lines in the terrain may cause erosion because the road may transport the water mimicking a river. In cases of heavy rainfall and flood the amount of water may be extensive and may damage the road and surrounding areas. At road curves, the water will continue straight forward and create large gullies and possible cover large areas with eroded matter. Erosion may also occur if construction activity blocks natural water courses. Vegetation clearing and access road maintenance/widening and construction can consequently potentially result in increased soil erosion and sedimentation in adjacent creek beds. These reversible impacts could be pronounced in areas of significantly steep slopes and where the soils erosion potential is severe or very severe. Slopes on the access roadway and in the creek flats will be maintained at relatively mild slopes. Therefore, the impact of the proposed Project construction on soils would be moderate (low severity; medium likelihood).

The likelihood of soil erosion and sedimentation will be minimized or avoided by the implementation of the following mitigation measures:

- Implementation of best management practices (Storm Water Management Plan) for soil erosion, storm water runoff, and sedimentation control;
- Implementation of reclamation immediately after mining ceases

The movement of heavy equipment during construction and mining may impact soil resources by causing rutting and compaction of susceptible soils. Heavy earthmoving equipment will increase soil erosion and result in changes in hydrology. Heavy earthmoving equipment will increase mechanical erosion and facilitate wind and water erosion of materials loosened by their passage. Runoff from construction sites can be as much as eight times greater than runoff from adjacent, unused areas with associated similar sediment yields. Hydrologic changes will result primarily from near surface soil compaction which will reduce the ability of the soil to absorb water. Furthermore, water already in the soil will become more tightly held and, thus, less available to plants and animals. Compaction will also change the variability of soil temperature.

This effect would be most apparent near the surface, where the soil becomes hotter during the day and colder at night.

The construction and mining operations will be restricted to mineralized areas, compaction and rutting would therefore be localized to these areas. These reversible impacts to soil resources are expected to be minor (low severity, low likelihood). No mitigation would be required.

All road construction will be in accordance to The Code of Practice for Forest Operations 3rd edition which was provided by Guyana Forestry Commission (GFC). It provides guidelines and standards on what constitutes satisfactory road building and other related forestry activities.

Topsoil mixing could potentially occur during the access road maintenance/widening, creek diversion excavation and during vegetation clearance and landscape grading. Soil development is a complex process. The rock and hydrologic cycles have interacted at the project site to produce weathered rock materials that are basic ingredients of soils. Weathering is the physical and chemical breakdown of minerals and rocks and the first step in soil development. Weathered rock is further modified into soil by the activity of soil organisms. The common master, or prominent, soil horizons are the O and A horizons. The O Horizon and A Horizon contain highly concentrated organic material, such as decomposing plants. The difference between these two layers is reflected by the amount of organic material present in each. In general, the O Horizon consists almost entirely of plant litter and other organic material, whereas the underlying A Horizon contains a good deal of both organic and mineral material. Below the O or A horizons, some soils have an E horizon, or zone of leaching, a light-colored layer that is leached of iron-bearing components. This horizon is light in color because it contains less organic material than the O and A horizons and little inorganic coloring material, such as iron oxides.

The mixing of the O Horizon and A-Horizon soils with less organic from the active leaching zones underlying these soils will result in a loss of soil fertility and the loss of viable seeds present (topsoil seedbank) in the O-Horizon Soils. This will result in moderate irreversible impacts (medium severity; medium likelihood).

To prevent topsoil mixing and the associated loss of viable seed banks, the following mitigation measures will be implemented:

- Topsoil will be segregated from subsurface layers during construction activities
- Topsoil will be stored separately from other overburden materials
- Topsoil will be replaced following mining activities

Implementation of these mitigation measures will result in minor irreversible impacts (low severity; medium likelihood). In addition, all roads would be maintained/widened according to GFC Code of Practice for Timber harvesting to ensure impacts associated with roadway construction are minimized.

7.2.2.2 Operation Phase

In the operational phase risks of erosion would exist if maintenance routines are inadequate, or if the location of the road has not been considered carefully. The area is subject to intense precipitation events and large seasonal variations in rainfall intensity which will increase the likelihood of severe erosion. The operational phase can therefore result in increased soil erosion and consequent blocking of natural water courses particularly those which only function in times of rainfall. This will retard runoff from the area and may result in localized flooding of some areas within the site and in the vicinity of the site and associated increased sediment discharge to waterways around the mine site operations.

Areas cleared of vegetation for the mine site will be terraced and measures such as planting, catch water drains, and small ponds will be used to retain the water in the watershed area and to reduce the amount of water reaching cleared areas. These actions will minimize surface water discharge during precipitation events. The mining operation will also occur as a closed loop which will create no discharge to surface

water in the mining areas. The minimization of surface water discharge and a closed loop process circuit coupled with implementation of best management practices in the Storm Water Management Plan will result in insignificant irreversible impacts to soils (low severity; low likelihood).

7.2.2.3 Closure Phase

During closure operations, the creeks will be restored to their original alignment and the creek banks will be revegetated. Soil conservation measures such as contour plowing of the upper sections of cleared areas will be used to improve the humidity of the soil and its ability to sustain vegetation. Culverts to be maintained beneath roads, required for monitoring, will be large enough to allow for the maximum flow of water to avoid water washing out parts of the road. Discharge of water to natural streams and small rivers at rapid flow may increase erosion of the river bank.

Increased sedimentation is therefore likely to occur to creeks during the restoration exercise. These are moderate irreversible impacts (medium severity, medium likelihood). These impacts will be mitigated by using silt fences in the creeks during restoration. The velocity of water, in streams and small rapids will be reduced by planting grass in streams or building up rows of stones and/or wooden sticks. The implementation of these mitigation measures will result in minor irreversible residual impacts (low severity, low likelihood).

7.2.3 Air Quality

7.2.3.1 Construction Phase

Construction works will result in emissions of dust and products of combustion. Fugitive dust emissions would result from land clearing and from excavation and grading. Dust generated would be a function of construction activities, soil type, moisture content, wind speed, frequency of precipitation, vehicle traffic and vehicle type. Fugitive emissions would be greater during dry periods.

Dust is broadly defined as small solid particles created by the break up of larger particles. Depending on their size, dust particles can become hazardous to worker health, particularly when suspended in air. The largest size particle that can be suspended in air for long periods of time from wind velocity acting upon it is about 60 micrometers (μm), which is about the thickness of a human hair. Particles ranging from about 60 to 2,000 μm can also become suspended in air, but they only reach heights up to approximately three feet above the ground before they fall back to the surface. Particles larger than about 2,000 μm generally creep or roll along the surface due to wind velocity acting upon them. These larger particles of dust can affect the nasal passages, causing an irritated and congested nose, and might also cause an irritant cough should they deposit in the throat. Smaller airborne particles of dust, which can remain suspended in air for hours, pose a greater risk to the respiratory system when inhaled. In general, the smaller the aerodynamic diameter of the inhaled dust particle, the more likely it will be deposited more deeply in the respiratory tract.

The reversible impacts to air quality would be moderate (low severity; high likelihood). These impacts will be mitigated by employing the following measures:

- Scheduling land clearing activities to less windy days
- Limiting vehicle speed during construction to a maximum 30 km/hr
- Employing dust suppression techniques.

Water would be used as the primary dust suppressant. Other suppressants may include surfactants, petroleum emulsions, polymers, and adhesives. Selection of the preferred agent for use will depend on

conditions at the mine site. Performance of each of the each dust control agent would be evaluated based

on control efficiency which compares the dust concentration of a treated road surface to that of an untreated or uncontrolled road surface. Equipment to be used for the application of the dust suppressants will include a road grader equipped with scarifiers, a compactor, and a water truck for distribution of the suppressant to the road surface

Implementation of the mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Combustion emissions would result from chainsaw operations and the use of diesel and/or gasoline fired heavy duty equipment. Products of combustion will include: Benzene, PM₁₀, PM_{2.5}, carbon monoxide, NO_x, SO₂, VOCs – a precursor of ozone and Hydrocarbons.

Ozone, sulfur dioxide, fine particulates, and nitrogen dioxide have both acute and chronic health effects. Carbon monoxide has acute effects only, whereas lead, being a toxic metal, has chronic effects (at ambient air levels). Ozone is a strong oxidizer that affects the respiratory system and may lead to damage of lung tissues. Its acute effects include cough and chest pain, eye irritation, headaches, lung function losses, and asthma attacks. The acute effects of Sulfur dioxide include irritation and restriction of air passages. There is reduced mucus clearance from the restricted air passages and chest tightness. Under normal conditions, the lung passages are open, however, the lung passages constrict in a response to SO₂. This constriction further aggravates other health conditions. Sulfur dioxide also causes immune system suppression and increases the probability of bronchitis. There are some indications that chronic exposure to sulfur dioxide may also act as a cancer promoter in addition to being an immune system suppressor.

Exposure to elevated concentrations of fine particulates increases mortality rate, increases incidence of asthma and bronchitis, and rates of infection in the respiratory system. Particulates also directly irritate the respiratory tract, constrict airways, and interfere with the mucus lining of the lung passages. The chronic effects of fine particulates include loss of lung capacity and lung damage, resulting from scarring caused when fine particulates are not cleared from the lung passages or alveoli. Fine particulates also act as carriers for toxic contaminants and, in particular, heavy metals particularly when the contaminants exist in a fume or a vapor state and condense onto the fine particulates. In the alveolar regions, heavy metals may be absorbed into the blood and circulated to other parts of the body. Particulates, and in particular the fine particulate fractions, are also responsible for visibility reduction.

The acute effects of nitrogen dioxide are both direct and indirect. The direct effects are damages to the cell membranes in the lung tissues as well as constriction of the airway passages. Asthmatics are, in particular, affected by these acute effects. The indirect effects are that nitrogen dioxide causes edema, or a filling of the intercellular spaces with fluid, which may develop into local areas of infection.

Carbon monoxide affects health through binding with hemoglobin in the blood. Hemoglobin is the oxygen-carrying protein that is responsible for the oxygen and CO₂ exchanges necessary for life. When CO binds to hemoglobin, the blood loses its ability to transmit vital oxygen to all tissues of the body. At high levels of carbon monoxide, the potential exists for asphyxiation. In addition, Carbon Monoxide causes impairment of performance, slow reflexes, fatigue, and headaches due to the lack of oxygen in the brain. Carbon Monoxide also results in aggravated heart and lung disease symptoms as well as impairments in the central nervous system and brain functions.

Aromatic compounds such as benzene, directly affect the central nervous system by asphyxiation resulting from the loss of oxygen to the brain.

These emissions would be short-term and would be in the area of the vicinity of construction operations only. The impacts to air quality were assessed using the USEPA Screen 3 Model. This model estimates the air quality impact of stationary sources. This model was used since no database exists to conduct an

alternative analysis of air quality impacts. The equipment which will generate emissions during both construction and operation are as follows:

- 1 950 G Caterpillar Loader
- 4 320 Caterpillar Excavators
- 1 D6 Caterpillar Crawler Tractor
- 4 Dump Trucks
- 1 Super Miner
- 2 Vehicles
- 2 – 60 KVA Generators
- 1 -500 KVA Generator
- 4 Water Pumps

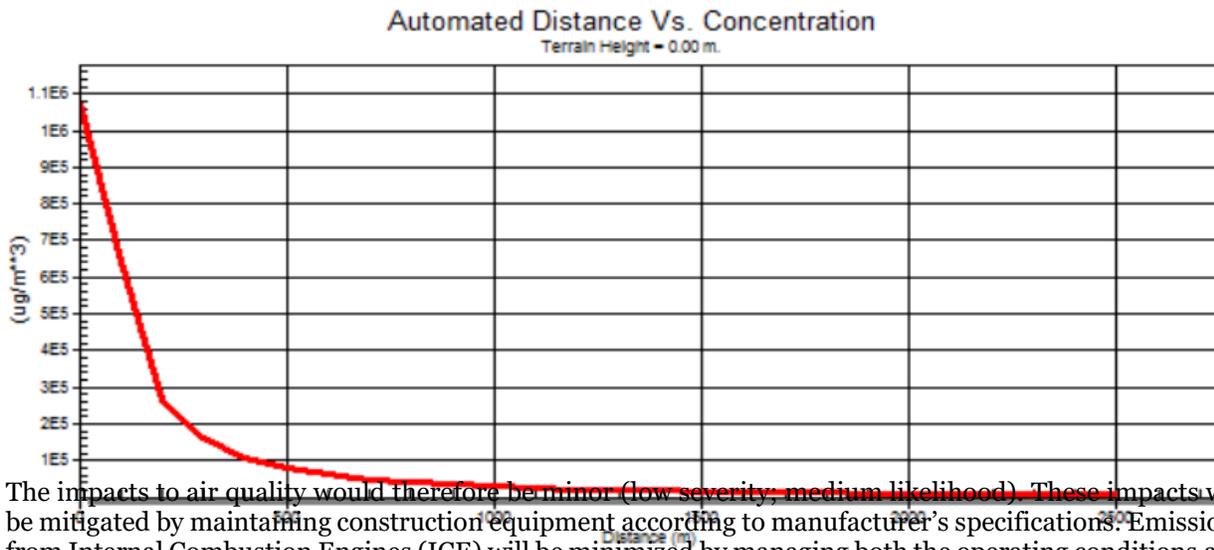
Source emissions to air were estimated using the USEPA AP-42 emission factors. It was assumed that at the peak of activity all of the equipment listed above would be operational. To generate conservative estimates of emissions, each piece of equipment was assumed to burn diesel fuel in two shifts of 10 hours each. The US AP-42 Emission Factors for diesel industrial engines were then used to estimate emissions from construction equipment. Further conservatism was factored into the emissions estimates by assuming that all equipment was concentrated in a single area approximately 50 m square. The total daily emissions and unit emissions are detailed in Table 34.

Table 34: Emissions from Equipment – Construction and Operational Phases

Pollutant	Total Daily Emissions (kg)	Emission Concentration (ug/ m ³)
NO _x	3.19E+03	7.92E+04
CO	6.88E+02	1.71E+04
SO _x	2.11E+02	5.24E+03
PM ₁₀	2.27E+02	5.62E+03
CO ₂	1.18E+05	2.94E+06
Aldehydes	4.77E+01	1.18E+03
Benzene	6.76E-01	1.68E+01
Toluene	2.96E-01	7.35E+00
Xylenes	2.06E-01	5.12E+00
Propylene	1.87E+00	4.63E+01
1,3 Butadiene	2.83E-02	7.02E-01
Formaldehyde	8.55E-01	2.12E+01
Acetaldehyde	5.56E-01	1.38E+01
Acrolein	6.79E-02	1.66E+00
Formic Acid	1.02E-01	2.51E+00

The analyses assumed that the emissions were from an area source approximately 10 m wide and 5 m long with a total height of 13.0 m to correspond to the exhaust height of most of the equipment. The variation in concentrations was computed using NO_x as the trace constituent. The concentration of NO_x was determined for distances ranging from 5 m to 2500 m from the emission source. The analyses indicated very minor impacts on air quality ranging from a change in NO_x concentration of approximately 1,074,000ug/m³ at a distance of 5.0 m, to 7848 ug/m³ at 2500 m. The distribution of the concentrations of NO_x over distance is shown in Figure 33.

Figure 33 - Distribution of NO_x Concentrations with Distance from Mine Site



The impacts to air quality would therefore be minor (low severity, medium likelihood). These impacts will be mitigated by maintaining construction equipment according to manufacturer's specifications. Emissions from Internal Combustion Engines (ICE) will be minimized by managing both the operating conditions and selecting appropriately designed ICEs. ICEs to be used for this project will have air-to-fuel ratios which will reduce CO and hydrocarbon emissions. ICEs used for this project will have ratios generally less than or equal to 1.0. Spark timing of ICEs will also be changed to reduce engine temperatures and the associated NO_x emissions. This may also result in marginal reduction of hydrocarbon emissions. ICEs selected for this project will also have low compression ratios which will result in significant reduction in both oxides of nitrogen and hydrocarbons emissions. Implementation of the mitigation measures will result in insignificant reversible impacts (low severity, low likelihood).

Approximately 5100 ha of tropical forest will be cleared for the mine site operations. The forest in the mine site area has a sequestration ability of approximately 166 tonnes of carbon per hectare (tC/ha). Consequently approximately 850,000 tons/year of CO₂ will no longer be sequestered by the forest if the entire area is cleared all at once. In addition, the project will also generate approximately 43,100 tonnes of CO₂ each year due to emissions from construction and other fossil fuel equipment. If the entire area is cleared the project will result in a yearly increase in the global CO₂ emissions by approximately 900,000 tonnes.

Loss of sequestration capacity is a direct, long-term, reversible impact (medium severity, high likelihood). This impact will be mitigated by phased clearing of the areas to be mined such that all areas would not be cleared at once. In addition, mined out areas will be revegetated after mining is completed. This will result in long term restoration of the forest cover allowing the mined out areas to again serve as a carbon sink. The mitigation measures will result in insignificant residual impacts (low severity, low likelihood).

7.2.3.2 Operation Phase

Mining operations will entail excavation, screening and concentration. The screening operations will be conducted using water and would generate no emissions. The operations would generate dust and combustion emissions from:

- Vehicles using the access and site roads
- Excavation of pay dirt

- Operation of heavy duty equipment and generators

Dust generated would be a function of mining operations, soil type, moisture content, wind speed, frequency of precipitation, vehicle traffic and vehicle type. Fugitive emissions would be greater during dry periods.

Dust is broadly defined as small solid particles created by the breaking up of larger particles. Depending on their size, dust particles can become hazardous to worker health, particularly when suspended in air. The largest size particle that can be suspended in air for long periods of time from wind velocity acting upon it is about 60 micrometers (μm), which is about the thickness of a human hair. Particles ranging from about 60 to 2,000 μm can also become suspended in air, but they only reach heights up to approximately three feet above the ground before they fall back to the surface. Particles larger than about 2,000 μm generally creep or roll along the surface due to wind velocity acting upon them. These larger particles of dust can affect the nasal passages, causing an irritated and congested nose, and might also cause an irritant cough should they deposit in the throat. Smaller airborne particles of dust, which can remain suspended in air for hours, pose a greater risk to the respiratory system when inhaled. In general, the smaller the aerodynamic diameter of the inhaled dust particle, the more likely it will be deposited more deeply in the respiratory tract.

Dust emissions from roads and from the excavation of pay dirt will occur for the duration of the operation. The site is approximately 125 km from the nearest settlement. The reversible impacts to air quality would therefore be minor (low severity, medium likelihood). These impacts will be mitigated by employing the following measures:

- Limiting vehicle speed to a maximum 30 km/hr
- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications
- Providing facemasks with dust removal filters
- Conducting periodic medical checks of employees for effects of dust exposure
- Providing goggles and eye wash lotion for dust-induced eye irritation.

Water would be used as the primary dust suppressant. Other suppressants may include surfactants, petroleum emulsions, polymers, and adhesives. Selection of the preferred agent for use will depend on conditions at the mine site. Performance of each of the dust control agent would be evaluated based on control efficiency which compares the dust concentration of a treated road surface to that of an untreated or uncontrolled road surface. Equipment to be used for the application of the dust suppressants will include a road grader equipped with scarifiers, a compactor, and a water truck for distribution of the suppressant to the road surface. Implementation of the mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Combustion emissions would result from heavy earthmoving equipment and the use of diesel and/or gasoline fired heavy duty equipment. Products of combustion will include: Benzene, PM_{10} , $\text{PM}_{2.5}$, carbon monoxide, NO_x , SO_2 , VOCs – a precursor of ozone and Hydrocarbons.

Ozone, sulfur dioxide, fine particulates, and nitrogen dioxide have both acute and chronic health effects. Carbon monoxide has acute effects only, whereas lead, being a toxic metal, has chronic effects (at ambient air levels). Ozone is a strong oxidizer that affects the respiratory system and may lead to damage of lung

tissues. Its acute effects include cough and chest pain, eye irritation, headaches, lung function losses, and asthma attacks. The acute effects of Sulfur dioxide include irritation and restriction of air passages. There is reduced mucus clearance from the restricted air passages and chest tightness. Under normal conditions, the lung passages are open, however, the lung passages constrict in a response to SO₂. This constriction

further aggravates other health conditions. Sulfur dioxide also causes immune system suppression and increases the probability of bronchitis. There are some indications that chronic exposure to sulfur dioxide may also act as a cancer promoter in addition to being an immune system suppressor.

Exposure to elevated concentrations of fine particulates increases in mortality rate, increases incidence of asthma and bronchitis, and increased rates of infection in the respiratory system. These particulates also directly irritate the respiratory tract, constrict airways, and interfere with the mucus lining of the lung passages. The chronic effects of fine particulates include loss of lung capacity and lung damage, resulting from scarring caused when fine particulates are not cleared from the lung passages or alveoli. Fine particulates also act as carriers for toxic contaminants and, in particular, heavy metals particularly when the contaminants exist in a fume or a vapor state and condense onto the fine particulates. In the alveolar regions, heavy metals may be absorbed into the blood and circulated to other parts of the body. Particulates, and in particular the fine particulate fractions, are also responsible for visibility reduction.

The acute effects of nitrogen dioxide are both direct and indirect. The direct effects are damages to the cell membranes in the lung tissues as well as constriction of the airway passages. Asthmatics are, in particular, affected by these acute effects. The indirect effects are that nitrogen dioxide causes edema, or a filling of the intercellular spaces with fluid, which may develop into local areas of infection.

Carbon monoxide affects health through binding with hemoglobin in the blood. Hemoglobin is the oxygen-carrying protein that is responsible for the oxygen and CO₂ exchanges necessary for life. When CO binds to hemoglobin, the blood loses its ability to transmit vital oxygen to all tissues of the body. At high levels of carbon monoxide, the potential exists for asphyxiation. In addition, Carbon Monoxide causes impairment of performance, slow reflexes, fatigue, and headaches due to the lack of oxygen in the brain. Carbon Monoxide also results in aggravated heart and lung disease symptoms as well as impairments in the central nervous system and brain functions. Aromatic compounds such as benzene, directly affect the central nervous system by asphyxiation resulting from the loss of oxygen to the brain.

These emissions would be long-term and would be in the vicinity of mining and haul roads operations only. The reversible impacts to air quality would therefore be minor (low severity; medium likelihood). These impacts will be mitigated by maintaining operation equipment according to manufacturer's specifications. Emissions from Internal Combustion Engines (ICE) will be minimized by managing both the operating conditions and selecting appropriately designed ICEs. ICEs to be used for this project will have air-to-fuel ratios which will reduce CO and hydrocarbon emissions. ICEs used for this project will have ratios generally less than or equal to 1.0. Spark timing of ICEs will also be changed to reduce engine temperatures and the associated NOx emissions. This may also result in marginal reduction of hydrocarbon emissions. ICEs selected for this project will also have low compression ratios which will result insignificant reduction in both oxides of nitrogen and hydrocarbons emissions. Implementation of the mitigation measures will result in insignificant reversible impacts (low severity, low likelihood).

7.2.3.3 Closure

Closure impacts to air will result from dust and combustion emissions generated by equipment during the restoration of the diverted creeks. The site is approximately 125 km from the nearest settlement. The impacts to air quality would therefore be minor (low severity, medium likelihood). Dust generated would be a function of closure operations, soil type, moisture content, wind speed and frequency of precipitation. Fugitive emissions would be greater during dry periods.

Dust is broadly defined as small solid particles created by the breaking up of larger particles. Depending on their size, dust particles can become hazardous to worker health, particularly when suspended in air. The

largest size particle that can be suspended in air for long periods of time from wind velocity acting upon it is about 60 micrometers (μm), which is about the thickness of a human hair. Particles ranging from

about 60 to 2,000 μm can also become suspended in air, but they only reach heights up to approximately three feet above the ground before they fall back to the surface. Particles larger than about 2,000 μm generally creep or roll along the surface due to wind velocity acting upon them. These larger particles of dust can affect the nasal passages, causing an irritated and congested nose, and might also cause an irritant cough should they deposit in the throat. Smaller airborne particles of dust, which can remain suspended in air for hours, pose a greater risk to the respiratory system when inhaled. In general, the smaller the aerodynamic diameter of the inhaled dust particle, the more likely it will be deposited more deeply in the respiratory tract.

These reversible impacts will be mitigated by employing the following measures:

- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications
- Providing facemasks with dust removal filters
- Providing goggles and eye wash lotion for dust-induced eye irritation.

Water would be used as the primary dust suppressant. Other suppressants may include surfactants, petroleum emulsions, polymers, and adhesives. Selection of the preferred agent for use will depend on conditions at the mine site. Performance of each of the each dust control agent would be evaluated based on control efficiency which compares the dust concentration of a treated road surface to that of an untreated or uncontrolled road surface. Equipment to be used for the application of the dust suppressants will include a road grader equipped with scarifiers, a compactor, and a water truck for distribution of the suppressant to the road surface. Implementation of the mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Combustion emissions would result from heavy earthmoving equipment and the use of diesel and/or gasoline fired heavy duty equipment. Products of combustion will include: Benzene, PM_{10} , $\text{PM}_{2.5}$, carbon monoxide, NO_x , SO_2 , VOCs – a precursor of ozone and Hydrocarbons.

Ozone, sulfur dioxide, fine particulates, and nitrogen dioxide have both acute and chronic health effects. Carbon monoxide has acute effects only, whereas lead, being a toxic metal, has chronic effects (at ambient air levels). Ozone is a strong oxidizer that affects the respiratory system and may lead to damage of lung tissues. Its acute effects include cough and chest pain, eye irritation, headaches, lung function losses, and asthma attacks. The acute effects of Sulfur dioxide include irritation and restriction of air passages. There is reduced mucus clearance from the restricted air passages and chest tightness. Under normal conditions, the lung passages are open, however, the lung passages constrict in a response to SO_2 . This constriction further aggravates other health conditions. Sulfur dioxide also causes immune system suppression and increases the probability of bronchitis. There are some indications that chronic exposure to sulfur dioxide may also act as a cancer promoter in addition to being an immune system suppressor.

Exposure to elevated concentrations of fine particulates increases in mortality rate, increases incidence of asthma and bronchitis, and increased rates of infection in the respiratory system. These particulates also directly irritate the respiratory tract, constrict airways, and interfere with the mucus lining of the lung passages. The chronic effects of fine particulates include loss of lung capacity and lung damage, resulting from scarring caused when fine particulates are not cleared from the lung passages or alveoli. Fine particulates also act as carriers for toxic contaminants and, in particular, heavy metals particularly when the contaminants exist in a fume or a vapor state and condense onto the fine particulates. In the alveolar regions, heavy metals may be absorbed into the blood and circulated to other parts of the body. Particulates, and in particular the fine particulate fractions, are also responsible for visibility reduction.

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affected by these acute effects. The indirect effects are that nitrogen dioxide causes edema, or a filling of the intercellular spaces with fluid, which may develop into local areas of infection.

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These emissions would be long-term and would be in the vicinity of mining and haul roads operations only. The reversible impacts to air quality would therefore be minor (low severity; medium likelihood). These impacts will be mitigated by maintaining operation equipment according to manufacturer's specifications. Emissions from Internal Combustion Engines (ICE) will be minimized by managing both the operating conditions and selecting appropriately designed ICEs. ICEs to be used for this project will have air-to-fuel ratios which will reduce CO and hydrocarbon emissions. ICEs used for this project will have ratios generally less than or equal to 1.0. Spark timing of ICEs will also be changed to reduce engine temperatures and the associated NOx emissions. This may also result in marginal reduction of hydrocarbon emissions. ICEs selected for this project will also have low compression ratios which will result insignificant reduction in both oxides of nitrogen and hydrocarbons emissions. Implementation of the mitigation measures will result in insignificant reversible impacts (low severity, low likelihood).

7.2.4 Geology

7.2.4.1 Construction Phase

Construction works will entail the construction of site facilities such as the airstrip, clearing and grubbing the workshop and laboratory areas, construction of the camp buildings and diversion of the creeks located within areas to be mined.

The stratigraphic profile at the site consists of a zone of residual soil which has been completely weathered to soil with no remaining structure of the rocks from which the soils were formed, being visible. There is some laterite, a more specific sub-grouping of residual soil where secondary iron or aluminium oxides form, present at some location at the site. The residual soil is underlain by saprolite. The saprolite is representative of a portion of the weathered profile which has retained the original fabric and structure of the parent rock. Saprolite differs from weathered rock in degree of alteration. It is material that is sufficiently broken down that it can be augered through or dug with a shovel yet it retains the original rock structure (Anderson & Anderson, 2010). The retention of the rock structure implies that the saprolite has undergone no strain. The saprolite is underlain by weathered rock or Saprock which constitutes the transition zone between saprolite and bedrock. In this zone intact rock material is present in a discontinuous framework separated by soil-like material. Typically saprock is defined by having a rock content of 50 % or more. The rock material can be present in various states of weathering from highly weathered to fresh. Significant zones of soil like material can be encountered within a saprock zone due to preferential local weathering. The saprock is underlain by a stratum of intact rock with no indication of weathering.

Surficial soils, represented only by a part of the residual soils at the site, will be removed over that area of the site which has been identified for the above facilities. Removal of these surficial residual soils will result in insignificant impacts (low severity, high likelihood). No mitigation would be needed. The construction

works will not alter the stratigraphic profile at the site. Construction work will consequently have no impacts on the geology of the area.

7.2.4.2 Operation Phase

During the operation phase, open pits will be excavated to depths of less than 4 m and large areas would not remain open for protracted periods. The stratigraphic profile at the site consists of a zone of residual soil which has been completely weathered to soil with no remaining structure of the rocks from which the soils were formed, being visible. There is some laterite, a more specific sub-grouping of residual soil where secondary iron or aluminium oxides form, present at some location at the site. The residual soil is underlain by saprolite. The saprolite is representative of a portion of the weathered profile which has retained the original fabric and structure of the parent rock. Saprolite differs from weathered rock in degree of alteration. It is material that is sufficiently broken down that it can be augered through or dug with a shovel yet it retains the original rock structure (Anderson & Anderson, 2010). The retention of the rock structure implies that the saprolite has undergone no strain. The saprolite is underlain by weathered rock or Saprock which constitutes the transition zone between saprolite and bedrock. In this zone intact rock material is present in a discontinuous framework separated by soil-like material. Typically saprock is defined by having a rock content of 50 % or more. The rock material can be present in various states of weathering from highly weathered to fresh. Significant zones of soil like material can be encountered within a saprock zone due to preferential local weathering. The saprock is underlain by a stratum of intact rock with no indication of weathering.

Excavation during the operation phase may extend through the residual soil and into the saprolite. This will result in alteration of the geologic soil profile within the area excavated for recovery of gold bearing ore. Removal of the soils to depths of 4 m will result in minor irreversible geologic impacts (low severity, high likelihood). Materials removed from excavations will be returned to the excavation after scalping on the 25 mm screen. The material will however not be replaced at the consistency/compactness at which it existed prior to excavation. Areas excavated for diversion of the creeks shall also be refilled immediately after mining ceases. Mining operations, while not requiring excavations to excessive depths, will alter the geologic profile of the areas mined. This will result in minor irreversible impacts (low severity, high likelihood). No mitigation would be undertaken.

7.2.4.3 Closure

Closure will have no impacts on geology. No mitigation is required.

7.2.5 Water Resources

7.2.5.1 Surface Water

7.2.5.1.1 Construction Phase

Sediment discharge from cleared areas has the potential to reduce water quality in creeks adjacent to cleared areas. Sediment entering surface water may alter the habitat of benthic organisms when they settle. Sediment cloud water and make it difficult for plants, such as underwater grasses, to receive sufficient sunlight to survive. Suspended sediment may limit light penetration and algae productivity. The settling velocity of fine sediment particles is very small. The presence of these particles in the water column affects heat adsorption and the depth of the eutrophic zone. These particles also increase the attenuation of light in the water column which can inhibit photosynthesis activity and reduce the ability of algae to produce food and oxygen. This will affect higher level organisms which depend on primary producers. Sediments may also transport pollutants into surface water. These are moderate reversible impacts (medium severity, medium likelihood). The construction duration will be relatively short. An Erosion and Sediment Control

Plan will be implemented during the project to mitigate potential impacts to water quality from erosion and associated sediment discharge to surface water. The mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Clearing of vegetation will affect water movement, stream channel shape and function and water quality and habitat. Water balance is a measure of the amount of water entering and leaving a system. As rain falls to earth, some of it is infiltrated, absorbed, evaporated, transpired, and some becomes runoff. In a present state, much of the rainfall, incident on the site, is absorbed by the surrounding vegetation, soil, and ground cover. Construction and development of the site will disrupt the natural water balance. In the post-construction setting, the amount of water running off the site would increase and the amount of water infiltration would decrease.

The clearing of vegetation will reduce interception and transpiration and will alter overland flow paths, reduce the amount of water that is able to seep to groundwater sources, and the time that it takes for the runoff to reach the catchment outlet. This reduction in travel time will lead to higher peak flows that reach the catchment outlet much earlier than in the natural state. The increase in runoff will increase discharge to creeks around the construction area and water levels in these creeks.

Construction of mine site facilities will replace vegetated land cover with partly impervious surfaces. Construction works will also include alterations to the natural drainage network to include several ponds, ditches, and conduits on the ground. The impervious surfaces will further reduce infiltration and increase surface runoff and reduce baseflow. These are moderate reversible impacts (medium severity, high likelihood). The area is isolated from receptors and the construction period would be relatively short. Increased water levels in the creeks will not create adverse impacts to receptors and are unlikely to exceed typical adverse wet season levels. These impacts will be mitigated by undertaking most of the construction activities, which may result in increases in stormwater runoff, in the dry season and would be supplemented by detention ponds on site to control runoff discharge from the site. The mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Surface water quality may be negatively impacted during construction by accidental discharges of fuels, oils and grease from construction equipment. Contaminants in surface water can be taken up and become bioaccumulated in aquatic organisms. When larger animals feed on these contaminated organisms, the toxicants are taken into their bodies, moving up the food chain in a process called biomagnification. Contaminants in surface water may bioaccumulate in fish and pose health threat to animals in the project area. Contaminants in accidental discharges can also be transported through surface water by suspended sediments, deposited to stream bottoms and/or resuspended from the sediment bed and transformed by chemical, biological and hydrodynamic processes. These are moderate irreversible (high severity, low likelihood).

The potential for accidentals spills of fuels, oils and grease and the associated contamination of surface waters will be minimized by implementation of a Spill Prevention and Contingency Plan (SPCP). The SPCP will detail measures to be implemented to prevent, and if necessary, contain spills of fuels, oils, or other contaminants. Implementation of these mitigation measures would result in reversible, insignificant (low severity; low likelihood) impacts on surface water quality during construction.

Access road construction and maintenance may include placing culverts at several stream crossings. Culverts constructed through the road may modify the natural flow of surface water and concentrate flows at certain points and increase the speed of surface water flow. Culverts will cause downstream turbulence

where substantial energy dissipation is involved. This turbulence will scour areas downstream of the culvert and undermine and weaken the stream banks. Erosion may also occur on the stream bank due to reverse currents downstream of culverts.

These changes may potentially result in soil erosion, and increased sediment discharge to other streams in the vicinity of the access road. These are major irreversible impacts (high severity, moderate likelihood).

Culvert siting and construction will be preceded by topographic surveys to indicate the position, alignments and the gradient of existing streams and other natural features that influence the drainage system. Where possible the dimensions and capacities of the drainage channels and the natural water courses will be also determined.

To allow flow across the roadway, culverts will be built at the lowest point of the valley. The hydraulic design of culverts will select a culvert capable of passing the design flow without excessive headwater elevation. Culverts will also be designed to ensure that the maximum headwater elevation provides a reasonable freeboard against flooding of the road and is low enough so that no flooding occurs upstream of the culvert crossing. Culvert sizes will also be based on hydraulic, structural, and geotechnical considerations. Culverts will also be placed in the natural channels and will be laid for smooth flow, little excavation, and channel works at the inlet and outlet. Longitudinal culvert profiles will have grades of 1 -3 %, to approximate the natural stream bed. If other profiles are chosen for either economic or hydraulic reasons, the culvert slope, or a slope other than that of the natural stream, will be used if required to prevent stream degradation, to minimize sedimentation, to improve the hydraulic performance of the culvert, to shorten the culvert, or to meet the structural requirements. If the permeability of culvert backfill earth is high, anti-seepage collars would be provided along the culvert. Culverts shall also be lined with grass and/or, riprap, where necessary. These mitigation measures will result in minor reversible residual impacts (low severity, low likelihood).

Surface water quality may potentially be impacted by discharges to surface water of spilled and leaked oil during access road maintenance activities. Contaminants in surface water can be taken up and become bioaccumulated in aquatic organisms. When larger animals feed on these contaminated organisms, the toxicants are taken into their bodies, moving up the food chain in a process called biomagnification. Contaminants in surface water may bioaccumulate in fish and pose health threat to animals in the project area. Contaminants in accidental discharges can also be transported through surface water by suspended sediments, deposited to stream bottoms and/or resuspended from the sediment bed and transformed by chemical, biological and hydrodynamic processes. These are moderate impacts (medium severity, medium likelihood). These impact will be mitigated by identifying specific points on the access road for equipment storage and maintenance. These areas shall have segregated and contained locations with sumps and oil traps. Construction equipment shall be mandated to be provided with leak detection resources. Oils collected from sumps, segregated areas and leak detection devices will be stored in drums and would be disposed of at off-site locations. The mitigation measures will effectively remove any potential impacts to surface water quality. The residual impacts will consequently be minor (low severity, low likelihood).

Removal of vegetative cover over the access road alignment will increase surface runoff volumes and alter drainage patterns in the immediate vicinity of the roadway. Clearing of vegetation will affect water movement, stream channel shape and function and water quality and habitat. Water balance is a measure of the amount of water entering and leaving a system. As rain falls to earth, some of it is infiltrated, absorbed, evaporated, transpired, and some becomes runoff. In a present state, much of the rainfall, incident on the roadway alignment, is absorbed by the surrounding vegetation, soil, and ground cover. Construction and development of the roadway will disrupt the natural water balance. In the post-construction setting, the amount of water running off the road would increase and the amount of water infiltration would decrease.

Clearing of vegetation, for the road, will reduce interception and transpiration and will alter overland flow paths, reduce the amount of water that is able to seep to groundwater sources, and the time that it takes for the runoff to reach the catchment outlet. This reduction in travel time will lead to higher peak flows that

reach the catchment outlet much earlier than in the natural state. The increase in runoff will increase discharge to creeks on the roadway alignment and water levels in these creeks.

Road construction works will include alterations to the natural drainage network to include culverts and other stream crossings. These are moderate reversible impacts (medium severity, high likelihood). The road is remote of receptors. Increased water levels in creeks, adjacent to the road, will not create adverse impacts to receptors and are unlikely to exceed typical adverse wet season levels. These impacts will be mitigated by minimizing the area cleared for the road and undertaking road construction works in the dry season. The mitigation measures will result in minor reversible impacts (low severity, low likelihood).

7.2.5.1.2 Operation Phase

The beneficiation will occur in a closed loop and no water will be discharged from the gold recovery circuit to the environment. Water percolating through mine tailings or waste rock may leach sulfides, if present, from ore and surrounding rock and result in acid drainage. If this acid solution is discharged to surface water, depending on the hydrology of the site, the acid generation potential, as well as the potential for release of other constituents, would increase after exposure to the atmosphere. Tailings are susceptible to leaching because of the increased surface area exposure of minerals. Surface water discharges and seeps from tailings impoundments may contain elevated concentrations of metals leached from the tailings. Acid drainage may contribute to the leaching and mobility of metals. These are moderate reversible impacts (medium severity, high likelihood). All water from the process circuit will be fed back into the current pond being excavated or into a previously excavated pond. Water from mining and the recovery operations will have no impacts on surface water quality.

Water quality may be potentially impacted by wastewater discharges from the onsite sewerage system, domestic wastewater or by stormwater run-off from developed areas such as workshops and other equipment storage and service areas. Discharge of wastewater from these areas to surface water may impair surface water quality by causing changes to its physical, chemical and biological properties. Discharged waste water from onsite sewerage systems may introduce pathogenic (disease-bearing) bacteria into the water body. Pathogens are small in size. Once released into the environment, they are easily transported by water and are often found densely packed on suspended sediments. Pathogens can infect human and animals through skin contact or by ingestion of contaminated water or food. Among pathogens are bacteria responsible for Cholera, typhoid fever, hepatitis and respiratory illnesses. Pathogens are capable of causing varying degrees of illnesses among humans and animals consuming contaminated surface water. These are major irreversible impacts (high severity, low likelihood).

Potential impacts of discharges from onsite sewerage systems and domestic wastewater will be mitigated by channeling wastewater to an onsite septic tank and then through a granular filter bed and by monitoring the “end-of-pipe” water quality before final discharge to surface water.

Surface water quality will also be impacted by stormwater runoff from workshops and other equipment storage and service areas. Contaminants, in stormwater discharged to surface water, can be taken up and become bioaccumulated in aquatic organisms. When larger animals feed on these contaminated organisms, the toxicants are taken into their bodies, moving up the food chain. Contaminants in storm water discharge to surface water may bioaccumulate in fish and pose health threat to animals in the project area. Contaminants in stormwater discharges can also be transported through surface water by suspended sediments, deposited to stream bottoms and/or resuspended from the sediment bed and transformed by chemical, biological and hydrodynamic processes. These are major irreversible impacts (high severity, low likelihood).

Stormwater from workshops and other equipment storage and service areas will be channeled through several oil-water separators prior to discharge to surface water. Water from the on site laboratory will also

be channeled through a filter bed and several oil-water separators prior to discharge. The discharge from the laboratory will also be monitored to determine “end-of-pipe” water quality before final discharge to surface water. These mitigation measures will result in insignificant impacts (low severity, low likelihood).

Surface water quality may be negatively impacted by accidental discharges of fuels, oils and grease from equipment and/or the failure of fuel containment facilities. Contaminants in surface water can be taken up and become bioaccumulated in aquatic organisms. When larger animals feed on these contaminated organisms, the toxicants are taken into their bodies, moving up the food chain in a process called biomagnification. Contaminants in surface water may bioaccumulate in fish and pose health threat to animals in the project area. Contaminants in accidental discharges can also be transported through surface water by suspended sediments, deposited to stream bottoms and/or resuspended from the sediment bed and transformed by chemical, biological and hydrodynamic processes. These are moderate reversible impacts (medium severity, medium likelihood). These impacts will be mitigated by mandating that construction equipment be provided with leak detection systems. Oils collected from sumps, segregated areas and leak detection devices will be stored in drums and would be disposed of at off-site locations. The mitigation measures will effectively remove any potential impacts to surface water quality. The residual impacts will consequently be minor (low severity, low likelihood).

The potential for accidentals spills of fuels, oils and grease and the associated contamination of surface waters will also be minimized by implementation of a Spill Prevention and Contingency Plan. The Plan will detail measures to be implemented to prevent, and if necessary, contain spills of fuels, oils, or other contaminants. Fuel tanks will be founded on impervious bases and will be located within a bermed enclosure designed to hold 110 percent of the contents of the largest tank in the enclosure. Stormwater discharge from fuel storage areas will be channeled to an oil-water separator prior to being discharged to surface water. Implementation of these mitigation measures would result in insignificant impacts (low severity; low likelihood) on surface water quality during operation.

Several creeks will be diverted during the operational phase since these creeks cross the deposit to be mined. If the creek diversions are sized below current flow capacity, flows in the diversions can result in overflow of the diversions and sediment discharge to areas contiguous to the diversions. Creek diversions may modify the natural flow of surface water and concentrate flows at certain points and increase the speed of surface water flow. Diversions may cause downstream turbulence where substantial energy dissipation is involved. This turbulence will scour areas downstream of the diversions and undermine and weaken the stream banks. Erosion may also occur on the stream bank due to reverse currents downstream of diversions. These changes may potentially result in soil erosion. These are major irreversible impacts (high severity, moderate likelihood).

Creek diversions will be preceded by topographic surveys to indicate the alignment and the gradient of the stream to be diverted and other natural features that influence the stream performance. Where possible the dimensions and capacities of the stream will be also determined. The hydraulic design of streams will select a cross-section capable of passing the design flow without excessive. Diversions will also be designed to ensure that the maximum water surface elevation provides a reasonable freeboard against flooding of the road of the mining area. Longitudinal stream profiles will have grades to approximate the natural stream bed. These mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Surface water quality may potentially be impacted by discharge of fuel spills to surface water during transport to/from the mine site. Eggs and young stages are more vulnerable to oil pollution than adults. Even though many species spawn over large areas, direct effects on plankton due to oil spills, have been recorded. Fish will swim away from oil spills and long-term effects on local populations are avoided. However, fish populations moving back into an area following a spill may take some time to recover. Fishes

can also be disrupted if migration routes are changed as a result of an oil spill. Spills that affect spawning migration into rivers can affect fishes in subsequent years. Even very low concentrations of oil can affect

reproduction and feeding in fish. Fish exposed to oil may become tainted by oil-derived substances. Tainting is of particular concern in fish which cannot swim away. Taint is usually lost through the normal processes of metabolism once the oil source has gone, but testing is needed to determine when fish are fit to eat. Natural dispersion and dilution of oil is relatively restricted in areas of shallow water. Oil spills will consequently affect both plant and animal species used for shelter and food. These are potentially major reversible impacts (high severity, low likelihood). These impacts would be mitigated by implementation of the Spill Contingency Plan (SCP). Implementation of measures in the SCP will result in minor impacts (low severity, low likelihood).

7.2.5.1.3 Closure

No impacts to surface water quality will result from closure of the operations.

7.2.5.2 Groundwater

Spills of fuel and oils from equipment and equipment and fuel storage and service areas can flow to the underlying aquifer and potentially impact groundwater quality. Depending on the relative density of the spilled fuel, it will either float on top of the aquifer or sink to the bottom of the aquifer. The contaminant solubility and aquifer porosity characteristics will dictate contaminant concentrations in groundwater. Spilled fuel discharged to groundwater will undergo both aerobic and anaerobic biodegradation processes in the geological environment. Aerobic biochemical degradation of fuels is dependent mainly on the presence and species of microorganisms in groundwater, temperature, concentration of toxic and biogenic elements, fuel contamination and oxygen content of water.

Showering using fuel contaminated water will expose persons to skin dermatosis and sometimes even to skin neoplasia. Fuels will enhance the solubility of organic compounds and thus facilitate their penetration through the skin. The danger of direct poisoning by ingestion is minimal. However, hydrocarbons of lower molecular weights possess significant narcotic effect and may result in acute poisoning by inhalation. Chronic exposure to fuel contaminated water may cause weariness, headache, blood production malfunction and irritation to eyes and lungs. Chronic exposure of skin might lead to degenerative changes in liver, kidneys and spleen. The most dangerous fuel component is benzene, which is a proven human carcinogen. Another significant negative effect of fuels is deterioration of organoleptic properties of water and debasement of water sources in concentrations as low as 0.002 mg. Toxic effect can be observed at higher concentrations. These are moderate irreversible impacts (low likelihood, high severity).

There are no groundwater receptors within 125 km of the project footprint and groundwater. The project will consequently have no impacts on groundwater quality and/or quality for those receptors.

Potential contamination of the underlying aquifer will be minimized by enforcing a program to check for equipment leaks and implementation of a Spill Prevention and Contingency Plan (SPCP). The SPCP will detail plans for utilization of sorbents, biological agents, chemical dispersants, gelling agents etc. All fuel will be stored on impervious surfaces within containment walls designed to contain 110 percent of the contents of the largest tank within the enclosure. Implementation of these mitigation measures will result in insignificant reversible impacts (low severity; low likelihood) to groundwater quality.

7.2.6 Noise and Odor

7.2.6.1 Construction and Operational Phases

Construction activities will produce noise levels above the alert threshold of 86 decibels (dBA) and hazard threshold of 95 (dBA) from heavy-duty and earthmoving machines operation. Maintenance operations in the workshop will generate noise levels in the vicinity of 72-110 decibels. Noise levels from power

generation plants will range from 90-105 dBA. Exposure to noise levels above the internationally accepted level of 90 dBA can cause noise induced hearing loss. Noise levels above the tolerable threshold of 72 decibels may result in fatigue, tiredness, low morale and decreased production levels. Tired workers are prone to accidents which may contribute to an increase in work accidents. These are moderate irreversible impacts (medium severity, medium likelihood). There are no receptors within 125 km of the site and the only noise receptors will be individuals involved in construction activities at the site. These impacts will be mitigated by implementation of the following:

- Installation of sound suppression devices (such as mufflers) on earthmoving equipment, generators etc.
- Avoiding unnecessary idling of vehicles and machinery that are used intermittently
- Employing best available work practices on-site to minimize occupational noise levels
- Provide noise protection equipment to employees

Implementation of these measures would reduce the likelihood and impacts of noise occurrences. Noise impacts to receptors would as a result be minor and reversible (low severity; medium likelihood).

Noise generated by construction activities may prevent animals from approaching or crossing the access road corridor because of fear. Noise may potentially reduce the success of these species and contribute to ecological alteration. These are potentially moderate irreversible impacts (low severity, medium likelihood). Noise impacts will be mitigated by mandating that equipment be maintained to manufacturer's standards. The mitigation measures will result in minor reversible residual impacts (low severity, low likelihood).

Construction activities would be localized to the project area and are unlikely to generate any significant odors. The short construction duration coupled with the absence of odor generating activities will require no mitigation measures.

Activities would be localized to the project area and are unlikely to generate any significant odors. Some odors may be generated from the sewerage management system. There are no receptors within 125 km of the site and the only receptors will be individuals working during the project operational phase. These are minor impacts (low severity, low likelihood). No mitigation will be required.

7.2.6.2 Closure

No noise and/or odor will be generated after site closure. No mitigation is required.

7.2.7 Traffic

The access road to the Mine Site will be upgraded to permit travel at speeds of more than 60 km/hour. The increased speed on the access road can result in some instances of vehicular accidents. These are moderate irreversible impacts (medium severity, medium likelihood). These impacts will be mitigated by posting signs along the roadway to indicate vehicles associated with the mining operation should be given priority of passage. These mitigation measures will result in minor reversible impacts (low severity, low likelihood).

7.2.7.1 Closure

The traffic after closure will be restricted to vehicles periodically accessing the site for the post closure monitoring of the effectiveness of the closure measures. Traffic impacts related to the periodic passage of vehicles will be insignificant (low severity, low likelihood).

7.2.8 Biological Resources

7.2.8.1 Vegetation

7.2.8.1.1 Construction Phase

Dust and combustion emissions generated by equipment during the clearing for mine site facilities may cause injury to plants under ambient conditions of exposure. Pollutants confirmed to cause injury to plants include NO₂, and particulate matter both of which would be generated by equipment operations at this site. Plant injury would depend on physical and biological factors. Plants consist of four organs: roots, stems, leaves, and reproductive structures. The leaf is the principal target for damage, as it is the organ involved in gas exchange, and its damage would be most obvious. The upper surface of a leaf is overlain by a waxy layer referred to as the cutin. Below the cutin is a layer of colorless cells; the upper epidermis. Both the cutin and the upper epidermis protect the leaf from desiccation and mechanical injury. Located beneath the upper epidermis is a layer of photosynthetically active cells. Next are a mass of irregularly shaped and loosely arranged cells. The loose arrangement provides for large intercellular spaces in which gas exchange is facilitated. The lower surface of the leaf is bounded by the lower epidermis, which also functions to protect the leaf.

Emission impacts upon plants may include changes in leaf structure, which may include chlorophyll destruction (chlorosis), tissue death (necrosis), and pigment formation. Visible symptom patterns may result from either acute or chronic exposures. Acute injury may result from brief exposures (several hours) to elevated levels of a pollutant. Tissue necrosis is generally the dominant symptom pattern from acute exposures. Chronic plant injury may result from intermittent or long-term exposures to relatively low pollutant concentrations, with chlorophyll destruction or chlorosis as the principal symptom of injury. These are moderate irreversible impacts (medium severity, medium likelihood).

These impacts will be mitigated by employing the following measures:

- Employing dust suppression technique such as applying water or non-toxic chemicals
- Maintaining construction equipment according to manufacturer's specifications

These mitigation measures will result in reversible minor impacts (low severity, low likelihood).

Construction works will include clearing the mine footprint and areas for camp site facilities. The access road may also be widened from its current average width of 4 m. The areas occupied by the access road corridor, the areas to be mined together with the areas for the workshop and laboratory will be subtracted from the total area available to flora. Cutting of large tracts will make plant regeneration difficult. This difficulty arises since nutrients, contained in the biomass can be washed away by rainwater after clearing. In addition, enhanced leaching, occasioned by clearing, can deplete the soil of nutrients. The absence of nutrients may result in any new vegetation consisting mainly of grass species. Aggressive grass species and shrubs will effectively prevent seed-bearing plants from finding satisfactory living conditions. These grasses serve as a food source for a significant population of birds. The surrounding area is exactly the same ecologically as the cleared area and the area cleared is a very small percentage of the total area. Clearing will consequently result in only minor reversible impacts (low severity, medium likelihood) on the overall area.

Widening of the access road will cut an existing ecosystem into two parts. The two parts created by the road may potentially have less value than the initial whole ecosystem, since ecosystems are characterized by complex, interdependent relationships between component species and their physical environment. The access road may potentially fragment the area into weaker ecological sub-units and may make the entire

area vulnerable to invasion and degradation. This is a direct impact which may be regional, irreversible and long-term. This impact will be mitigated by minimizing the length and width of the new roadway required. The mitigation measures will result in minor reversible residual impacts (low severity, low likelihood).

7.2.8.1.2 Operation Phase

The removal of vegetation for mine site operations will alter the availability of food and shelter for wildlife. Mining may impact biodiversity by changing species composition and structure and may provide access to previously isolated areas thereby enabling exploitation of biological resources from the area. Imported species including weedy plants and insect pests may thrive while native species may decline. Improved access to the mine site areas may result in increased hunting, logging and land development.

Mining can potentially reduce biodiversity either directly, through activities which remove, damage or modify habitats, or indirectly where changes caused by project activities may create situations where species or their habitats can be damaged by activities other than those directly associated with mining. Examples of such indirect impacts include proliferation of weeds attracted to areas disturbed by mining, and exploitation of timber in forests made accessible by construction of mine site infrastructure.

During the operations, areas to be mined will be cleared of vegetation. Clearing of areas to be mined will make plant regeneration difficult since nutrients, contained in the biomass, can be washed away after clearing. The surrounding area is exactly the same ecologically as the cleared area and the area cleared is a very small percentage of the total area. Clearing will consequently result in only minor reversible impacts (low severity, medium likelihood) on the overall area. The potential impacts will be mitigated by revegetating the area after the completion of the mining operation. This would therefore result in insignificant impacts (low severity, low likelihood).

Dust and combustion emissions generated by equipment during operations may cause injury to plants under ambient conditions of exposure. Pollutants confirmed to cause injury to plants include NO₂, and particulate matter both of which would be generated by equipment operations at this site. Plant injury would depend on physical and biological factors. Plants consist of four organs: roots, stems, leaves, and reproductive structures. The leaf is the principal target for damage, as it is the organ involved in gas exchange, and its damage would be most obvious. The upper surface of a leaf is overlain by a waxy layer referred to as the cutin. Below the cutin is a layer of colorless cells; the upper epidermis. Both the cutin and the upper epidermis protect the leaf from desiccation and mechanical injury. Located beneath the upper epidermis is a layer of photosynthetically active cells. Next are a mass of irregularly shaped and loosely arranged cells. The loose arrangement provides for large intercellular spaces in which gas exchange is facilitated. The lower surface of the leaf is bounded by the lower epidermis, which also functions to protect the leaf.

Emission impacts upon plants may include changes in leaf structure, which may include chlorophyll destruction (chlorosis), tissue death (necrosis), and pigment formation. Visible symptom patterns may result from either acute or chronic exposures. Acute injury may result from brief exposures (several hours) to elevated levels of a pollutant. Tissue necrosis is generally the dominant symptom pattern from acute exposures. Chronic plant injury may result from intermittent or long-term exposures to relatively low pollutant concentrations, with chlorophyll destruction or chlorosis as the principal symptom of injury. These are moderate irreversible impacts (medium severity, medium likelihood).

These impacts will be mitigated by employing the following measures:

- Employing dust suppression technique such as applying water or non-toxic chemicals

- Maintaining construction equipment according to manufacturer's specifications

These mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Traffic on the access road and mine service roads during the operation phase would impact the early succession/edge and secondary forest habitats located along these roads by increasing dust, which will settle on vegetation. Dust accumulation on plants has been found to impair biological functions including metabolism and photosynthesis, stunt growth, make them more susceptible to disease, and even cause mortality. Road dust may deposit on vegetation up to one km away from the generation site and may contain pollutants or chemicals that can alter the permeability of the leaves or the pH of the leaves' surfaces (Farmer, 1993). Given the limited geographic scope of this impact, the impact of dust accumulation on plants would be reversible and minor (low severity; medium likelihood). Wetting roads during the dry seasons would reduce this impact to insignificant (low severity; low likelihood).

The project may use equipment that were previously used on other projects. Soil pathogens, insects and fungi can be introduced from these items unless stringent measures are taken to avoid this possibility. These are moderate irreversible impacts (high severity, medium likelihood). These impacts will be mitigated by having all equipment fumigated prior to deployment to the mine site. This will result in minor reversible impacts (low severity, low likelihood).

7.2.8.1.3 Closure

The areas cleared for recovery of alluvial/colluvium ore will be reclaimed after mining ceases. Weeds may be inadvertently introduced during closure. Species which are not invasive in their natural habitats may prove to be highly invasive if introduced to the area during reclamation activities. Non-native species considered for mine rehabilitation would be carefully tried and closely monitored prior to its introduction. Inadvertent weed introduction can occur through the use of seed contaminated with seeds of weeds. Suppliers would be requested to certify that seed supplied is weed free, and seedlings would be closely monitored for signs of unwanted species. During regeneration the area may encounter encroachment by particularly aggressive and unwanted plant species (pests). These pests may result in the loss of some vegetation species. These pest species may have significant effects on native ecosystems by changing fire regimes, changing soil nutrient regimes, increasing soil erosion, eliminating or altering the natural vegetative strata, and displacing native species.

Regrowth in the area after closure may consequently alter the diverse nature of the trees present in the area. This is a moderate irreversible impact (low severity, high likelihood). A weed management program would be implemented to control the spread of pest species. The weed management program will use commercial brands pesticides such as "Round-up" to control weeds and would reduce this to an insignificant reversible impact (low severity; low likelihood).

It is expected that the road will remain in place after site closure. Traffic after closure will be totally for recovery of samples for the continued monitoring program. There would be no impacts on vegetation associated with that infrequent use of the access road after closure.

7.2.8.2 Wildlife

7.2.8.2.1 Construction Phase

Widening of the access road and clearing of the area, for workshop and laboratory facilities, will fragment the area and can potentially impact wildlife since some animal species depend on the existence of other plant and animal species within the habitat for nutrients/food, cover, etc. The areas to be cleared are relatively small in comparison to the available area. Clearing and encroachment will alter several of the

physical conditions including light, humidity and temperature. The installation of facilities and other construction works will form temporary barriers to the movement of animals, including access to water bodies. These are minor reversible impacts (low severity, low likelihood). These impacts will be mitigated by minimizing the area cleared for the facilities and by maintaining wildlife corridors within the cleared areas. The implementation of the proposed mitigation measures will result in insignificant residual impacts (low severity, low likelihood).

The habitat will also become fragmented if the area of land is broken up into smaller and smaller patches. This will make dispersal by native species from one patch to another difficult or impossible and may cut off migratory routes. Isolation may lead to local decline of species, or genetic effects such as inbreeding. Species that require large patches of forest may simply disappear. These are moderate reversible impacts (medium severity, medium likelihood). These impacts will be mitigated by ensuring that a single area is cleared for the mine site facilities. This will result in minor reversible impacts (low severity, low likelihood).

People working on the project may harvest commercially valuable animal and plant species. Species population may therefore decrease due to hunting and trapping. These are potentially moderate irreversible impacts (medium severity, medium likelihood). A term of employment of employees and contractors of the company would be the prohibition of hunting and fishing. In addition, terms of employment for both employees and contractors will forbid trading in species. The mitigation measures will result in minor impacts (low severity, low likelihood).

The physical disturbance and noise produced by equipment may impose additional stresses upon wildlife and may lead to increased migration. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These are potentially major irreversible impacts (high severity, medium likelihood). These impacts will be mitigated by minimizing the extent of the cleared areas and by ensuring that noise levels are maintained at the lowest possible. The mitigation measures will result in moderate reversible impacts (medium severity, medium likelihood).

7.2.8.2.2 Operation Phase

During operation of the mine, wildlife may move away from the area. This displacement will increase competition with wildlife on the periphery of the area. This is a moderate reversible impact (medium severity, medium likelihood). This impact cannot be mitigated.

The physical disturbance and noise produced by mining equipment may impose additional stresses upon wildlife and may lead to increased migration. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These are potentially major irreversible impacts (high severity, medium likelihood). These impacts will be mitigated by minimizing the extent of the cleared areas and by ensuring that noise levels are maintained at the lowest possible. The mitigation measures will result in moderate reversible impacts (medium severity, medium likelihood).

Most animal species follow established patterns in their daily and seasonal movements. The areas through which animals travel on their way to and from feeding, breeding and birthing grounds, and between their seasonal ranges, are known as corridors. If the mine service roads and widened access road intersects or blocks wildlife corridors, animals may cease use of the corridor since animals are reluctant to cross open spaces and may be hit by vehicles using the roads. This may result in potential increase in animal mortality because of collisions with vehicles, or a delay in migration in search of food and for breeding and birthing. These are moderate irreversible impacts (medium severity, medium likelihood). These impacts will be

mitigated by conducting an assessment after the roads are cleared to identify corridors and signs will be posted notifying drivers of the existence of these corridors and speed restrictions will be placed on the

roads in the vicinity of the corridors. The mitigation measures will result in minor reversible impacts (low severity, medium likelihood).

Wildlife species live in communities that depend on each other. Survival of these species depends on soil conditions, local climate, altitude, and other features of the local habitat. Mining operations will result in direct and indirect impacts to wildlife. The impacts will stem primarily from disturbing, removing, and redistributing the land surface. Most of these impacts would be short-term and would be confined to the mine site. Mining operations will displace and possibly destroy wildlife in areas to be excavated and to be used for disposal of mine wastes. The mobile wildlife species, like game animals, birds, and predators will leave these areas, however, the more sedentary animals, like invertebrates, many reptiles, burrowing rodents, and small mammals, may be more severely affected. Mining operations will include relocation of streams and mining of existing streams. Several of these streams may contain fish, aquatic invertebrates and amphibians. The mining of these streams may result in loss of these aquatic resources. This will reduce food supplies for predators which feed on these aquatic resources which may result in the reduction or disappearance of these predators. Some wildlife species depend on vegetation growing in natural drainages. This vegetation provides essential food, nesting sites, and cover for escape from predators. Mining activity may destroy vegetation near streams and reduce the quality and quantity of habitat essential for waterfowl, birds, and other terrestrial species. These are moderate irreversible impacts (medium severity, medium likelihood). These impacts will be mitigated by conducting an assessment of the area and alignment of streams diverted before the start of work. The work on both areas to be cleared and streams to be diverted will be conducted in a phased manner to identify and manage the potential environmental impacts to preclude these impacts from being realized. The mitigation measures will result in minor irreversible impacts (low severity, medium likelihood).

Some animals would be attracted to the open spaces created by the mine and service roads for protection from predators, good food supplies and better travel conditions. This may potentially lead to accidental death and poaching. These are moderate irreversible impacts (medium severity, medium likelihood). These impacts will be mitigated by constraining the areas cleared for the mine and service roads to the narrowest width possible and by lowering the vertical alignment. The service roads will also be designed to minimize cuts and fills and will have relatively flat side slopes with minimal clearing of existing vegetation. The narrower rights-of-way and lower vertical alignment will make crossing easier for animals and will provide longer sight lines for drivers resulting in less frequent collisions with animals. The mitigation measures will result in minor reversible impacts (low severity, low likelihood).

7.2.8.2.3 Closure

The access road will be infrequently used after closure for the recovery of monitoring samples. The infrequent use will result in insignificant impacts (low severity, low likelihood).

7.2.8.3 Aquatic Resources

7.2.8.3.1 Construction Phase

Construction activities may alter the complex dynamic between stream flow and aquatic life. Fish and aquatic species respond dynamically to river flows and changes in discharges and vegetation. Aquatic life must account for extreme flow events ranging from long drought periods to very large floods. Flooding and riverine migration are essential for the survival of many species and biodiversity of aquatic systems, however, this is an interactive process. For example, floods may have significant negative impacts on fish habitats. During floods in-stream vegetation can be removed by scouring, hence heightening competition and increasing susceptibility to predation. In response to these pressures, the population may decline markedly. But fish microhabitats may reduce the impacts of floods: e.g. fish using in-stream vegetation to mitigate the negative impacts of excessive stream flows, for predator avoidance or reproduction. Migratory

and reproductive behavior may be triggered by slight changes in water level, in flow velocity and sediment load caused by construction activities. These are moderate irreversible impacts (high severity, low likelihood). These impacts will be mitigated by minimization of alterations to stream hydrology and by ensuring that new streams replicate the hydrology of the streams they are intended to replace and by reconstructing former streams to their current hydrological parameters. This will result in minor reversible impacts (low severity, low likelihood).

Construction activities will include diversion of some streams and construction of mine service roads. Erosion and sedimentation from construction activities could transport contaminants from the construction areas into the aquatic systems. The introduction of sediment by surface runoff may introduce additional nutrient loads to the streams. The altered nutrient levels can potentially result in eutrophication. Pollution by contaminated surface runoff can also impact water quality in the streams and may lead to denitrification and increased oxygen consumption resulting in an environment less conducive to the survival of fishes. Contaminants could be ingested by aquatic organisms causing reproductive impairment, stunted growth, and other physiological effects. Also, as contaminants naturally break down, they use dissolved oxygen, sometimes significantly reducing the dissolved oxygen content of the water, which can lower spawning success for many fish species and reduce overall habitat suitability for many aquatic organisms. During construction there could be hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel. Hydrocarbons introduced into aquatic environments may change aquatic plant and animal growth, mortality and communities. These are major irreversible impacts (high severity, medium likelihood).

These impacts will be mitigated by implementation of an Erosion and Sediment Control Plan and by channeling contaminated runoff to oil-water separators prior to discharge. The mitigation measures will result in insignificant reversible impacts (low severity, low likelihood).

Several culverts and/or bridges may be built on the site service roads. Constriction of surface water flows at culverts and other road crossings may potentially create currents too fast for some fish species to survive. The service roads may potentially serve as barriers to movement of some aquatic species, especially where culverts are used. This may potentially restrict the migration of fish. These are moderate irreversible impacts (high severity, low likelihood). The impacts on aquatic ecosystems will be mitigated by bridging areas of standing water and by designing culverts to enable the passage of migratory aquatic species by incorporating baffles to slow the flow enough to allow fish and others to swim against the current, and by setting culvert bottoms below the level of the stream bed. Culvert gradients will also be designed to ensure that streambed gradients existing prior to construction of the access road are maintained to the maximum extent practicable. This will result in minor reversible residual impacts (low severity, low likelihood).

7.2.8.3.2 Operation Phase

During mining operations, the water management system will function as a closed loop and no water will be discharged to the environment. Sediment discharge to streams may nevertheless occur from precipitation runoff in cleared areas. Increased sediment discharge to creeks may result in increased mortality caused by gill damage; increased predation due to sedimentation of shelter; increased susceptibility to disease; impaired developmental rates; reduction of suitable spawning habitat; reduced spawning success; modification of migration patterns, impairment of visual feeders, and reduction of light penetration, which impedes primary production, reduces food availability, and alters food webs. These are major irreversible impacts (high severity, moderate likelihood).

These impacts will be mitigated by implementation of an Erosion and Sediment Control Plan and by channeling contaminated runoff to oil-water separators prior to discharge. The mitigation measures will result in insignificant reversible impacts (low severity, low likelihood).

Sewage discharge from the site during operations may introduce nutrients to streams in the project area. The variables representative of trophic state are total phosphorus and total nitrogen. Excessive levels of phosphorus and nitrogen may lead to eutrophication of streams in the mine site area. The excessive nutrient levels will produce more phytoplankton/vegetation than can be consumed by the waterbody. This overproduction will lead to low dissolved oxygen levels, high suspended solids, high algal concentrations, low light penetration and water clarity, odors from algae and changes in species composition. These are major irreversible impacts (high severity, medium likelihood). These potential impacts will be mitigated by construction of septic tanks on the site. All discharge from septic systems will be directed through a leach field before discharge to the environment. The mitigation measures will result in minor reversible impacts (low severity, low likelihood).

Discharge to surface water, during operations, may increase metal concentrations in streams and may create an impoverished aquatic environment. Species of algae and invertebrates which are more tolerant of high metals concentration may, in fact, thrive in less competitive environments. Freshwater aquatic environments may be impacted by accidental discharges during operations. Acid mine drainage from the mine, waste dumps or tailings facility may contaminate the water downstream of the mine site and may result in the death of species resident in streams. During operation there could be hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel. Hydrocarbons introduced into aquatic environments may change aquatic plant and animal growth, mortality and communities. These are major irreversible impacts (high severity, medium likelihood). These potential impacts will be mitigated by implementation of the Spill Contingency Plan. The mitigation measures will result in minor reversible impacts (low severity, low likelihood).

7.2.8.3.3 Closure

Discharges to surface water after closure will only occur after attainment of discharge water quality. The Erosion and Sediment Control Plan will be implemented until the area is adequately re-vegetated. Closure will therefore have no impacts on aquatic organisms. No mitigation is required.

7.2.9 Low Carbon Development Strategy

TAAMOG expressed concerns about the impacts of the project on the proposed Low Carbon Development Strategy (LCDS). The LCDS is outlined in the document “Transforming Guyana’s Economy While Combating Climate Change” dated June 2009 from the Office of the President, Republic of Guyana.

The LCDS aims to build “on previous reforms to further stimulate investment, economic growth and job creation as well as to improve security and social services, protect vulnerable sections of society, and deal with increased climate change induced flooding”. It recognizes that the majority of Guyana’s 15 million hectares is suitable for timber extraction and places an annual value of US \$580.0 million on that resource.

The LCDS recognizes the need for “continuing the modernization of the traditional economic sectors which have generated Guyana’s historical growth and employment”. The document further “prioritizes the modernization of four traditional sectors: sugar, rice, forestry and mining”.

The LCDS is focused primarily on the consequences of deforestation and avoided deforestation. The intent is to ensure a carbon neutral position results from forestry operations. It has very little discussion on the mining sector and proposes “to align all land-use policies with the LCDS - most importantly forestry and mining policies”. It was proposed by the GGMC, as a consequence of the LCDS, that the use of mercury in mining be curtailed entirely.

The project will entail progressive reclamation of areas cleared for mining. The project impacts on forest resources will consequently be carbon neutral. The beneficiation process to be utilized will entail the use of

no chemical reagents thereby ensuring early compliance to the mercury ban proposed by the GGMC. The impacts of the project on the LCDS are consequently minor (low likelihood, low severity). No mitigation is necessary.

8.0 SOCIO-CULTURAL IMPACTS AND RISKS

This section of the ESIA documents key socio-economic findings and issues/concerns related to the project. As highlighted in the socio-economic baseline there are very few communities located in close proximity to the project. The closest community is more than 120 km away from the mine site, consequently there are no direct impacts on communities and/or indigenous villages. However there would be potential indirect impacts that create social risks due to the project such as possible influx in the remote areas due to upgrading of the access road to the site. In this section the potential impacts and risks are segregated by project component and phase (wherever appropriate) along with a rating of the impacts.

8.1 Construction and Operation Impacts

Mining projects stimulate economic growth. The project will require a workforce of several hundred people. During operation the project will provide direct and many more indirect employment opportunities. Since mines often project an image of wealth, it may attract people seeking jobs to increase both their income and provide a better livelihood. The project will stimulate economic growth both in Region 7 and in Guyana. This growth may result in increased education levels, improved public health and improved public infrastructure. The mine will also provide gold required to support growth of human civilization.

The development of the mine and potential employment opportunities may attract people to the site for work. Currently hiring is done out of offices in Georgetown and no recruitment is done on the site. If the recruitment process is not streamlined and made known to the general public, a potential exists that people will come to the area looking for jobs at the site. There is a possibility that the development of the mine may attract local vendors, service providers and even prostitutes into the area. Social interaction with other groups is also likely to bring about an increase in alcohol and drug abuse, prostitution and crime.

The influx of individuals seeking work and individuals intending to provide goods and/services to the mine could potentially increase pressures on existing resources in the area. The site is in a remote area which lacks resources and infrastructure. Increases in population related to goods and service providers will pressurize the limited resources such as land, water, forest use and the current goods and services in the area. In addition, uncontrolled access to the area may create security issues and result in increased crime and indirect impacts on communities in proximity to the mine site.

The uncontrolled influx of people from outside could possibly create health risks to Sun and Sand employees and vice versa. This may be manifested in the form of increased transmission of contagious and other diseases. Influx of sex workers often leads to rise in HIV and other STD. The circulation of money from wages and salaries would sustain all of the workers' leisure activities. This may increase the demand for alcohol, drugs and sexual services especially for those migrant and expatriate workers. In the mid-term this may bring about an increase in sexually transmitted diseases. These are moderate reversible impacts (high severity, low likelihood). The mine site is not directly linked to any community and all traffic to the mine site must pass thru Itaballi. These impacts will be mitigated by working with the Itaballi Village Council to control access to the mine site. In those instances where individuals are able to get to the access road by bypassing Itaballi, Sun and Sand will liaise with GGMC to control access to the mine site. In addition, Sun and Sand will incorporate into their employment contract a stipulation that dismissal will result for employees who patronize service providers. The mitigation measures will result in minor impacts (low severity, low likelihood).

The project will create a demand for skilled labor. While there is a limited knowledge base for skilled jobs using heavy-duty equipment, persons surveyed expressed a willingness to be trained in these areas. The project may therefore result in people in the communities acquiring new skills. The demand for skills may

result in improved education standards and services in the communities. This is a moderate impact (medium level of enhancement, high likelihood). This impact would not be mitigated.

There are several small and medium scale miners surrounding the Concession. Conflicts may develop between these miners and Sun and Sand as the miners begin to find that areas previously used to extract ore are now more closely controlled by the company. These are moderate irreversible impacts (low severity, medium likelihood). These impacts will be mitigated by developing a system of interaction between Sun and Sand and the miners. Interaction between Sun and Sand and small and medium scale miners will result in the small and medium scale miners working outside of the boundaries of the concession controlled by Sun and Sand since Sun and Sand will inform the GGMC and EPA of the presence of illegal activities within its concession. The mitigation measures will result in insignificant impacts (low severity, low likelihood).

The project will introduce chemical free technology to Guyana gold mining industry and will serve as a demonstration project for application elsewhere. The Government of Guyana and the GGGMC has recently stated their intention to phase out mercury use in the gold mining industry within two years. The GoG and GGMC would be able to point to this project as a successful example of the utilization of benign methods for gold recovery from alluvial deposits. This is a major impact (high level of enhancement, high likelihood).

Opportunities of paid employment may change the traditional division of labor between men and women in communities in close proximity to the mine. Residents may alter their lifestyles after exposure to culture and lifestyles introduced by Project employees, from areas remote to the communities in the Project area. If traditional farming and food gathering practices are abandoned, residents may develop a dependence on job opportunities to provide for their families and their existence may be determined by their spending power. This may disrupt social cohesion within communities where cultural norms and values are still treasured. These are moderate impacts (medium severity, medium likelihood). These impacts cannot be mitigated.

The road will follow the existing roadway alignment between Itaballi and Quartz Stone and will not introduce impacts beyond those currently existing to communities along the road. The project will not result in significant increases in the level of traffic on the Itaballi to Quartz Stone road. It is predicted that a maximum of four 15 tonnes supply trucks will pass over the road each week to maintain the project. The alteration in traffic volume would result in minor impact (low severity, low likelihood).

The upgraded road from Itaballi and Quartz Stone would impact positively on the social sectors particularly in health and education. With improved access health workers would be able to visit communities more regularly and sick persons would be able to reduce the time needed to receive medical attention by using the improved access to get to hospital. This is a potential moderate impact (medium level of enhancement, high likelihood).

8.2 Landscape and Visual Resources

The project will not alter the vertical dimensions of the landscape or the materials present therein. In addition, the color, reflectivity and visible emissions will be essentially unchanged from current levels. Landscape and visual impacts will result from widening of the access road from Itaballi to Quartz Stone and the flow of traffic over this road. These impacts will be minor (low severity, low likelihood). These impacts will not be mitigated. Additional landscape and visual impacts will result from clearing of greenery for recovery of alluvials. The scale of the area to be cleared is however relatively small in comparison to the overall area and would be shielded and adsorbed by the adjacent forest. The impacts of clearing will be minor (low severity, low likelihood). These impacts will not be mitigated.

8.3 Heritage

Removal and destruction of artifacts currently in the project area will compromise the quality of these artifacts. In additions, if artifacts exist below ground in the project area, removal of the ground cover may alter the pressure required to maintain the integrity of these artifacts. Changes in water conditions may also compromise the quality of any artifacts located below ground in the project area. If artifacts are present in the area their quality may be compromised. These are irreversible moderate impacts (medium severity, low likelihood). These impacts will be mitigated by preparing an archaeological watching brief for implementation during earth moving, topsoil stripping and excavation. Archaeological evidence would be recorded and artifacts should be removed or preserved in place after consultations with the Guyana National Trust. The mitigation measures will result in insignificant impacts (low severity, low likelihood).

8.4 Land Use

The primary land use activities in the area are mining and forestry. The land will be initially used for mining and will be reconverted to forestry after mine closure. The project will result in no impacts on land use. These impacts will not be mitigated.

9.0 CUMULATIVE IMPACTS

9.1 Introduction

Cumulative impacts are defined as the combination of multiple impacts from existing projects, the proposed project, and/or anticipated future projects that may result in significant adverse and/or beneficial impacts that would not be expected in the case of a stand-alone project. Presented herein is a description and analyses of potential cumulative impacts of the proposed mining project and past, existing, or future actions/projects on the natural environment, social and economic conditions, and community health.

9.2 Scope of the Cumulative Impacts Assessment

A cumulative impact assessment is only useful to decision-makers and stakeholders if it is limited to effects that can be meaningfully evaluated instead of exploring infinite possibilities. The three important aspects which must be considered prior to the evaluation of cumulative impacts are as follows:

1. Identification of the resources and/or receptors at risk and likely to experience interactions with the Project;
2. Determination of the appropriate spatial and temporal boundaries for evaluation; and
3. Identification of relevant past, existing, and future actions/projects for consideration.

9.3 Potential Cumulative Impacts

Region 7 is well known for its gold mining activities and has historically been the lead geographical region in gold and other mineral resources exploitation. Anecdotal evidence from communities within the project's area of influence indicate employment in mining and logging in addition to other subsistence livelihood activities are the main sources of livelihood in the Region.

The gold mining project at Quartz Stone is one of several long term mining projects (Aurora Gold Mine and SandSpring Resources being others) proposed for Region 7. Additionally, there are a number of largescale (TSAs) logging projects within the region. The Quartz Stone Mining Project in addition to the AuroraGold Mine and SandSpring Resources Gold and Copper project and several logging operations may be significant sources of employment, training, and revenue for the region. The success of this project may encourage the development of additional mining concessions by other mining companies which could lead to greater levels of employment and extend the duration of the increased employment as well.

The Itaballi-Quartz Stone road access is critical to the economic success of many large scale investment projects as well as other economic development activities within the Region in that it provides the access way to a vast majority of exploitable natural resources such as timber and minerals. Currently, the road is utilised by a number of major stakeholders including TSAs holders such as Puruni Wood Products Ltd,

A. Mazarally and Sons Ltd, Garner Forest Industries Inc., and mining concessions such as Peter's Mine in addition to many small and medium scale miners and other persons accessing the area.

The upgrade of the mine access road from Itaballi to the mine site may lead to migration of people to the project area to access and exploit resources to support their livelihood activities. Improved access to the project area may consequently result in increased mining, logging, agriculture and other livelihood activities such as subsistence farming, fishing, and hunting. The presence of foreign companies in the area may result in rumors of major gold finds in the area. This may potentially result in a proliferation of artisanal mining

activities in the area, both illegal and legal operations and an increase in the number of businesses associated therewith such as shops, hotels, and brothels.

An upsurge in uncontrolled resource extraction activity and other knock on activities may have significant adverse effects on the natural environment, social and economic conditions, the overall health of the area and Region. These are major irreversible impacts (major severity, medium likelihood). These impacts will be managed by implementation of a Multi-Stakeholder Influx Management Committee. This committee will be comprised of representatives of each community, GGMC, GFC, major stakeholders such as loggers and miners and Sun and Sand. The committee will provide an ongoing mechanism to manage and respond to attempts by unauthorized persons to access the areas adjoining the access road and mine site to exploit resources construed to be present in those areas. This committee will meet quarterly or with greater frequency if circumstances dictate, to discuss access issues and concerns related to development of the access road and mine site. At a minimum the committee will conduct periodic stakeholder and access management reviews. These measures will result in insignificant irreversible impacts (low severity, low likelihood).

10.0 ENVIRONMENTAL MANAGEMENT PLAN

An applicable, relevant and appropriate Environmental Management Plan (EMP) has been developed to mitigate and minimize the environmental consequences identified in Sections 7, 8 and 9. The EMP incorporates protection, mitigation, and enhancement measures. A separate monitoring plan has been developed to assess the effectiveness of the management plan. The environmental mitigation measures in this EMP include:

Production technology, disposal methods, and engineering designs

Pollution controls, recycling and conservation of resources, monitoring, special social services or community awareness and education and

Compensatory measures for restoration of altered resources

Monitoring would be undertaken to evaluate the success or failure of the environmental management plan measures and to reorient the EMP, if required.

The EMP is intended to ensure that impacts which cannot be mitigated are minimized to the maximum extent possible and that positive impacts are enhanced. The EMP will ensure that impacts which cannot be mitigated do not exceed tolerable limits. Wildlife and vegetation impacts are not exactly mitigated by the provisions of the management plan, however, there is a relative abundance of similar vegetation and wildlife in the surrounding area.

It is expected that wildlife will return to the area after completion of the mining operations and site closure. Regrowth may result in the introduction of some plant types not initially present in the area.

10.1 Biological Resources

Access would be controlled to areas identified as being important for biodiversity that do not need to be disturbed during operations, to prevent inadvertent destruction of habitats or disturbance of species. In particular, corridors that allow safe movement of fauna will be protected and maintained, especially where larger animals may move through the area. In areas where extensive clearing has already occurred, resulting in the fragmentation and degradation of remnant habitat, the company will implement controls to prevent further fragmentation and isolation of fauna populations.

If areas are identified to be protected during operations, these areas will be clearly demarcated to avoid inadvertent destruction through ignorance or carelessness. Sun and Sand will also implement controls to prevent vegetation and associated fauna from being harvested and removed from the site.

Sun and Sand will also implement a program to maximize the use of seed and other plant propagules, soil nutrients and soil biota, decaying organic matter, logs and other potential fauna habitat that can be used for mine site rehabilitation by integrating clearing operations with the requirements of subsequent rehabilitation operations. The Project Proponent will also implement a program to prevent the introduction of pest plants and animals to the project site. Employees will be strictly advised to not bring or keep native animals as pets. All vehicles will be washed/disinfected to control weeds and plant diseases.

Gaps in biodiversity data for the site identified by the baseline phase of the ESIA, will be filled by undertaking additional work to increase the knowledge base and to close these gaps. These gaps include understanding the impacts of land use changes in the area that may have resulted from secondary impacts

and the behavior of invasive pests and includes integration of species recovery programs and other detailed studies of patterns of usage of biodiversity by local fauna.

The operational stage will include selective handling of overburden materials, topsoil management to conserve nutrients and plant propagules, construction of landforms that will control erosion and prevent any long-term impacts on the biodiversity values of surrounding waterways, and progressive rehabilitation of areas as they become available.

Regular monitoring through audits, observation, and surveys would be performed to evaluate the effectiveness of biodiversity management programs. Mine site employees will also be trained to identify and report uncommon flora and fauna species that may not have been detected during the baseline surveys.

New vegetation will be planted in the areas exploited for ore after mining ceases. Ditches dug for the diversion of creeks will be refilled to eliminate barriers to the passage of animals. Vegetated corridors will be maintained and gradually removed during construction to enable wildlife present in the area to relocate to adjacent areas. Construction, including diversion of the creeks, will occur in a manner slow enough to ensure that animals and aquatic life can move to other locations. If aquatic life and animals are stranded during the diversion of creeks, these animals will be trapped and will be relocated to the diverted creeks.

Buildings will be sited within areas which were previously cleared and the footprint of areas identified for mining together with the access road will be minimized. Particular attention will be paid to vulnerable or conservation worthy plant and animal species that will be affected and conservation measures will be enforced in consultation with the EPA Biodiversity Unit. All discharges from workshops and the laboratory will be monitored to ascertain that discharges are safe for fish, as well as people. The company will restrict hunting for wildlife in the Project area by non-indigenous peoples. Access to the concession by non-indigenous persons, not employed by the Project, will be restricted and the workforce will be educated about the consequences of hunting. The Project Proponent will also establish a reporting mechanism for hunting incidents within the concession.

The area will be revegetated with indigenous species after completion of mining as part of the Closure Plan. Primary and secondary site roads will be identified and site roads no longer needed would be closed to employees. The revegetation program will be tested on these closed roads to develop an appropriate revegetation program. The Project Proponent will enact a policy to ensure no plants or wildlife is removed from the mine site. In addition employees will not be permitted to bring plants and wildlife from other areas to the mine site.

10.2 Excavated Area Management

Improper design of the excavated areas coupled with improper excavation operations may result in slope failure and pose threats to workers health and safety and equipment. The depth of areas to be mined will be limited to a maximum of 4 m. Excavation slopes will be designed based on the properties of the soils to be excavated to preclude slopes failures and slides. Excavated soil will not be stored at the crest of slopes and will be fed back into the previously mined area.

Since discharge of contaminated water through the base of the excavations can result in groundwater contamination, equipment will not generally be serviced in the excavations. Vehicle and equipment servicing, in these areas, will be restricted to emergency repairs only. In the event of emergency repairs, work will be undertaken to ensure there are no oil and/or fuel spills in the excavations.

The mining operation will occur as a closed loop system and all water within the area being excavated will be used to beneficiate the ore and would be returned to the pond currently being excavated or into a previously

excavated pond. Overflow from these ponds will be prevented by surrounding the ponds with berms built to contain the design storm from results of the hydrological analyses undertaken for the project. Berms will be maintained at the edge of excavations to prevent surface runoff from entering the excavations and from adding to the volume of groundwater inflow and direct precipitation.

10.3 Overburden Waste Management

To reduce discharge of overburden spoils to surface water only pay dirt will be excavated from the ponds. To minimize excessive land consumption and the associated clearing of forested areas, material scalped from the 25 mm sieve will be immediately returned to the excavations. No overburden material shall be placed outside of excavations. Overburden placed back into excavated areas will be surrounded by a soil containment berm to preclude the easy flow of surface runoff and sediment. The containment berms will be constructed of soil pervious enough to enable the passage of surface runoff water while trapping sediment contained in that runoff. All excavated areas will be backfilled, seeded and revegetated after closure.

Overburden waste dumps will be constructed to ensure that the rehabilitation plan will minimize erosion potential and facilitate a drainage system that reflects the final drainage network. If the presence of acid or other undesirable leachate-producing material is detected by laboratory tests, these materials will be provided with an impermeable cap in the waste dump. Alternatively, if the material is determined to be inert it will be placed at low density to encourage infiltration.

Where possible, natural drainage paths would be maintained, and room would be left around the top of excavated areas for interception of surface runoff drainage. Berms around excavations would not be constructed immediately adjacent to natural watercourses. Provisions would also be made to preclude runoff, leachate and seepage from mining area from entering surface water bodies.

Room would be left in the vicinity of mining pit to construct retention ponds or drains around these pits to direct surface runoff into other ponds for the removal of suspended materials. Efforts will be directed to ensure no culverts are located immediately downstream of overburden waste areas since high sediment load in waste area runoff may block these culverts. If this is not possible, sediment retention dams will be located upstream of the culverts. Culvert inlets would also be designed to maximize velocities into the culvert to ensure that sediment is removed from the outfall.

Severe rilling on overburden waste dumps and the problems associated with high sediment loads in waste dump runoff will be reduced by proper design and construction of the waste dumps. This will include incorporation of batter slopes, benching, armouring and drains.

If acid drainage and other leachate formation are to be minimized by capping waste dumps with impervious clay, there will be very high volumes of runoff. Erosion controls will be incorporated into these areas to preclude runoff. These controls may include properly designed drains, drop structures, armored batters and immediate placement of topsoil and grassing. The impervious material will also not be excessively dispersive clays.

Waste dumps will be designed to allow for surface water infiltration, if seepage of water into the waste dump will not cause structural instability or result in contaminated leachate and groundwater seepage. This will reduce runoff volumes and erosion. Increased infiltration would be achieved by contour ripping of the surface, and by creation of small detention ponds or sink holes on top of the stockpile.

10.4 Water Management

Temporary ponds will be designed to provide adequate capacity to contain the design rainfall event and to eliminate the likelihood and frequency of overflows associated with precipitation events and to prevent the discharge of contaminated water and sediments to surface water and overtopping of berm surrounding work

areas. Site clearing operations will progress in a gradual and phased manner to ensure there are no large increases in sediment discharge. Sediment control structures will be used to prevent the inflow of

sediments to surface water. These control practices will include sediment traps and screens to control runoff and sedimentation.

Precipitation data, topographic maps and stream flow measurements will be used during the design of temporary ponds to prepare hydrographs and frequency curves for use in estimating volumes of precipitation. Precipitation data from wet and dry years will be used to provide minimum, average, and maximum precipitation volumes to determine storage capacity for the temporary ponds. The design of the ponds will include capacity to store precipitation incident on the ponds during rainfall. Surface runoff from other areas of the site will be channeled away from the ponds currently being excavated.

Workshop management will include frequent inspection of storage tanks and piping for corrosion. Both above ground and underground facilities will be constructed within the workshop to collect leaks and contain minor spillages outside the bunded area during refuelling operations. Water contaminated within bunded areas during rain events will be collected and diverted through oil interception or separation facilities. Fuel dispensing facilities will also be designed to prevent drips and spillage. All workshop areas will be covered to prevent storm water in those areas from picking up contaminants. Separate collection systems will be provided to separate clean and contaminated water streams from within and surrounding the workshop area. All oil contaminated water will be diverted to a separation system ranging from simple concrete sumps through to oil water separators, skimmers or centrifugal separators.

Surface runoff from the workshop and other vehicle service areas will be channeled to oil/water separators. All water from the oil/water separators will be skimmed prior to discharge. The operations will monitor discharges to surface water upgradient and down gradient of the site.

10.5 Hazardous Material Management

The four common characteristics of hazardous material are ignitability, corrosivity, reactivity and toxicity. Each substance to be used for this project will be evaluated to identify both physical hazards (e.g., flammability or reactivity) and health hazards (e.g., carcinogenicity or sensitization). The hazard determination will form the basis for the hazard information which would be provided on hazardous material tags, signs, and employee training.

A hazardous material management program will be implemented to handle hazardous materials safely and efficiently and to minimize present and future costs due to improper management. Hazardous materials at the mine site are expected to include waste oils and grease from work shop operations and from vehicle. The Project Proponent will develop a system to track all hazardous material used by the project. The system will maintain a hazardous materials inventory. The inventory will track each hazardous material from the time it is dispatched to the site until it is fully used or disposed as a permitted environmental release.

To ensure minimization of hazardous material use, The Project Proponent will procure Hazardous Materials in the smallest practical size and quantity and will maintain a sensible stock level. Open containers of hazardous materials will be used first and no hazardous materials will be stored in work areas. When the task which requires use of the hazardous material is completed, residual material will be returned to the designated storage area. The Project Proponent will also non-toxic materials for toxic materials when possible.

All hazardous liquid storage areas will be provided with secondary containment. This will include drum areas for storage of smaller quantities of liquids. The secondary containment will be equipped with overflow

protection and their surfaces would be visible on all sides to allow for leak inspections.

Hazardous materials will be located in secure storage facilities on-site to prevent accidental release and to protect against rainfall that may result in contaminated run-off and leaching. All storage areas for hazardous material will be concreted to provide an impervious surface and to prevent uncontrolled discharges to groundwater. Material Safety Data Sheets (MSDS) will be kept on site and all measures to contain spills of hazardous materials shall be in accordance with the procedures therein. No rainfall would be allowed to percolate through areas where hazardous materials are stored and no uncontrolled run-off will be permitted from these areas.

Since segregation is one of the most important factors required to ensure a successful hazardous waste management program, operation personnel will use the original empty product can or container (provided it is in good condition) to collect the hazardous wastes whenever possible. The containers used will be small enough to easily be handled and filled-up in less than 90 days.

Flammable hazardous wastes will be stored in containers approved by the EPA. Since metal to metal contact and the use of electrical devices while working with stored wastes may cause sparking, all storage containers will be properly grounded when transferring flammable wastes, and while being used to store flammable solvent wastes.

Hazardous wastes will be packaged and labelled correctly so that they can be transported and stored safely pending disposal. Wastes will be packaged in tightly closed containers, either in the original container or ones approved by the EPA. Most wastes would be collected in the original containers, provided the containers show no signs of deterioration or damage. The containers construction material would also be checked to ensure that it is chemically compatible with the contents to be stored.

Storage containers will be tagged with the name of the substance, and the beginning date of initial storage. Hazardous waste containers will be segregated from other materials and signs will be placed along the limits of the storage areas warning of the potential danger. All hazardous waste containers will be color coded to indicate if the contents are toxic, corrosive, flammable or reactive.

Incompatible substances that can react upon mixing to generate heat, fire, gas, explosion, or violent polymerization will not be located within proximity of each other. Hazardous material will be disposed of in accordance with guidelines established by the EPA.

10.6 Waste Management

The following waste will be generated by the project:

- solid waste, including food waste from the camp operations
- septic waste from the camp operations
- construction waste, used batteries, tyres and scrap metal

All food waste and organic matter will be composted and the composted material will be used as fertilizer for revegetation of the cleared areas after closure. At any given time, the temperature of a pile of organic waste reflects the balance between microbial heat generation and the loss of heat to the surroundings. The rate of heat generation during composting is a function of factors such as temperature, oxygen, water, nutrients, and the remaining concentration of easily biodegradable organic materials. The rate of heat loss is a function of factors such as ambient temperature, wind velocity, and pile size and shape. Temperature is

a powerful determinant of the rate of decomposition. The range of favorable temperatures for composting is 20 to 60°C. Temperatures at this site fall within this range which qualifies all organic waste for composting.

Sewerage waste will be managed by a septic tank on site. Discharge from the septic tank will be channeled through a sand filter. The sand filter would be made of a buried plastic liner filled with sand and gravel. The coarse sand filter will create an oxygen rich surface area for sewerage treatment. Microbes in the sand filter will consume most pollutants out of the water before it flows to the drain field. The sand filter will discharge to a drain field before discharge to the environment.

Solid waste from the operation of the camp will be disposed of in secure areas designed in accordance with guidelines provided by the EPA.

10.7 Land Reclamation

The land reclamation program will restore the area to pre-mining conditions and will focus particularly on restoration of native ecosystems. This will ensure that reclamation of the area will replicate the pre-mining land-use and ecological value of the mine site area. If the pre-mining land use and ecosystem prove difficult to restore, the land reclamation will focus on the return of low maintenance native vegetation.

Sufficient personnel and resources would be allocated during mining to enable progressive rehabilitation without impeding production. Funding for final rehabilitation would be considered during mine planning and money would be budgeted while the mine is operational for progressive reclamation works. A detailed description of planned reclamation activities is presented in the Closure Plan.

All mined out area and creek diversions will be refilled and will be revegetated after mining ceases. The creeks will all be restored to their original alignment and depths and would be regraded to fit into the surrounding topography. Erosion controls would be applied around regraded areas to minimize soil loss prior to vegetation taking hold. Minimum compactive effort will be exercised during regrading to ensure that the soil compaction does not prevent stormwater infiltration. This will ensure the soil would be able to fulfill its diverse functions as a water reservoir, a biotope for plants and animals, and a basis of agricultural production. Regraded areas will be covered by humus to enhance conditions for revegetation.

10.8 Air Quality, Dust and Noise

Dust suppressants will be used to control dust emissions from site roads, spoilpiles and stockpiles. The preferred dust suppressant to be used would be water. Watering roads is the most common method used for haul road dust control. Its application is the simplest and the easiest of all dust control measures, as it does not require any road preparation prior to application. Application would be achieved through the use of a water truck which will spray water onto the road. However other such as petroleum emulsions, polymers, and adhesives would be used if available as a by-product of the site operations.

Surfactants or wetting agents may be added to the water to extend its life as a dust control agent. Like water, surfactants would not require any special application procedures. Surfactants work by reducing the surface tension of water. This allows the particles from the road surface to better penetrate the water droplets, thereby increasing the potential surface area coverage of the droplet (i.e., the penetration of the water droplet lets the water wet a larger surface area). The reduced surface tension also permits easier penetration of the treated water into a few inches of the subsurface. This action will allow the wetted subgrade to act as a reservoir of water such that, once the surface moisture evaporates, the subgrade can provide moisture for dust control through capillary action, thus extending the life of the water.

Dust emissions from site road will also be reduced by limiting vehicle speeds. Since this may conflict with the project production schedule, haul trucks would be allowed to operate at speeds which will not affect the production schedule.

Since more dust will be generated by trucks working in batches following each other, traffic controls will be implemented to ensure that the interval between trucks passing the same point is no less than 20 seconds. This interval has proven to result in up to a 52 percent reduction of respirable dust exposure to the trailing truck driver. Additionally, this 20-second time interval will allow for the dust cloud generated from the lead truck, which can impair the visibility of the trailing driver, to dissipate. This will also reduce the possibility of an accident due to impaired visibility from the dust generated by trucks.

All mobile equipment would be provided with computerized engine controls coupled with on-board diagnostic systems to ensure optimized operation of the combustion process. The optimized operation controls regulates fuel-to-air control, spark timing, and enhances control settings for engine control devices, such as exhaust gas recirculation valving. This optimization will minimize hydrocarbon and Carbon Monoxide emissions as well as oxides of nitrogen.

Engineering or administrative controls or a combination of both will be used to reduce noise exposures. Special considerations would be afforded to multiple noise sources, a situation common in the mining industry. Multiple noise sources present unique challenges in their control. The effectiveness of noise controls on multiple noise sources will be systematically evaluated to determine that source's contribution to a total noise emitted. All equipment to be used for the project will be purchased from the manufacturer with the noise controls already engineered into the unit. If the equipment is not purchased with noise control equipment, it will be retrofitted to ensure the availability of the appropriate engineering controls. Damaged noise control equipment will also be replaced during scheduled rebuilds. Administrative controls which will be used to reduce noise exposure include performance of equipment maintenance work during idle time and work rotation.

Noise will also be reduced by incorporating acoustical materials which will reduce noise either by absorbing or blocking sound waves, or damping vibrations. These materials, referred to as absorption, barrier, composite, and damping materials can substantially increase the effectiveness of other acoustical devices. Selection of appropriate acoustical materials will be made based on a firm noise control engineering basis and will be commensurate to the task, properly installed, used, and maintained. Acoustical devices include, but are not limited to, mufflers, silencers and enclosures.

10.9 Employee Health and Safety

The Project Proponent would set up a health and safety management system to implement a health and safety policy which is proportionate to the hazards and risks. Risk assessment methods would be used to decide on priorities and to set objectives for eliminating hazards and reducing risks. This would include a program, with deadlines for the completion of the risk assessment process, together with suitable deadlines for the design and implementation of the preventive and protective measures which are necessary.

The risk assessment will select appropriate methods of risk control to minimize risks. Priorities would be established and performance standards would be developed both for the completion of risk assessment(s) and for the implementation of preventive and protective measures, which at each stage will minimize the risk of harm to people. Wherever possible, risks would be eliminated through selection and design of facilities, equipment and processes.

Employees and their representatives would be involved in the performance of risk assessments and in deciding on preventive and protective measures and implementation of health and safety requirements in the workplace. It will use formal health and safety committees and teamworking, to ensure that employees are involved in deciding on appropriate preventive and protective measures and health and safety written procedures.

The company will establish communication and consultation procedures to ensure the positive approach to health and safety is visible and clear. Health and safety information would be communicated to all employees and their representatives, so informed decisions can be made about the choice of preventive and protective measures. Standards would be established to judge the performance of individuals with health and safety responsibilities to ensure they meet them. A health and safety monitoring regime will also be established to measure the success of the health and safety policy and to assess how effectively risks are being controlled.

The Health and Safety Plan implemented by The Project Proponent will ensure compliance with the regulations of the OSH Act 1999. The plans will apply to the following:

- Industrial Accident prevention and management
- Occupational Hygiene.
- Illness & Infectious disease prevention and management.
- Sewage and Waste Disposal.

Safety inspection would be undertaken periodically. The objectives of safety inspection would be the following:

- to identify hazards
- to examine compliance with safe systems at work, the use of personal protective equipment, safe use of substances, etc;
- to examine the workplace as part of an accident investigation;
- to examine maintenance and housekeeping standards and
- to ensure employees are adequately protected against risks to their health and safety.

Safety inspection will entail walking the workplace, internally and externally, observing working practices and identifying hazards and shortcomings in the employer's protection arrangements.

10.9.1 Industrial Accident Prevention and Management

An accident is defined as an unplanned and uncontrolled event which can lead to or could cause injury to persons, damage to plant or other loss or as an undesired event which can result in physical harm to a person or damage to property. It usually results from contact with a source of energy above the threshold limit of the body or structure or an unexpected, unplanned event in a sequence of events that occurs through a combination of causes. It results in physical harm (injury or disease) to an individual, damage to property, business interruption or any combination of these.

The company will implement a safe work system to prevent accidents. The system will involve people in planning operations and will provide information, instruction and training and identify and remove hazards at the design stage of work activities. Site equipment will be properly maintained to ensure their safe working and employees will be provided with information, instruction, training and supervision in the correct operation and use of equipment.

alkalis, flammable substances, poisons, carcinogenic and mutagenic substances, in terms of handling, storage and disposal of waste products.

The Industrial Accident Prevention and Management safety program will commence during the construction phase of the facility and last through the operating phase until the cessation of operations. The program will include the following:

1. Hazard identification and control.
2. Monitoring and reporting of industrial accidents.
3. Training or education of employees in industrial first aid.
4. Industrial Accident Protocol.
5. Fire Safety & Preparation.
6. Hazard Identification and Control

The Project Proponent will provide various forms of personal protective equipment (PPE) under the Personal Protective Equipment regulations. Employees would be mandated to use and wear PPE in defined work situations. PPE will be carefully selected and will be appropriate for the risks it is designed to provide protection against.

Table 35 lists the potential hazards in different phases of the operations of the facility and the preventative and remedial activities necessary for their elimination and control. In addressing these hazards, the first priority will be their elimination via modification in the design of equipment or process. If this is not possible or feasible and the hazard cannot be eliminated, then the employees will be provided with the necessary safety protective gear to prevent any injuries during the work process.

Table 35: Potential Hazards

Phase	Potential hazard	Protective & preventative safety measures
1. Clearing of Site & Construction of Living Quarters: felling trees, removal of topsoil & overlying vegetation, assembly of building	Falling Trees Insect Bites Snake Bites Minor Trauma to Extremities Lacerations from use of sharp tools	Use of safety (hard) hats Use of insect repellants Provision of snake bite kits Use of safety shoes & gloves
2. Excavation of Ore	Steep and Saturated pit faces Fugitive dust blown into eyes Inhalation of fugitive dusts High noise levels from working of heavy duty vehicles - trucks, tractors etc.	Designed slopes and control of runoff Use of clear goggles Use of dust/mist respirators Use of ear plugs
3. Operation of Power generating plant	High noise levels	Use of ear muffs, Wearing of ear plugs
4. Maintenance shop operations	Contact dermatitis skin irritation from exposure to grease	Use of barrier creams & detergents on hands Use of air plugs
5. Onsite and Offsite Spill	High noise levels Discharge to Groundwater Discharge to Surface water Possible breakage of Berms	Containment around storage areas Monitoring discharges Communication with impacted areas
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6. Temporary Storage of Surface water	Overtopping of ponds in rainy season	Monitoring of berms and implementation of corrective works as needed
7. Heavy equipment operations	High noise levels	Use of ear muffs, Wearing of ear plug

Hazard identification and reporting will constitute an ongoing activity in which the employees' participation will be considered an integral part of his work functions. The OSH Act 1999 clearly stipulates the responsibilities of employees and supervisor/management in this regard. In accordance with those regulations the supervisor/manager will do the following:

- Inspect all machines and equipment for the existence of potential hazards and ensure that they are in working order.
- Undertake scheduled maintenance of all machines and equipment in accordance with manufacturers guidelines
- Inform the worker of any hazards present.
- Instruct the employee in the correct safe work procedures to prevent injuries and ensure that those instructions are followed
- Provide the necessary safety protective gear when required.

In accordance with OSH Act 1999 employees will be authorized to do the following:

1. Cease work once a hazard is perceived.
2. Report the hazard to the supervisor who will in company with the safety representative inspect the condition or circumstance and determine its validity.
3. Obey the instruction to perform alternative work or cease work completely as directed by the supervisor.
4. Return to the workstation or proceed once the hazard has been adequately dealt with or eliminated.

10.9.2 Hazard Monitoring and Reporting

The Safety Representative, elected from among the workers, will monitor hazards and work conditions. He will do the following:

- Perform Safety Inspections on and off the operations site on a regular and programmed basis (at least once per month) for the detection of unsafe conditions or any potential hazards and report these hazards to management.
- Record all minor and loss time accidents in a ledger as required by the Ministry of Social Protection (Table 36 shows the format to be used for recording industrial accidents).
- Remit reports of industrial accidents or fatalities to the Ministry of Social Protection and GGMC when required

Table 36: Accident Report Format

ACCIDENT REPORT FORMAT

Personal injury	Equipment damage	
Name of person involved	Dept/Area	
Name of injury		
Place of injury		
Description of accident		
Type of accident:	Loss Time	Minor
Foreman Signature.....		
Diagnosis.....		
Remarks.....		

In addition to the abovementioned, all employees will be educated about their responsibility to participate in the creation of a healthy and safe environment by:

- reporting unsafe and hazardous conditions when detected
- performing work in a safe manner by following the correct work procedure.

10.9.3 Training & Education of Employees

The company will run periodic training program in:

- Basic first aid programs (all employees).
- Advanced first aid programs
- Accident investigation & reporting seminars (supervisory personnel & safety reps.)

The basic first aid program will be extended to all employees and would be geared to ensure that in the event of an accident or injury, someone with first aid knowledge will always be present to render initial assistance until further medical attention can be made available. Qualified personnel will run seminars to impart the necessary theoretical as well as practical skills required. These courses will be scheduled depending on employee strength and attrition.

The advanced first aid program will constitute an upgrading course from the basic first aid program in which selected employees including supervisors and the Safety representative will be exposed to advanced first aid knowledge and techniques which will enable them to participate in the recognition and the initial management of serious injuries and illnesses e.g. Fractures, Spinal Injuries, Malaria, Typhoid fever etc.

10.9.4 Industrial Accident Protocol

Serious injuries will be referred to a medical practitioner and medical institution. The medical institution and practitioner will be chosen from Bartica and contact will be maintained by radio/radiophone at all times. In the event of an industrial accident the following protocol will be followed:

- A basic first aider will be summoned if not already present at scene of accident.
- The basic first aider will render first aid care.

- The basic first aider will summon an advanced first aider who will administer further care if necessary and evaluate the necessity for removal to the first aid centre.
- The advanced first aider will summon the vehicle specifically identified for this purpose and supervise the removal of the injured to the first aid station.

The employee's immediate supervisor will be informed. He will:

- Make contact with the identified medical Practitioner and Institution and inform them of the time of arrival of the injured employee.
- Complete the accident form and forward same along with the injured to the medical institution for completion by medical practitioner
- Inform the Safety representative who will record the accident in the Industrial accident register.

A vehicle will be available at all times to respond to accidents. That vehicle will be equipped with a four wheel drive and will have the following equipment:

1. oxygen cylinder and gas masks resuscitation equipment,
2. a bed and accommodation for a first aid attendant to sit alongside the injured,
3. a flashing light attached to warn other road users,
4. communication equipment.

10.9.5 Occupational Hygiene

The main environmental occupational hazards to which employees will be exposed during the operations phase of the operations are:

Dust
Noise
Heat

10.9.5.1 Dust Exposure

The following measures will be implemented in order to decrease or eliminate respirable dust inhalation and prevent any adverse effects on workers:

1. Provision of dust respirator with filters to employees exposed during the excavation of ore
2. Siting of living quarters a convenient distance from the site operations and on the leeward side of same.
3. Minimal denudation of vegetation around campsite
4. Chest X-Rays of all employees once yearly in order to detect any incipient pulmonary disease such as persistent coughing and/or shortness of breath

Respirators will be used if engineering controls are not adequate to achieve satisfactory dust levels. The respirators used must be approved by the Guyana Bureau of Standards. All respirators will be mandated to have a filter that is 95% efficient for 0.3 µm particles. These measures will assist in elimination or reduce further the very low risk of the development of lung impregnated disease by employees exposed to dust.

Workers in the excavation phase of the operations would be exposed to wind blown/fugitive dust being blown into the eyes and causing eye irritation and conjunctivitis. These employees will be provided with

clear goggles and eye wash lotion will at all times be available for washing the affected eyes.

10.9.5.2 Noise

The following measures will be implemented to address worker health and safety related to noise associated with the operation:

- Control of noise levels at source via installation of silencers on exhaust system of power generating plant.
- Provision of hearing protection to employees exposed to high noise levels: ear muffs for employees in the maintenance shops and generating plant areas.
- Earplugs for employees who operate heavy-duty machines.
- Siting of power generating plant and mining operations in locations away from the living quarters of employees.
- Warning signs in areas of high noise levels instructing employees to wear earmuffs or earplugs as required.

The Project Proponent will also institute hearing conservation program for employees exposed to noise. The program will consist of:

- Audiological examination before employment to establish baseline hearing capacity on initiation of employment
- Yearly audiological testing of employees exposed to high noise levels
- Acquisition of a portable sound level meter
- Measurement of sound levels in instances where it is suspected that deviations from the previous levels are occurring

10.9.5.3 Heat

Measures to decrease the effect of increased exposure to heat will include:

- Measurement of ambient temperature levels in vicinity of generating plant
- Provision of heat shields and coating of surface of generating plant by high reflective material such as polished aluminum.

10.9.6 Food and Water Safety

Food and water will be provided by the mine site operator to employees. No sales of food, beverages will be permitted by vendors etc. within the mine site. A condition of employment will forbid purchasing of food, beverages etc from vendors. All food including both raw and refrigerated foods will be stored in accordance with guidelines provided by the Environmental Health Unit of the Ministry of Health. Redundancy will be provided for storage of refrigerated goods to ensure capacity exists in the event of damage or loss of any unit. All waste generated by the operation will be disposed in accordance with the Waste Management Plan.

Personal hygiene is very much a matter of individual training and upbringing. However, certain processes and operations may expose workers to health risks, such as those resulting in occupational dermatitis or metal poisoning through contamination of the hands and other parts of the body. Hand to mouth contamination arising from consumption of food contaminated by dirty hands, or the use of contaminated drinking vessels, may pose a serious risk. All forms of eating and drinking would be restricted to a canteen or dining area.

Good standards of personal hygiene would be promoted through induction and refresher training and the use of safety propaganda, such as safety posters. This would be supported by the provision and maintenance of adequate welfare facilities including washing and showering facilities, separate clothing storage areas for work clothing and personal clothing not worn at work, and frequent replacement of contaminated overalls and other forms of work clothing.

A vector control program will be implemented over the duration of the project. Should an outbreak of flies occur, an insect exterminator would be used to control the flies at the source. Uncovered and available food wastes will not be permitted, thereby minimizing the development of any rodent populations. Should an outbreak of rodents or other vermin occur within the area, the vermin will be exterminated by a licenced exterminator in a manner that is appropriate for the vermin in question.

All water for drinking purposes will be imported to the site from acceptable and certified drinking water sources. If groundwater is utilized for drinking water, it would be treated by chlorination and filtration to acceptable quality for potable water use. Samples of drinking water will be tested at the Government Analyst Department to ensure it conforms to drinking water standards.

10.10 Fuel Oil Management

Fuel oil storage areas will be located well away from areas of fire hazard such as where welding operations will be performed. All fuel will be trucked to site by secure fuel trucks and transferred into fuel storage tanks that are founded on impervious concrete surfaces. The fuel tanks will be housed within bermed enclosures. The enclosures will be sized to retain the contents of 110% of the tank in the event of tank failure. Discharge from fuel storage areas will be channeled to oil-water separators prior to being discharged to surface water.

Indiscriminate dumping of waste oil will not be permitted under any circumstances. Waste oil will be stored in suitable containers at designated points located around the Project site. All locations will be selected based on factors such as proximity to water, migration routes, fire risks and access. All waste oil storage area will be provided with secondary containment to deal effectively with any leakage or spillage. All liquids, spent oils, fuels and lubricants will be collected and returned in drums to oil companies and/or to Bosai for fueling of their calcination operations.

10.11 Spill Contingency Plan

The spill contingency plan prepared for the project consists of two distinct plans; the Emergency Response Plan (ERP) and the Spill Prevention and Cleanup Control (SPCC) Plan. The elements of each plan are detailed below.

10.11.1 Emergency Response Plans

The objective of the Emergency Response Plan (ERP) is the protection of the communities and the environment in the project area of influence through the development of emergency response strategies and capabilities. This Emergency Response Plan details measures to respond to potential releases of fuel oils and/or other hazardous material. In addition it details emergency response procedures for potential release of hazardous material which is being transported to the site.

Examination of the proposed project has identified several possible scenarios which may require the activation of emergency response procedure. Emergency response actions will be needed for as follows:

1. Spills of fuel oil or other hazardous material during road transport to the site
2. Releases of fuel oil or other hazardous material during unloading and mixing,
3. Releases of fuel oil or other hazardous material during fires and explosions,
4. Release of fuel oil or other hazardous material due to pipe, valve and tank ruptures,
5. Power outages and pump failures,

This ERP describes specific response actions, as appropriate for each emergency situations identified above. The response actions include clearing site personnel and potentially affected communities from the area of

exposure, notification to operational, management and response personnel, use of antidotes and first aid measures for chemical exposure, control of releases at their source, containment of releases, assessment of the release and mitigation, procedures to examine the cause of the release, and implementation of measures to prevent reoccurrence of releases.

The company will maintain an Emergency Response Centers (ERC) at the mine site. A Primary and alternate Emergency Response Coordinator will be located at the ERC. Each coordinator will have explicit authority to commit the resources necessary to implement the ERP. Emergency response teams would be identified and would be appropriately trained and prepared. After the commencement of construction, this ERP shall be extended to include call-out procedures and 24-hour contact information for the coordinators and response team members.

All personnel involved in mining operations would be trained to recognize and respond to situations which can result in releases to the environment. The training will include identification of procedures to be followed if a release is discovered, including notification of the appropriate site personnel, measures to assure worker safety, and methods to stop or contain the release, if possible.

The following list of equipment and supplies will be provided for response to emergencies.

1. Earthmoving Equipment
2. Mobile Generators
3. Sand and Gravel
4. Sand Bags
5. Pumps
6. Pipes
7. Booms
8. Absorbents

If there is a slowly developing emergency or unusual situation, where an emergency is not imminent, but could occur if no action is taken, the EPA, GGMC and Ministry of Natural Resources (MNR) will be notified. The Regional Democratic Council of Region 7 will be notified of the potential problem and will be kept advised of the situation. During these contacts, the agencies will be requested to indicate if there are any immediate actions that can be taken to reduce the risk of the emergency and if necessary, preventative actions will be implemented. An Emergency Response Coordinator will be assigned the task to continuously monitor the situation and to coordinate emergency action if required.

If an emergency is imminent, but has not yet begun steps will be initiated to immediately advise persons in the vicinity of the emergency to evacuate due to the potential release. The EPA, GGMC and MNR will be notified. A single Emergency Response Coordinator will be tasked with responding to the potential release to minimize disparate utilization of resources. Equipment and personnel will be deployed to the maximum extent necessary to prevent the potential release to the environment.

If there is a release of fuel oil or other hazardous material, all persons downstream and downwind from that release will be notified immediately and efforts will be coordinated with others to reduce impacts associated

with the release. The EPA, the GGMC and MNR will be immediately notified. If a spill of fuel oil or other hazardous material/waste enters waters adjacent to the access roads, Guyana Water Inc. (GWI) will be added to the entities notified.

All transport vehicles will be fitted with absorbent material and vehicle operators will be provided with a radio to maintain contact with the emergency response centers. If there is a spill/leak of fuel oil or other hazardous material onto roadways during transportation to/from the site prompt action will be taken to contain the leakage or spillage. All combustibles/ignition sources such as running engine, likely to result

in fires will be removed from the vicinity of the spill and anyone in the area will be advised to stay upwind of the spill. Absorbent material in the transport vehicle will be used to cover small spills. The vehicle operator will immediately notify the Emergency Response Center which will assign an Emergency Response Coordinator to respond to the emergency.

A berm will be constructed around the spill area to control runoff to surface water. All soils impacted by the spills will be excavated from the spill area and disposed in accordance with the hazardous waste management procedures. In the events of spills to surface waters, fauna will be trapped and will be relocated to areas within close proximity of the site, which are the same ecologically as the spill area. Fishes will be trapped with nets and animals will be snared in traps designed to ensure that animals are not injured during trapping. The relocation of fauna impacted by accidental spills is expected to be a very infrequent occurrence and will have insignificant impacts on the areas to which the fauna is relocated. Spills of fuel oil will be responded to by the addition of surfactants and by retrievals with skimmers. Surface water will subsequently be monitored for the EPA EIA Guidelines Mining Version 1, August 2000 Water Quality target parameters including turbidity and Total Suspended Solids (TSS). After monitoring determines that water quality has attained acceptable standards, sensitive fauna will be allowed to naturally reenter the area.

If an earthquake is felt in the vicinity, visual inspections shall be conducted of the berms surrounding the ponds being excavated/reclaimed. If damage has occurred, but is judged not serious enough to cause failure of any facility, the nature, location, and extent of the damage, as well as the potential for failure will be quickly observed. The EPA, GGMC and MNR will be contacted and a description of damage, including the location, extent and rate and the associated effects on adjoining structures, prevailing weather conditions, and other pertinent facts will be provided.

If any of these facilities is damaged to the extent that a potential release to the environment is possible, the emergency imminent procedures will be immediately implemented. A close watch will be kept on the facilities for the next two to four weeks as some damage may not show up immediately after the quake.

If there is overtopping of ponds, power outages and pump failures, all persons downstream from the site will be notified immediately and efforts will be coordinated with others downstream to try and reduce impacts, if applicable. The EPA, the GEA and MNR will be immediately notified. The Emergency Response Center will assign an Emergency Response Coordinator to respond to the emergency. Emergency response procedures will replicate those for a spill during transportation of fuel oil or other hazardous materials to the site.

Any time levels in the ponds exceed the design levels, these facilities will be inspected daily. If the water surface level rises to within 0.25 m of the crest of the pond, the following will be immediately implemented:

- contact EPA, GEA and MNR
- discharge excess water from the pond to surface water through sediment control structure
- monitor the receiving surface water body for sediment
- perform the discharge in stages to reduce sediment inflows

10.11.2 Spill Prevention and Cleanup Contingency Plan

This Spill Prevention and Cleanup Contingency (SPCC) Plan will become effective coincident with the

commencement of construction activities at the mine. The Emergency Response Coordinator will have authority to expend funds and recruit employees to implement the Spill Prevention and Cleanup Contingency Plan. The SPCC Plan addresses the following:

- Operating procedures to prevent oil spills;
- Control measures which will be installed to prevent a spill from reaching surface waters; and
- Countermeasures to contain, clean up, and mitigate the effects of any spill which discharges to surface or ground water.

This SPCC also sets out an organized, planned, and coordinated course of action to be followed in case of a fire, explosion, or release of hazardous material which could threaten human health or the environment. The SPCC Plan would be implemented for on-site, as well as off-site releases that could threaten human health and the environment, even if the Emergency Response Coordinator does not believe that the spill will leave the site. The Plan deals with threats to facility personnel, as well as with threats to people outside the facility.

After the completion of construction works at the site, a site plan detailing the physical layout and a facility diagram will be appended to this SPCC. The appended information shall include contact list and phone numbers for the Emergency Response Coordinator(s), the EPA, cleanup contractors, and other appropriate national and local agencies who will be contacted in case of a discharge. The SPCC shall also be expanded to include prediction of the direction, rate of flow, and total quantity of fuel oil/hazardous material which may be discharged after a Hazard Assessment has been conducted.

An internal communication or alarm system capable of providing emergency instructions shall be maintained at the mine together with devices capable of summoning external assistance (telephone or two-way radio). Portable fire extinguishers, fire control equipment, spill control equipment, and decontamination equipment will also be maintained at the mine site.

All fuel storage areas shall be founded on impervious surface and will be sited in containment facilities designed to retain 110% of the tank contents. The containment may be either dikes, berms, retaining walls or curbs. Discharge from the containment area shall be directed into gutters which flow to oil-water separators prior to release to the environment. End-of-pipe water quality shall be monitored to ensure adherence to water quality. If there is a discharge from the fuel storage area to the environment, an Emergency Response Coordinator shall respond to that discharge and an alternate source of water will be provided to persons located downstream of the discharge.

Spills of fuel oils will be cleaned by mechanical methods, chemical dispersants, gelling agent or biological agents. The specific method to be used will depend on the quantity and location of the spill.

Mechanical cleanup, using booms and skimmers, will be used to recover spills to surface water. Containment booms would be used to control the spread of spilled product and to concentrate the product in thicker surface layers to make recovery easier. In addition, booms will be used to divert and channel oil slicks along desired paths, making them easier to remove from the surface of the water. Skimmers would be used to recover spilled oil from the surface of the water. Skimmers will be either self-propelled or operated from the bank of streams/creeks. Chemical dispersants will be used to accelerate the breakup of fuel oil spills to surface water. Dispersants would be applied immediately following a spill, before the lightest materials in the oil have evaporated. The use of dispersants in freshwater would be authorized by the Emergency Response Coordinator only if it does not pose any threat to human health or the environment. Gelling agents will be used to respond to small spills of fuel oil. Gelling agents will be applied by hand to small spills and would be left to mix on their own. The gelled oil would be removed from surface water using

skimmers. Biological agents will be used to mitigate the impacts of spills of crude oil and refined products to surface water and to soils.

Surface water and soil samples will be recovered from the impacted areas after cleanup to ensure that residual levels of hydrocarbons and other fuel oil constituents do not exceed tolerable limits. If these limits are exceeded in soil, additional soil will be removed from the spill area until the residual levels fall below

tolerable limits. The soil excavated from the area shall be disposed in accordance with the Hazardous Waste Management protocol. If surface water quality has not been attained, monitoring will be continued. Persons downstream of the spill will continue to be provided with clean water until water in the affected area again attains acceptable water quality.

If the discharge of fuel oil results in contamination of the aquifer, a detailed investigation will be conducted to define the contaminant plume. A plan to clean-up the aquifer will be prepared after the delineation of the plume. The contaminated groundwater will be treated and would be re-injected into the aquifer. Treatment will cease when analyses of groundwater samples indicate acceptable groundwater quality.

If there is a fire which results in release of toxic fumes and if the fire spreads and is likely to ignite materials at other locations at the site or can cause heat-induced explosions, water and/or chemical fire suppressant shall be used as fire suppressant. In addition to fires, if an explosion has occurred which poses an imminent danger that can result in a safety hazard due to flying fragments or shock waves or if an imminent danger exists that an explosion could result in release of toxic material The EPA, the GEA and MNR will be immediately notified. The Emergency Response Center will assign an Emergency Response Coordinator (ERC) to respond to the emergency. The ERC shall determine whether the situation warrants evacuation of employees and persons within proximity of the fire or explosion. If evacuation is required, all employees shall be picked up from designated assembly points and will be evacuated along pre-planned evacuation routes. Previously identified alternate evacuation routes shall be used if primary exit routes are blocked by releases of toxic substances or fires.

During the emergency control phase, the emergency coordinator will take all reasonable steps necessary to ensure that explosions and releases do not occur, recur, or spread to other areas. These steps will include, where applicable, stopping operations. The emergency coordinator would monitor for leaks, pressure buildup, gas generation, or ruptures in valves, pipes, or other equipment, wherever appropriate. Details would be provided to emergency personnel concerning the types of on-site emergency equipment to be used and the need for personnel protection equipment.

Immediately after an emergency, the emergency coordinator would treat, store, or dispose of recovered waste, contaminated soil or surface water, or any other material. The recovered material would be handled as a hazardous waste unless it is a characteristic hazardous waste only, which is analyzed and determined not to be hazardous. The emergency coordinator would ensure that in the affected areas, no waste which may be incompatible with the released material is treated, stored, or disposed of until cleanup procedures are completed. All emergency equipment would be cleaned and made fit for its intended use before operations are resumed.

The SPCC Plan will be reviewed, and be immediately amended whenever the following situations apply:

- applicable regulations are revised
- the plan fails in an emergency
- the facility changes its design, construction, operation, maintenance, or other circumstances in a way that materially increases the potential for fires, explosions, or releases
- the list of emergency coordinators changes
- the list of emergency equipment changes

10.12 Social Management Plan

The Project Proponent will actively discourage influx into the area and not allow outsiders to settle in the periphery of the camp. The Project Proponent will also train its personnel on site to handle influx sensitively without conflict or security issues. The Project Proponent would also promote and run health awareness

campaigns especially on HIV, STD and malaria amongst the workers as well as local communities upstream and downstream of the project site.

The Project Proponent will dialogue with the local communities to understand their expectations and create strategies to generate local employment. The company will also promote community development projects that enhance local benefits and which create skills, capacities, improve education, health and infrastructure of the local communities. The developer will take practical measures to ensure that residents do not abandon their current livelihoods.

The Project Proponent will consult and engage with artisanal miners who come into the concession and will patrol the concession boundaries. The Project Proponent will inform the GGMC and EPA of the presence of illegal activities within its concession and will work with the GGMC to evict these miners. The company will train and build capacities of the workers and service providers to find economic opportunities with other industries in Guyana.

The Project Proponent will estimate the volume of traffic likely during construction and operations phases and Partner with government and the GGMC to promote safety and reduce risks. The company will conduct driver safety training programs, identify zones of high risks on the roads and will coordinate movement of traffic with other road users to minimize risks.

10.13 Traffic Management

The company will enforce speed limits of less than 60 km/hr on the access road and 40 km/hr on mine service roads. Signs will be posted along the access road to indicate to other road users, safe driving speeds on that road. The Project Proponent will place no restrictions on traffic using the access road constructed to the mine site. Restrictions will be imposed on traffic flows into active mining areas. Project vehicles only will be permitted into mining areas. Signs will be posted along the access road indicating to road users that The Project Proponent will not accept liability for accidents on the access road and also indicating that road users are responsible for providing their own insurance cover for accidents on the access road.

10.14 Noise Management

Best Management Practices (BMP) will be enforced to minimize noise levels to prevent annoyance and complaints. Workshops and equipment service areas will be sited away from and downwind of the employee dormitories. In addition, noise emissions will be controlled at source by appropriate selection of equipment and by fitting equipment with silencers. If sound levels in employee dwelling exceed tolerable levels, sound adsorbers or acoustic fencing at source or receivers will be provided. Traffic will also be managed to ensure smooth flow and less stop/starts and equipment will be well maintained to ensure performance at optimum levels.

10.15 Catchment Area Management

The concession will be managed to ensure minimal impacts to the watershed. The objective of the catchment management plan will be to maintain as closely as possible the pre-project hydrological runoff characteristics of the watershed in which the project is located. The catchment management plan addresses the protection and conservation of the local natural resources and contains measures for safeguarding water for future development. The plan will also ensure that water quality and security of water supply is provided to transient people who use the creeks in the vicinity of the mine site.

All forest cover outside of the area cleared for the mine site operation will be maintained to control run-off, to limit erosion, to minimize sediment and nutrient supplies, to maximize infiltration and to maintain pre-

project rates of evapotranspiration. The adoption of sound catchment management practices for the area

will reduce the inflow of debris and other material from both point and diffuse sources into the creeks thereby ensuring the maintenance of water quality both upstream and downstream of the project.

The Project Proponent will provide the EPA and GFC with information on logging operations within the Project Area. The responsible national statutory authority will undertake to ensure that a formal Environmental Impact Assessment is conducted where any new forestry exploitation project is proposed. If the company determines that uncontrolled logging is occurring in the area covered by this ESIA report, both the EPA and GFC will be informed. If timber concessions are granted by the responsible national statutory authority, during the life of these operations, the developer will review the draft ESIA report prepared for logging in the area to ensure implementation of the following:

- appropriate use and choice of cutting implements and machinery
- selective felling
- establishment of buffer areas around the mine
- road construction in accordance with sustainable practices
- closing roads after completion of logging activities.
- regular monitoring of the logging areas to ensure no encroachment

The Project Proponent will report to the EPA instances of clearing for small scale agriculture along access routes and within forested areas that could prove detrimental to the environment if left uncontrolled. The Project Proponent will in consultation with the responsible national statutory authority, develop methods to curb or mitigate these problems.

Since The Project Proponent has no legal authority, the responsible national statutory authority will be required to establish clear demarcation between areas of different land-use potential and promote awareness of the consequences of encroachment within areas identified for specific land use. The responsible national statutory authority will also provide training on environmentally friendly methods of agriculture such as selective clearing instead of slash and burn; terracing, mulching, crop rotation or strip cropping and on adopting proper land tenure procedures. The responsible national statutory authority will further be required to ensure that any type of land development meets all relevant legal requirements and be in accordance with any land use plan drawn up by the local authorities.

In those instances where The Project Proponent has legal authority, travel along access roads by the public will be controlled. Where this is not the case, the developer will report to the responsible national statutory authority, levels of use and incidents of encroachment.

10.16 Erosion and Sediment Control Plan

Mining will be undertaken with long-term erosion and sediment control as a primary consideration. Mining operations conducted during the rainy season will be clearly demonstrated, to the satisfaction of the EPA, that at no stage of the operations will there be any substantial risk of increased sediment discharge from the site. When mining occurs in the rainy season, the smallest practicable area of erodible land will be exposed during mining operations and the time of exposure shall be minimized. Natural features, including vegetation, terrain, watercourses and similar resources shall be preserved wherever possible. Limits of mining shall be clearly defined and marked to prevent damage by mining equipment.

Permanent vegetation and structures for erosion and sediment control shall be installed as soon as possible. The sediment control structures and berms will be monitored and adequate provision shall be made for long-term maintenance of permanent erosion and sediment control structures and vegetation. No topsoil shall be removed from the area outside the mining limits unless approved by the EPA. Topsoil overburden shall be stockpiled and redistributed to provide a suitable base for seeding and planting. Runoff from the

stockpiled area shall be controlled to prevent erosion and resultant sedimentation of receiving waters. Runoff shall not be discharged from the site in quantities or at velocities substantially above those which occurred before grading.

Stormwater runoff would be channeled to the pond being currently excavated. The pond would be designed to provide a detention time of 48 hours for stormwater runoff and discharge from the pond would be via a spillway and would be channeled through a sediment control structure constructed of a matrix of stone, sand and grass to remove sediment prior to discharge to surface water bodies in the site area.

Sediment control structures and practices would be used to prevent the inflow of sediment to surface water. These control practices would include sediment traps or screens to control run-off and sedimentation. Surface runoff from maintenance workshops and other vehicle service areas would be channeled to an oil/water separator. All water from the oil/water separators would be skimmed prior to discharge.

Erosion control operations would be performed under favorable weather conditions. When excessive moisture or other unsatisfactory conditions prevail, the work would be stopped. Erosion control materials shall not be applied in adverse weather conditions which could affect their performance. Erosion control will be accomplished by using one of the following:

- Erosion control blankets
- Geotextile fabric
- Seeding

Before placing the erosion control blankets the subgrade will be graded smooth with no depressions or void areas and would be free from obstructions, such as tree roots, projecting stones or other foreign matter. No vehicles will be permitted directly on the blankets. Before geotextile fabric is placed the subgrade shall be compacted and graded level with no depressions, voids, soft or uncompacted areas and shall be free from obstructions, such as tree roots, projecting stones or other foreign matter. Seeding shall then be applied to the areas.

Site roads would be constructed as close as possible to the existing topography in order to minimize cutting, to decrease erosion rates and possibility of slope failure. Site clearing and intensive earthworks would be scheduled during the time of year when the erosion potential of the site is relatively low, i.e. during the dry season. Wide area clearance of the project site would be avoided. Planning and staging of land disturbance activities will be such that only the area currently under use will be exposed at any one time.

Only those areas essential for completing mine site activities would be cleared. Other areas would remain undisturbed. This will minimize the area of bare soil exposed at one time thus reducing erosion rates at any one time. Additionally, the proposed limits of land disturbance would be physically marked off to ensure that only the required land area is cleared.

Unsuitable materials and surplus earth will be disposed of at a designated area. Soil will not be placed near any watercourses or at the crest of steep slopes. Open soil will be sprinkled with water, to reduce the potential for the soil to be moved. Earth dikes, perimeter dikes and swales, or diversions will be used to intercept and convey runoff above disturbed areas. Diversion channels will be used to intercept flow from denuded areas or newly seeded areas to keep the disturbed areas from being eroded from uphill runoff.

Temporary drains will be constructed prior to any land clearing activities. Diversion channels will be inspected after heavy rainfall, and sediment build-up will be removed.

Benches, terraces and ditches will be used to break slopes by providing channels of low slope in the perpendicular direction. This will keep water from proceeding down the slope at increasing volume and

velocity and will direct flow to suitable outlets, such as a sediment basins. The frequency of benches, terraces or ditches will depend on the credibility of the soils, steepness and length of the slope.

If runoff during operations causes erosion in channels, the channels would be lined with grass to reduce runoff velocities and to provide water quality benefits through filtration and infiltration. If the velocity in the channel erodes grass within the channel, the slope of the channel would be altered. Procedures which promote rapid establishment of a grass or mulch cover on a cleared or graded area will be established. Newly established vegetation do not have strong root and would be more prone to erosion. Only seed mixtures which are adaptable to the site would be used and exotic species would be avoided. The seeding rate would be determined to ensure that adequate soil protection can be achieved.

Silt/Sediment traps would be installed in drainage ways or other point of discharge from disturbed area, and will be constructed prior to operations. Silt traps will also be constructed to minimize the amount of silt/sediment flows into the streams. Vegetated filter strips will be provided and will have relatively low slopes and would be of adequate length and would be planted with erosion-resistant plant species. A common species which is used is vetiver grass which is normally planted in several rows and over amply long strips. Other applications of such grass are in riparian planting along narrow streams as well as along the inner faces of sediment ponds.

Inlet protection provisions will be incorporated at inlet points to stormwater drainage systems to prevent excessive silt and sediment from entering the system. These will include filter fabrics, packed gravel, or sand bags. These structures will be regularly maintained to prevent clogging.

All structural and non-structural erosion controls will be checked periodically especially after heavy rains, and maintained sufficiently to ensure efficient performance. An Inspection and Maintenance Plan would be prepared and implemented. The plan will include:

- Assigned personnel responsible for inspection and maintenance;
- Maintenance requirements for control measures and the requirements to be implemented accordingly (e.g replace failed controls, remove trapped sediment, etc.);
- Systematic preparation and updating of the inspection and maintenance records.

10.17 Cultural and Archaeological Resources

Consideration would be given to both natural and cultural landscapes in the planning and implementation of the project. Relics and artifacts encountered during operations of the mine will be set aside from the operations and will be preserved. The Guyana National Trust will be consulted on the most appropriate mechanism for management of these resources, if any are encountered.

11.0 INSTITUTIONAL REQUIREMENTS FOR MANAGEMENT PLAN

The Project Proponent is committed to ensuring environmentally sound management of its mining areas. This first phase of that compliance is performance of this ESIA to comply with the Environmental Protection Act. The Project Proponent is committed to conformance to reasonable and technically justifiable guidelines established by the EPA for environmental management of the mine site.

The company's objective is to ensure that the mining and beneficiation are integrated harmoniously into their host environments, and that the operation will provide an opportunity to play an active part in regional development. The company will provide staff to achieve the following objectives:

- propose management rules and specific measures that are compatible with biodiversity protection while allowing the operation of the facility at competitive costs
- foster the enhancement and multiple use of the facility, in a context of biodiversity;
- promote awareness by its employees and the general public regarding biodiversity protection
- propose concrete means of applying the EPA's biodiversity strategy and action plan.

The Organization Chart for plant operations is depicted as Figure 34. The specific function of each component of the management structure is detailed below. The Mines Manager will be responsible for all the mining and beneficiation operations. Included under his jurisdiction would be the Health, safety and environmental (HSE) Department. The HSE Manager will have direct responsibility for health, safety and environmental (HSE) aspects of the operations and would be the primary authority for enforcement of the HSE policy. This will include HSE issues related to beneficiation and providing support to the Emergency Response Coordinator in the event of emergency responses.

The mines manager will support the HSE Manager by providing additional expertise and resources on an as needed basis to satisfy operational, maintenance and emergency response needs. The Project Proponent will retain a qualified firm to provide support to the HSE Manager to assist with specialized training and emergency response expertise and will provide additional technical resources for operational and emergency response needs. It is anticipated that local government officials in the project vicinity will provide emergency aid if required and that the EPA will review HSE plans prepared by the operations to ensure that all HSE concerns are appropriately addressed.

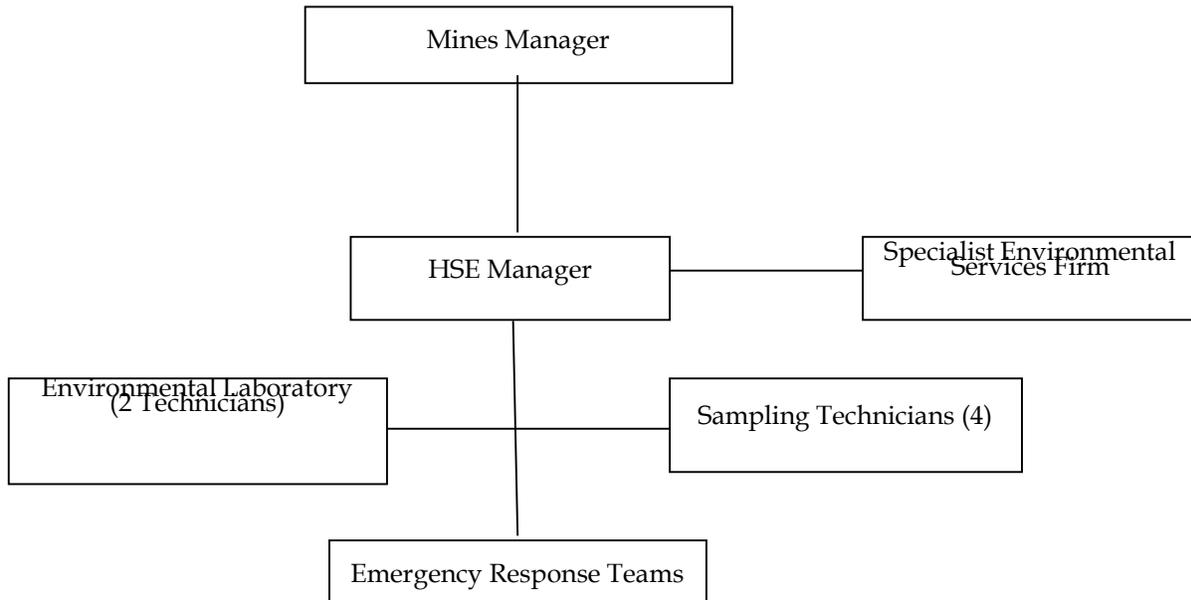
The HSE Manager will manage all HSE related activities on site and will provide training to employees and will identify equipment and resources needed to satisfactorily perform their duties and responsibilities. The HSE Manager will also provide onsite training and auditing of Health, Safety and Environmental effectiveness.

The HSE manager will have 2 technicians in his department. The primary duties of the technicians will be to inspect the local environmental monitoring stations for water, air and sediment and to collect grab samples for routine checks. They also work with the EPA and other authorities to report and assure that discharges are within guidelines.

An environmental laboratory staffed by a complement of two individuals will be located on site. Individuals working in the laboratory will analyze samples of surface water, sediment and groundwater and will serve

as response team advisors in Health, Safety and Environment emergencies. The environmental laboratory will be responsible for the analyses of samples to assess environmental compliance. The laboratory will also be responsible for collecting and packing samples for off site quality assurance tests by an independent laboratory approved by the EPA.

Figure 34 - Organization Chart for Environmental and Social Management Plan



Emergency response team will be comprised of employees who have been specially trained to handle potential incidents. These employees will also be responsible for maintaining the operational effectiveness of the emergency response equipment.

All employees will be trained in emergency response procedures. Operations teams will be charged with responsibilities for emergency process shutdown and firewater pump/emergency generator operation. Maintenance teams will supply labor, equipment and tools as needed to assure all support required to handle any emergency situation is available and in good working condition.

12.0 MONITORING PLAN

The environmental monitoring program for the mine will serve as an integral part of the operation and would be implemented to generate information for environmental management and environmental information dissemination. The monitoring plans described in this chapter encompass two distinct categories, environmental and operational. The environmental aspect is structured to monitor the physical, biological and socioeconomic changes in the environment, if any, and the mitigation measures. The operational monitoring will include those variables important for day-to-day operations such as beneficiation methods and camp facilities.

Monitoring will be conducted during all phases of the project; construction, operation and closure. The monitoring program will play a pivotal role in ensuring that the trends for specific parameters are tracked and will provide information on compliance with legislative norms, set guidelines or desirable operational limits and will provide a basis for corrective actions and modification of activities if necessary. Sampling intensity during monitoring will depend on the time and location of the development activities and results derived from monitoring data.

12.1 Terrestrial Resources

In preparation for reclamation of mined out areas, a record will be maintained of all spontaneous and natural regrowth during the construction and operational phases of the works. Factors considered to have contributed to that spontaneous growth will also be recorded. The record will note plant species, soil type, weather conditions during the period, drainage conditions etc. The records will be used to examine parameters considered necessary for the successful establishment of plant cover after reclamation.

Wildlife monitoring will be conducted concurrently with the vegetation monitoring. Observations will be recorded in a wildlife-sighting logbook and these will be periodically examined to determine if there have been any significant changes in species abundance and/or distribution. All collisions with wildlife on the access and/or mine service roads will be recorded. The record will note the proximity to cleared areas, the animal involved in the collision and the time of that collision etc. These records will be used to evaluate the success of the measures outlined in the Management Plan.

Biodiversity sampling will be conducted once every two years utilizing the same methodology as that used for the ecological baseline development to record any alterations in species type and abundance. The areas sampled for the initial baseline study will be sampled during the monitoring program and biodiversity changes in these control areas will be identified and their severity rated.

12.2 Aquatic Resources

Aquatic resources will be monitored during the diversion of the creeks, during the operational phase of the works and for a period of two years after the creeks have been restored to their original alignment. The monitoring program will be focused on both aquatic plant and animal life in the creeks. Observations will be recorded in an aquatic resources logbook and these will be periodically examined to determine if there have been any significant changes in species abundance and/or distribution. These records will be used to evaluate the success of the measures outlined in the Management Plan.

Biodiversity sampling conducted once every two years will also include sampling of aquatic resources and will utilize the same methodology as that used for the ecological baseline development to record any alterations in species type and abundance. The areas sampled for the initial baseline study will be sampled during the monitoring program and biodiversity changes in these control areas will be identified and their severity rated.

12.3 Water Monitoring

Before construction work commences surface water samples will be recovered from selected creeks within the area to be mined. Results of analyses on these samples will be used to establish baseline conditions in these creeks before mining commences. Samples will be recovered from these same points twice yearly after construction commences to track temporal changes in surface water quality in the creeks. Empirical hydrological data will be collected for each creek prior to the creek being diverted to provide information on baseline flows.

During operation, samples of water from discharge points will be recovered quarterly for the first year of operation and twice yearly after that time. Groundwater monitoring wells will be installed both up- gradient and down-gradient of the area to be mined prior to commencement of construction operation at the site. Samples will be recovered from these monitoring wells twice yearly after construction commences to track temporal changes in groundwater water quality upstream and downstream of the area being mined.

All surface and groundwater samples will be analyzed for the presence and concentration of the following:

- pH
- Total dissolved Solids (TDS)
- Total suspended solids (TSS)
- Turbidity
- Conductivity
- Phenol
- Oil and grease
- Calcium
- Magnesium
- Sodium
- Potassium
- Total Kjeldahl Nitrogen
- Total Ammonia
- Phosphate
- Nitrate
- Nitrite
- Aluminium
- Manganese
- Molybdenum

- Selenium
- Arsenic
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron, Total
- Lead
- Mercury
- Nickel
- Zinc

The surface water quality would be considered satisfactory if the World Bank Standards are not exceeded. Hydrological data will be collected for all monitoring points at the same time that samples are recovered for water quality analyses.

12.4 Hazardous Material Monitoring

Inventories of hazardous material will be monitored to ensure all material is used for the purposes intended. Waste containment areas will be monitored to ensure that the impervious surface upon which they are sited is not breached. The area will be monitored to determine that incompatible chemicals are not stored together and that stormwater discharges from the area are channeled to the water management pond.

12.5 Solid Waste Monitoring

The solid waste disposal operation will be monitored to determine the effectiveness of the recycling, composting and disposal operations. Manifests will be developed to ensure proper disposal of septic tank waste.

12.6 Reclamation Monitoring

The land reclamation area will be monitored to ensure that compaction of the ground surface does not preclude the infiltration of precipitation. The humus from the composting operation will also be monitored to ensure its use in the land reclamation. The growth of trees planted for revegetation will be monitored. Substitute plant types will be identified if the growth rates are unacceptable.

12.7 Air Quality & Dust Monitoring

Equipment will be visually monitored to ensure emissions do not exceed tolerable levels. Indications of exceedance of tolerable levels will include excessive black smoke and oil, indicative of incomplete combustion, being emitted by equipment exhaust. Roads will be monitored to ensure that excessive dust is not emitted from surface.

12.8 Noise Monitoring

Noise levels will be monitored at sensitive receptors to ensure that noise limits are not exceeded.

12.9 Hydro-Meteorological Monitoring

A weather station will be installed on site to obtain data on wind speed and direction, rainfall, temperature, solar radiation, humidity, barometric pressure and evapotranspiration. This data will be provided to the Hydro-Meteorological Services Division, Ministry of Agriculture based on their payment of charges not exceeding the current cost structure the Hydro-Meteorological Services Division charges the public.

12.10 Social Impact Monitoring

A record will be maintained of the levels and type of employment of local residents and of trends in local and regional employment to determine the need to modify the targeted employment levels for local residents. The company will also maintain a record of the number of individuals trained and the areas in which those individuals were trained. Periodic surveys will be conducted of the number of local residents in the workforce, the expenditure by the company on local goods and supplies and of travel patterns to and from the mining area. The company will also monitor incidences in surrounding communities to assess whether crimes are related to its operations.

13.0 RISK ASSESSMENT

13.1 Seismic Risk Assessment

Geological features indicating the likelihood of a seismic event include the following (Kramer, 1996):

- Fracture surfaces and indicators of fracturing directly evident at ground surface inclusive of disruption of the ground surface and evidence of the movement and grinding of the two sides of a fault (slickensides, fault gouge, and fault breccia).
- Geologically mappable indicators including juxtaposition of dissimilar materials, missing or repeated strata and the truncation of strata or structures.
- Topographic and geomorphic indicators including topographic scarps or triangular facets on ridges, offset streams or drainage, tilting or changes in elevation of terraces or shorelines, sag ponds and anomalous stream gradients.
- Secondary geologic features inclusive of abrupt changes in groundwater levels, gradients, and chemical composition, alignment of springs or volcanic vents and the presence of hot springs.
- Geophysical indicators of subsurface faulting such as steep linear gravity or magnetic gradients, differences in seismic wave velocities, and offset of seismic reflection horizons.
- Geodetic indicators such as fault movement appearing in geodetic surveys as tilting and changes in the distance between fixed points.

Fieldwork for the mine site was done primarily to determine the biodiversity of the area. While a detailed examination was not conducted to discern the features detailed above, fieldwork has not detected the occurrence of any of the features indicative of the likelihood of a seismic event.

An earthquake event was recorded for Guyana, in 1964, at a point defined by 2.64° North and 59.62° West at a depth of 50 km and with a magnitude of 4.50. Strong ground motion information for Guyana from the Caribbean Disaster Management Program has also indicated the possible occurrence of horizontal ground acceleration of 30 cm/sec² due to an earthquake event elsewhere. Based on the historical record it is possible that a low magnitude earthquake can affect the site.

Acceleration from a low magnitude seismic event, while quite low, can result in liquefaction of the sands present at shallow depths at the project site. The integrity of structures can be compromised if the sand liquefies during an earthquake event. The structures proposed for the site which may be susceptible to damage are the workshop and laboratory. The excavations for ore recovery are very shallow and any manifestation of earthquake activity will be sloughing of slopes in the active mining areas. These slopes failures would pose no threat to the operations. The buildings at the site will be constructed of timber which would be adequate to respond to any deflections induced by the low magnitude earthquake event recorded in the project vicinity.

13.2 Slope Stability

The road to be constructed to access the mining locations would be constructed on flat ground. The depths of excavated paydirt will not exceed 4 m (13 ft.). The soils present in the areas to be excavated are strong enough to sustain vertical slopes in excess of 6 m height. There is consequently very little risk of slope failure. The factors which will contribute to risks of slope failure are as follows:

- Pronounced increases in porewater pressures in excavated slopes
- Unsustainably steep slopes in the excavations

Slope stability failure can be triggered by one or a combination of these factors. If the proximity of the slope to the access roads is small, slope failure may have an impact on the efficient functioning of those facilities. Slope failure in the mine could result in a shutdown of the mine site operations.

Risks of slope failure of the excavations will be reduced by conducting insitu shear strength tests in the soils during excavation and conducting an analysis to determine if the soils are strong enough to sustain the proposed slope height and angle.

Monitoring and preventive maintenance would be undertaken to identify potential slope instability areas. Through careful monitoring, areas of concern will be noted and would be quickly repaired, to prevent slope failure. Monitoring will consist of visual observation of the slopes. Monitoring will also be conducted after the occurrence of unusual conditions such as heavy surface runoff or peak floods. The frequency of monitoring will be more pronounced during the wet seasons. Preventive maintenance will be undertaken at all potential trouble spots observed during visual inspection. Preventative maintenance will consist of work on critical slope areas to reduce the forces which will result in slope instability.

Visual monitoring will be done to identify typical distress signals associated with slope failure, such as cracks at the crest of the slope, wet spots on the downstream face of the slope, and critical settlement inwards of the slope crest.

Implementation of the design and monitoring program detailed above will ensure that slope instability is unlikely to develop, with slope instability problems likely to develop only under adverse conditions. If slope instability does develop, damage would be minor and would be limited to small areas. The slope instability would be easily corrected by the utilization of available construction techniques. The risk of slope instability would therefore be low and the design and monitoring program outlined would be adequate to manage that risk.

14.0 CLOSURE

The area will be progressively reclaimed as mining advances across the concession. The primary goal of the closure plan measures is to minimize water quality degradation. The other goal is to restore the area to a condition that is similar to the surrounding landforms and topography and that will provide long-term reclamation success and minimize the need for long-term operation and maintenance at the site after closure.

14.1 Mine Area

All excavations will be backfilled and the area will be reforested. The objectives of reforestation are to protect the soil against erosion and to restore biodiversity. The intent of the reclamation program is to develop reconstituted habitats which are ecologically functional and which are able to evolve naturally to the initial situation. Site rehabilitation will occur as mining proceeds so that on completion of the mining process reclamation will be substantially completed. The excavations will be reforested immediately after ore recovery to minimize loss of botanical or animal biodiversity. The reforestation process will mimic the natural closure of forest gaps by pioneer trees. The reclamation plan is developed on the basis of careful planning and respect of basic rules related to fast reforestation which will provide a new forest cover rich in biodiversity.

The reforestation program will commence before mining and its associated soil excavation begins at the site. Before the forest cover is removed, all useful seeds and seedlings will be collected and would be stored at the mine site area. The topsoil would be removed before work commences and would be collected and stored separately. Seeds which are in the top-soil would be collected with the topsoil and stored.

Nurseries would be established close to the mine site by collecting material in the wild. The nurseries would be established along creeks inside the forested areas not cleared for the mining operations closest to the bottom of the slope. The nurseries will contain young trees of the species already present in the impacted habitat, and hosting efficient indigenous ectomycorrhizal and endomycorrhizal fungi present in forest humus and nursery. Many species of pioneer trees (*Sesbania sp*, *Crotalaria sp*, *Senna sp.*) are sensitive to diseases and pests and as a result, many cuttings may be lost (sometimes up to 70%). The nurseries would therefore be sized to overcome this problem particularly since no pesticides will be used in the nurseries.

The reforestation process will begin immediately after the first pond³ has been closed, refilled and dried. As mining progresses into the next pond, a crew specifically delegated reclamation responsibility, will start the soil rehabilitation and the revegetation process. This action will be taken to avoid soil erosion and compaction.

Rehabilitation will commence with re-shaping of the material previously re-deposited into the mined out areas after scalping through the sieves. The topsoil previously collected and stored before the commencement of mining operations would then be used to cover the residual material from the process circuit.

The soil in the pond under reclamation will essentially consist of a matrix of clay, silt, sand, gravel and stones. The water retention in that matrix will vary from none in the highly porous areas to very high in clay soils areas. The soils will therefore be intermixed to ensure uniformity of its water retention capacity. The area will then be contoured to fit into the original topography including the creek bed and slopes. A thick layer of the topsoil, initially stored, would then be spread over the contoured area. Micro-topography artefacts will be added, if necessary, depending on the habitat, to provide traps for floating seeds and micro-habitats for fauna. Compost, lime and mineral fertilizer will then be added, if necessary, to the topsoil

3 Mine pond : the area excavated at one time.

during the revegetation and seeding process. The area will then be revegetated using seedlings and plants from the nurseries.

The reclamation program will be undertaken using seedling and planting rates which are designed to establish a minimum of one leguminous plant (nitrogen source) per square metre and one non-legume plant per square metre. Nutrients will be provided by using small amounts of lime fertilizers and compost. Large cuttings from leguminous trees will be used in order to establish a shade cover in five to eight months. After two to three years, these short lived plant species will contribute to the development of a litter layer. It is expected that they will age after five years and will be replaced by other species.

14.2 Other Facilities

All mine service roads and the airstrip will be regraded and closed except for agreed upon access routes. To match adjacent slopes, road and berm material will be pulled from the fill portions of the roads and placed in the cut portions to aid in regrading. All roads at the mine site will be regraded in a similar manner to the access roads. This will include all areas outside the active mining area.

All buildings and other structures and equipment used in mining and processing will be removed. Reclaimed facilities will be inspected and annual reports provided to the EPA to evaluate the success of prior reclamation. Reclamation monitoring would be coordinated with the EPA and GFC. Reclamation success will be evaluated both in terms of vegetation and erosion. The existing monitoring programs for surface and groundwater will continue in accordance with the proposed monitoring plans. Monitoring would be modified to address reclamation as it proceeds as necessary.

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APPENDICES

**APPENDIX A: FINAL TERMS OF REFERENCE ENVIRONMENTAL AND SOCIAL
IMPACTASSESSMENT**

QUARTZSTONE GOLD MINE

APPENDIX B: MINUTES OF CONSULTATION MEETINGS

APPENDIX C: METHODOLOGY FOR BIODIVERSITY SAMPLING PROGRAM

1.0 BIODIVERSITY SURVEY METHODOLOGY

To characterize the biodiversity within the concession, sample plots were selected based on topography, vegetation (forest) type, the level of disturbance and accessibility. The vegetation types within the concession were determined from the Guyana Forestry Commission (GFC) vegetation map, while elevation differences were established from a 1:50,000 topographic base-map.

The concession is characterized by mixed forest vegetation on high hills, mixed forest on flat to undulating terrain, and mixed forest on undulating to hilly terrain, as depicted in the GFC vegetation map for the concession. Using the maps, terrestrial and aquatic sample plot were initially identified for each mixed forest stratum. Figure 1 shows a schematic map of the sample plot locations. Terrestrial and aquatic survey plots initially identified from the map are labeled **T1**, **T2** and **T3** – Terrestrial plots, and **AQ1**, **AQ2** and **AQ3** – Aquatic survey plots.

Of the three terrestrial plots initially identified for the survey, sampling was conducted at **T1** situated within mixed forest on undulating to hilly terrain, and **T2** situated within mixed forest on flat to undulating terrain. **T3** situated within mixed forest on high hills was not assessed due to poor accessibility to the area of the plot. The area to **T3** is characterized by steep terrain and rock outcrops that prevented access. The time taken to access **T3** would have affected the equal application of sampling time and effort in each surveyplot.

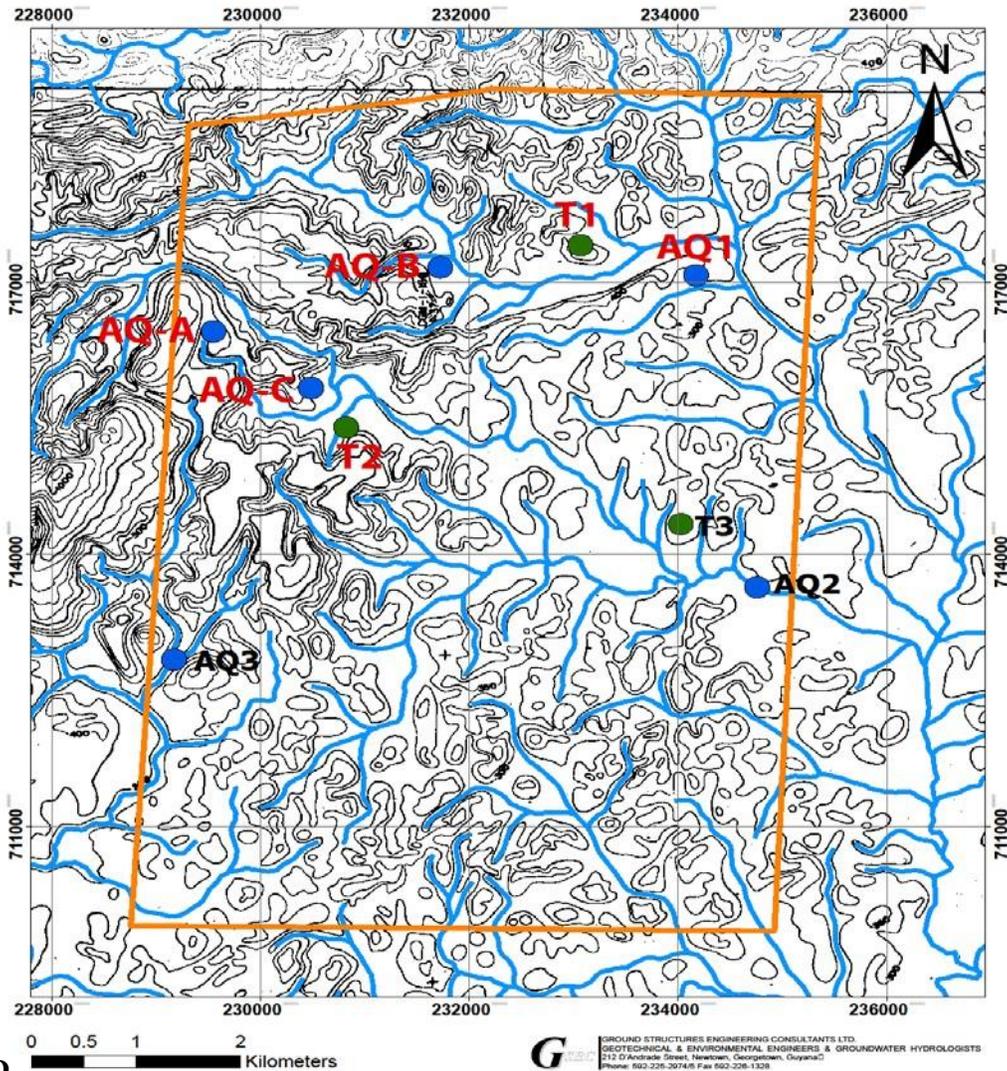
For the aquatic survey plots, sampling was conducted in both dry and wet season surveys at the creek marked as **AQ1**, situated within the mixed forest on undulating to hilly terrain. The creek initialed identified as **AQ2** situated in the mixed forest on flat to undulating terrain, did not exist when ground- truthed. **AQ3** situated in mixed forest on high hills was not assessed due to poor accessibility to the area. In the wet season survey, 3 additional aquatic sites were opportunistically assessed to optimize the surveyeffort. The 3 opportunistic survey sites are labeled **AQ-A**, **AQ-B** and **AQ-C** in Figure 1. The field surveys were conducted over the period of November 13-19, 2015 corresponding to a single dry season, and May 08-14, 2016 corresponding to a single wet season in Guyana.

1.1 Flora

The floral survey methodology utilised was adopted from the Alder and van Kuijk (2009) baseline assessment of forest carbon in Guyana conducted for the Guyana Forestry Commission (GFC). The floral survey consisted of both a terrestrial forest inventory (FI) and floristic surveys. Floristic surveys were conducted in the plots set up for the FI. Vascular plants species such as shrubs, herbs, and lianas (Pteridophytes and Angiosperms), not included in the FI were recorded during the floristic survey.

Two survey plots were established for the floral survey. A cluster of five circular plots were established in each survey plot. The circles were established in the pattern shown in Figure 2. The center to center distance of each of the larger circle was set at 100 m. Each circle or the main plot had a radius of 18 m. A smaller inner circle with a radius of 8 m was established concentric with the larger circle as depicted in Figure 3.

Figure 1 - SCHEMATIC MAP SHOWING SAMPLE PLOTS LOCATIONS



LEGEND

- T1** – Terrestrial Survey Plot (Sampled in wet and dry season)
- T2** – Terrestrial Survey Plot (Sampled in wet and dry season)
- T3** – Terrestrial Survey Plot (Not Sampled)

- AQ1** – Aquatic Survey Plot (Sampled in wet and dry season)

- AQ2** - Aquatic Survey Plot (Not Sampled)

- AQ3** - Aquatic Survey Plot (Not Sampled)

- AQ-A** – Opportunistic Aquatic Survey Plot (Sampled in the wet season)
- AQ-B** - Opportunistic Aquatic Survey Plot (Sampled in the wet season)
- AQ-C** - Opportunistic Aquatic Survey Plot (Sampled in the wet season)

Figure 2 - Cluster of Circular Sample plots

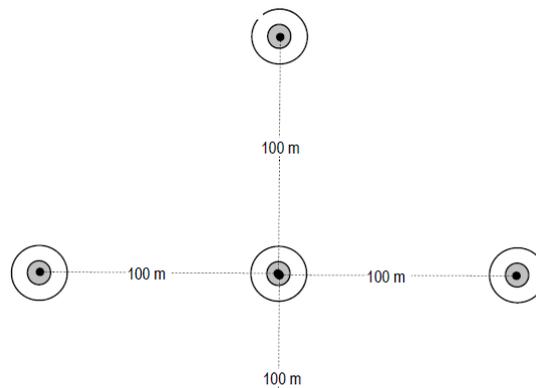
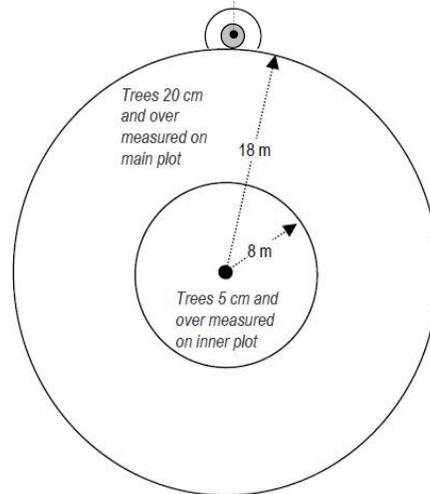


Figure 3 - Main circle plot design



All trees (including standing dead trees) of 20 cm DBH and above were recorded over the main circle plot. Within the inner circle plots a 100 % floristic inventory (FI) was undertaken of trees with diameter at breast height (DBH) greater than 5cm to estimate total biomass. Data recorded for the inner circle included both below ground-roots and above-ground tree biomass and necro-mass (leaf litter and fallen dead wood). Estimated quantities of plant biomass and necro-mass were prepared by measuring the DBH of climax canopy trees, saplings and seedlings.

Floral information recorded per plot included:

- Location (UTM Coordinate (Easting and Northing) of each sample plot and site elevation.
- Type of environment and physiographic position of subplot and soil type
- Plant species scientific name and common name.
- Estimated height of commercial of timber, for DBH of 35 cm and above. Volume estimates within each plot of mature trees with DBH of 35 cm and above to determine volume estimates of commercial and cultural use timber of the target area.

Data was collected and analysed using the DAFOR raking system. This method of evaluation involves assigning species as dominant, abundant, frequent, occasional or rare.

Plants in each survey plot were determined as belonging to one of three strata. These strata were respectively A, B and C stratum (all mature trees greater with DBH equal to or greater than 20 cm; Shrubs Layer (Smaller Woody Stems); and the Ground Layer (Seedlings/herbaceous stems) respectively.

Data was recorded on data sheets. Information recorded on the data sheets included plot composition (plot number, species diameter at breast height (DBH)), plot attributes (including location and soil type), and taxa specific and tree attributes. Unknown varieties were sampled, preserved and returned to Georgetown for identification.

Each plot was classified as primary or secondary growth to allow inferences to be drawn about the degree of disturbance within each plot. The volume of commercial and cultural use timber reported reflects the volumes computed over the transect area only. These volumes were extrapolated over the plot to determine the volume of wood available within each plot. The biomass quantities determined for the survey plots. This information was subsequently used to estimate carbon stock within the area. Forest carbon stocks estimates were developed to conform to requirements of the GFC.

Field data was recorded using data sheets and analyzed using Microsoft Excel. Timber volume estimates were determined using the following formula (Adopted from the GFC Metrification Manual for Timber Species, 1999):

- Timber Volume (m³) = 0.7854 * D² * L * 0.0001

Where D = Diameter at Breast Height (DBH)

L = log length

Biomass estimates were developed based on the pan-tropical biomass equation of Chave et al (2005). The Chave et al (2005) biomass allometric model was validated as applicable for use in the Guyana context in Alder and van Kuijk (2009) baseline assessment of forest carbon in Guyana. Biomass estimates were calculated strictly for trees with DBH greater than 5 cm and for saplings with BDH less than 5 cm. Carbon accounting estimates were expressed both in tonnes carbon per ha, (tC ha⁻¹) or tonnes of carbon dioxide-equivalent per ha, (tCO₂-e ha⁻¹). The IPCC (2006) recommended conversion factor of 0.5 for biomass to carbon was used. The CO₂-equivalent, tonnes of carbon was determined by multiplying by the ratio of 44/12, which is the ratio of the atomic weights of Carbon Dioxide (CO₂) to Carbon (C).

The Chave et al (2005) model is as follows:

- AGB = wood density (g/cm³) x exp(-1.499 + 2.148ln(DBH) + 0.207(ln(DBH))² - 0.0281(ln(DBH))³)

Wood densities were derived species by species from the database of Zanne et al (2009). These are available for 134 Guyanese species, including all common forest trees. For species with unknown wood density a weighted average wood density of 0.66 g/cm³ was utilized as recommended by ter Steege (2001).

Below ground tree (root) biomass was calculated as a root:shoot (R:S) ratio relative to above ground

biomass. This method is implicit in the IPCC (2006) equations for forest biomass calculations. The following root:shoot ratios adopted from Steege (2001) were utilized for the forest types encountered within this concession:

- Mixed Forest R:S ratio = 0.220

Necromass (dead wood and litter) was approximately estimated using an expansion factor of 8.6 % (adopted from Steege (2001)) relative to tree biomass.

1.2 Fauna

Two terrestrial/wildlife sampling plots for the faunal biodiversity survey were located in the general vicinity of the plots for the floral survey. At each sample location, the main wildlife transect was approximately 2 km in length. Different vertebrate groups were sampled at discrete intervals along the main transect to avoid and/or minimize interference between methodologies and sampling of different terrestrial vertebrate groups. Additional sampling was undertaken in sections of each transect which exhibited micro-habitat cues/features for the vertebrate group surveyed.

1.2.1 Mammals (Non-Volant Mammals)

A mixed method approach was employed to ensure that the various taxa were targeted. Survey methods used were:

Transect and opportunistic surveys: transects approximately 1 km long were established at T1 and T2. Transects were walked slowly and searches made for indirect evidence (including prints, scats/droppings, scent, feeding ground, prey remains) of mammals. Mammals seen or heard were identified and recorded. Observations were made and data collected at every 10 m on either side of the transect line. As transects were walked the canopy was carefully inspected for cryptic arboreal species and primates. Vocalizations were also used to identify mammals during transect survey. Transects were walked from 7:00hrs to 10:00hrs and 18:30 hrs to 21:00 hrs. Finally, mammals encountered opportunistically outside transect area were recorded. Surveys along transects were done mainly to target medium, large, nocturnal and cryptic species.

At survey plot 4 Cuddle back digital cameras were installed approximately 250 metres apart. Cameras were placed strategically in locations that appeared to be used by mammals and remained there for three consecutive nights. Efforts were made to avoid installation in potentially 'dead areas'. Cameras were numbered prior to their deployment in the field. During installation the following information was recorded: site name, camera trap number, GPS coordinates, date of installation, terrain, elevation and disturbance. Other features of the camera trapping points such as presence of animal trails, burrows were recorded. Thus total camera trap effort was 288 hours or 12 camera trap nights per sample location.

Interview was held with one worker attached to BK International who resided in the compound of Sun and Sand Mining Inc. The interviewee has extensive knowledge of the area since he has resided in the area for over 15 years. The interview was informal and the interviewee was asked to indicate via photographs mammals known to inhabit the area. Photographs presented to the interviewee were those in the Guide to the Neotropical Mammals by Emmons and Feer (1990).

1.2.2 Birds and Bats

Mist nets were used to capture both birds and bats. For bats, six understory mist nets were installed along the main transect at each survey plot. Bat nets were established in sets of two placed perpendicular to each other to optimize sampling effort. Mist nets placement were determined based on the forest structure of individual sites, openness of the understory, forest type, potential roosting site, accessibility and possible bat foraging sites. Bat mist nets were opened between 17:30 hrs to 22:00 hrs daily per transect. Captured specimens were identified, marked, recorded and released. Unidentified specimens were placed in individual cloth bags and transported to the camp 'laboratory' to facilitate identification.

For birds mist nets were established perpendicular to the main survey transect where mist netting and point counts were conducted. At each survey plot mist netting was done for two (2) days for understorey birds. Four netting stations (2 nets per station, set in the L-formation along the forest transect) were set up at each site. Nets were left open for approximately ten (10) hours per day except when disturbed by heavy rainfall. In each transect, mist nets were placed strategically to cover the different micro-habitats types, i.e. creeks, ravines, hills, dense and sparse forest, disturbed and undisturbed areas. Nets were opened from 05:00 hrs – 10:00hrs and 1500 hrs to 1900hrs daily and were checked every half hour. During rainy periods, survey time was extended. All birds captured were released unharmed within 30 minutes of capture following species identification. Captured birds were photographed, identified to species using checklists and field guides for the birds of Guyana and the Neotropics, marked by clipping the third tail feather (T1

– third tail feather from the right and T2 – third tail feather from the left).

Point counts were conducted at both sites, for approximately two hours at 0700 hrs and then at 1500 hrs. Additionally point counts were done along two disturbed areas within each of the primary areas; for T1 – the main access road into the project site, and T2 – the airstrip which is currently being constructed. Point counts were done along two (2km) transects, with points separated by 200 m. The surveyors would stop at every 200 m and record all birds seen and vocalizing. Birds encountered along the 200 m distance between points were only recorded if there were not encountered at the previous point.

1.2.3 Herpetofauna (Reptiles and Amphibians)

Each survey plot was sampled for two consecutive days. Within each location (T1 and T2), observations were made along the access road within the area of the survey plot and within the forest. This was done to capture differences in the species composition within the forest where there are limited wet areas during the dry season and the forest roads that have man-made water pools. Additionally surveys were done along two disturbed areas within each plot: T1 – the main access road into the project site, and T2 – the airstrip which is currently being constructed.

The approach used for the assessment of the herpetofauna was that of the systematic sampling survey. Microhabitats were located for intensive sampling within each of the sites with an objective of finding the following – accessible epiphytes (for breeding amphibians), loose bark (hiding places for both amphibians and reptiles), pools (for amphibians), puddles (for breeding amphibians) and trenches (man-made cut-ins in the forest and ground for amphibians and reptiles), streambeds (amphibians and reptiles), areas with compacted and more loose leaf litter (for amphibians and reptiles) and in tree hollows (for reptiles and amphibians).

Visual encounter surveys were conducted at nights between 1830 hrs and 2130 hrs. Locations were identified during the day based on the inclusion of varying microhabitat at the sample sites to be surveyed in detail at night. Additionally, man-made pools the forest roads were searched for the presence of breeding amphibians, as well as reptiles waiting for prey species coming to the water to lay eggs.

Researchers would also listen for calls of anurans while walking. For those that are fossorial and understorey an attempt to identify or capture the individual was made if it was deemed a species not yet encountered. The vocalizations heard were identified and cross checked using the guide prepared by Marty & Gaucher (1999) on the Tailless Amphibians of French Guiana.

Spotlighting for reptilian eyeshine was conducted. Leaf litter searches were also conducted. General searches for amphibians and reptiles around the campsites were also conducted and opportunistic observations were recorded along old trails and roads. All species were identified, and photographic vouchers taken for species captured for the first time. All captured specimen were released after

identification.

1.2.4 Macro-Invertebrates

The macro-invertebrate survey methodology employed included:

- Visual observation – This was done by walking at uniform pace along the main transect and recording macro-invertebrates observed within 5m on either side of transects. This method facilitated the sampling of diurnal lepidopteras and ground dwelling macro- invertebrates those flying and perching macro-invertebrates.
- Timed searches were conducted for 40 minutes along the main transects at night (1800 hrs to 1840 hrs). This was done to survey nocturnal macro invertebrates.
- Destructive sampling was also used to survey macro invertebrates that conceal themselves under dead wood, tree buttresses and rocks.
- Leaf litter searches along the main transect and open trails and roads were used to sample terrestrial macro-invertebrates that conceal themselves under tree buttresses, rocks and dead wood.

Benthic macro-invertebrates were actively sampled by using kick nets. Sample locations were placed at approximately 50m intervals, beginning downstream and moving upstream. Stream beds substrates and water vegetation were aggressively disturbed to drive organisms in to the nets. Micro-invertebrates were recorded, when encountered, in all transects. Macro Invertebrates were classified to the taxa Order due to the difficulty of identifying and classifying them to the species level.

1.2.5 Aquatic Fauna

Methods of capture for fish were both passive such as tangle siene method, and active such as the dip net method, and were selected based on site morphology. Each of the sample areas was further divided in sub-sites based on the need to ensure all habitats within the site were investigated. Sampling was done both diurnally and nocturnally, so as to capture species that were active at both times of the day. Upon collection, all individuals captured were photographed, and identified. Sampling methods employed were:

- Dip nets in wadeable depths since the majority of invertebrates in flowing waters dwell among stones, gravel and silt on the stream or river bed. The substrate was disturbed in-front of the net replicating this action moving from downstream to up stream.
- Vegetation and substrate active searches among immobile objects.
- Tangle seines to sample larger fishes (>8 cm in length). The nets were three (3) meters long with varying eye sizes 1/2", 1", 2 1/2". Weighted nets were used for swifter moving waters and depths beyond water visibility levels. Seines remained at each site for 24 hours, and were checked twice daily.
- Hook and line for 4 hours at each site. This time was shared equally between the diurnal and nocturnal periods of sampling.

APPENDIX D: GENERAL HABITAT DESCRIPTION OF THE TERRESTRIAL AND AQUATIC SAMPLE PLOTS

SAMPLE POINT (SP)	GPS LOCATION	HABITAT DESCRIPTION
TERRESTRIAL		
T1 - Mixed Forest	233068E 717471N	The area is mixed forest vegetation on undulating to hilly terrain on clay soils. Elevation of the area varied between 98-175 m. Leaf litter varied from moderate to thick. The understory was sparsely vegetated, while at other sections there undergrowth was very thick. Human alterations in the area were evident in the form of secondary roads and previous artisanal mining. Natural disturbance in the form of tree fall was evident. No tree species was observed flowering or fruiting at the time of survey. Mixed forest interactions included White Kapadula, Devil doer , Nibi, heavy presence of Turu palms, Monkey ladder, Manicole palms, Kapadula ,Monkey Plum ,Kufa , Turtle Ladder ,Granny back bone, Acia berry ,Epiphytes, Monje plum.
T2 - Mixed Forest	230876E 715438N	The mixed forest occurred on very elevated terrain of lateritic clay soil. Frequent rock outcropping occurred throughout the area. The understory was relatively thick along most sections of this transect. Elevation of this transect ranged from 136-175 metres.The area has been modified by previous mining activities. Mixed forest interactions included Trysil, Congo pump (indication of disturbance), Bitter tally, Ferns, Ferns, Money ladder, Monkey syrup, Nibbi, Kapadula, turtle ladder. No tree species was observed flowering or fruiting at the time of survey.
AQUATIC		
AQ1 - Mixed Forest	0234161E, 0717133N	Undulating freshwater habitat characterized predominately by mixed forest vegetation. Shallow heavily silted (turbid) in the shallow sections, consisting of a mixture of sand, clay, loam, laterite and forest litter (leaves and twigs), and a hard conglomerate bottom with little substrate through the deeper manmade channels. Early pioneer vegetation such as the broad leaf blood wood and cecropia inhabited the banks of the waterway. In some sections, the natural course of the waterway was diverted with depths ranging from 0.3m-1.5m and width of 1.5m-4m. Waterway covered by canopy of surrounding vegetation at intensity of approximately 50-80%. Old mining pits were observed in the area.
AQ-A - Mixed Forest	0229551E, 0716470N	Undulating freshwater habitat characterized by mixed forest that was heavily disturbed by historic mining. The sample area is part of a natural creek connecting mined out pits/ponds. The creek was moderately silted (turbid). Flow velocity was 0.3m/s upstream and 0.9m/s downstream. Along the banks of the pond and connecting stream, pioneer vegetation was present, along with shrubs/bushes which transitioned into thick dense mixed forest. Creek water temperature was 25.6 °C. Creek depth at the area sampled ranged from 0.6-1.2 m while the width ranged from 1.2-1.5 m. The length of the area sampled was 40 m. The creek bed was assessed to be pebbles and sand, aquatic vegetation, and woody debris.

AQ-B – Mixed Forest	0231723E, 0717163N	Flat terrain freshwater habitat characterized by mixed forest that was heavily disturbed by historic mining This sampling site was partially covered by canopy while some areas were completely exposed to sun light. Pond water was clear. The general area was heavily disturbed by historic mining resulting in a mined out pit/pond. No flow was recorded within the pond at the sample site. The length of the pond ranged from about 3-100 m while depth was recorded to be about 0.3-2.7 m. The length of reach was about 200m. The pond bed was examined to be a combination of pebbles with clayey loam, leaf litter, and woody debris.
AQ-C – Mixed Forest	0230487E, 0715831N	Flat terrain freshwater habitat characterized by mixed forest that was heavily disturbed by historic mining The sample area is a mined out pit/pond. Pond water was clear. The northwestern bank of the pond was dominated by pioneer vegetation of early shrubs and grasses, while the opposite banks transitioned from pioneer vegetation to dense Mora forest. The flow rate within the pond at the sample site was 0.3m/s. The pond bed was a combination of pebbles, clayey loam, leaf litter and woody debris.

APPENDIX E: DETAILED OBSERVATIONS RECORDED BY THE FLORISTIC SURVEY AND BY FAUNAL TRANSECT

Table 1: Cultural Uses of Floral Species Recorded Within the Concession

VERNACULAR NAME	SCIENTIFIC NAME	FAMILY	USE
WOODY STEMS			
Adebero	<i>Paypayrola guianensis</i> & <i>longifolia</i>	<i>Violaceae</i>	Cultural
Arara broad leaf	<i>Unonopsis spp.</i>	<i>Annonaceae</i>	Subsistence use of wood for board
Arara rough skin	<i>Unonopsis glaucopetala</i>	<i>Annonaceae</i>	Subsistence use of wood for board
Aromata	<i>Clathrotropis brachypetala</i>	<i>Papilionaceae</i>	Commercial timber - Heavy Construction; Boat Building
Awasokule	<i>Tovomita schomburgkii</i>	<i>Guttiferae</i>	Subsistence use of straight trunks for housing boards and firewood; the stilt roots served as whips or bows
Baromalli	<i>Catostemma altsonii</i>	<i>Bombacaceae</i>	Commercial timber - Plywood
Baromalli common	<i>Catostemma commune</i>	<i>Bombacaceae</i>	Commercial timber - Plywood
Burada	<i>Parinari campestris</i>	<i>Rosaceae</i>	Medicinal
Coffee mortar	<i>Terminalia dichotoma</i>	<i>Combretaceae</i>	-
Corkwood	<i>Pterocarpus officinalis</i>	<i>Papilionaceae</i>	Medicinal
Gamma cherry	<i>Cordia Tetrandra</i>	<i>Boraginaceae</i>	Subsistence , glue hunting
Haiawa	<i>Protium guianensis</i>	<i>Burseraceae</i>	
Haiawaballi	<i>Protium beglectum</i> & <i>Tenuifolium</i>	<i>Burseraceae</i>	Commercial Timber- boards, furniture, canoes and firewood
Itikiboroballi	<i>Swartzia benthamiana</i> & <i>bannia</i>	<i>Caesalpiniaceae</i>	Medicinal
Kairiballi	<i>Licania spp.</i>	<i>Rosaceae</i>	Cultural
Kakaralli black	<i>Eschweilera sagotiana</i>	<i>Lecythidaceae</i>	Cultural
Kakaralli fine leaf	<i>Eschweilera wachenheinii</i>	<i>Lecythidaceae</i>	Commercial timber
Kakaralli smooth leaf	<i>Eschweilera decolorans</i>	<i>Lecythidaceae</i>	Commercial timber
Kanakudiballi	<i>Cochlospermum orinocense</i>	<i>Cochlospermaceae</i>	
Kauta	<i>Licania guianensis</i>	<i>Rosaceae</i>	Subsistence used of wood as firewood
Kautaballi	<i>Licania majuscula</i>	<i>Rosaceae</i>	Subsistence used as firewood
Kwako	<i>Marlierea montana</i>	<i>Myrtaceae</i>	
Maho	<i>Sterculia spp.</i>	<i>Sterculiaceae</i>	Commercial Timber - Plywood; Interior Joinery
Maho black	<i>Sterculia guianensis</i>	<i>Sterculiaceae</i>	Commercial timber - Plywood; Interior Joinery
Marishiballi	<i>Licania buxifolia</i> & <i>micrantha</i> & <i>mollis</i>	<i>Rosaceae</i>	Subsistence used as firewood

VERNACULAR NAME	SCIENTIFIC NAME	FAMILY	USE
Mora	<i>Mora excels</i>	<i>Caesalpiniaceae</i>	Commercial timber -
Morabukea	<i>Mora gonggrijpii</i>	<i>Caesalpiniaceae</i>	Commercial timber -
Okokonshi	<i>Quina obovata</i>	<i>Quinaceae</i>	Subsistence used of the wood for house construction, warishi frames and arrow sockets
Parakusan	<i>Swartzia genmanii</i> & <i>arborescens</i>	<i>Caesalpiniaceae</i>	Subsistence - decorative
Shibadan	<i>Aspidosperma album</i>	<i>Hugoniaceae</i>	Commercial timber - Interior Joinery
Silverballi kereti	<i>Ocotea puberula</i>	<i>Lauraceae</i>	Commercial timber
Simarupa	<i>Simaruba amara</i>	<i>Simaroubaceae</i>	Commercial timber
Suradan	<i>Hieronyma laxiflora</i>	<i>Euphorbiaceae</i>	Commercial timber
Sweetheart	<i>Talisia elephantipes</i>	<i>Sapindaceae</i>	
Trysil	<i>Pentaclethra macroloba</i>	<i>Mimosaceae</i>	Subsistence used as a disinfectant for skin wounds and as fire wood
Turu Palm	<i>Jessenis bataua</i>	<i>Palmae</i>	Subsistence used of fruit to make drinks, etc.
Unknown			
Waiaballi	<i>Hebepetalum humiriifolium</i>	<i>Linaceae</i>	Subsistence used of wood for house post
Waiaballi	<i>Tapura guianensis</i>	<i>Chailletiaceae</i>	Subsistence used of wood for house post

Wallaba ituri	<i>Eperua grandiflora</i>	<i>Caesalpinaceae</i>	Commercial timber - Heavy construction
Wallaba soft	<i>Eperua falcate</i>	<i>Caesalpinaceae</i>	Commercial timber - Heavy construction
Wamara	<i>Swartzia leiocalycina</i>	<i>Caesalpinaceae</i>	Commercial Timber -Joinery
Warakosa	<i>Inga alba</i>	<i>Mimosaceae</i>	Subsistence used of fruit and as firewood
Wild Cherry	<i>Eugenia patrisii</i>	<i>Myrtaceae</i>	
Yarri Yarri	<i>Duguetia spp.</i>	<i>Annonaceae</i>	Subsistence used of wood for fishing rods and bows
NON WOODY PLANTS			
Kapadula	<i>Tetracera volubilis</i>	Woody Climber	Medicinal -used in aphrodisiacs as a builder, stimulating sexual activities and curing impotence.
Devil doer	<i>Strychnos sp.</i>	Woody Climber	Medicinal
Nibi	<i>Heteropisis flexuosa</i>	Hemi –Epiphyte (woody)	Commercial NTFP - used of root
Turu palms	<i>Jessenis bataua</i>	Solitary palm	Subsistence used of fruit to make drinks, etc
Monkey ladder	<i>Bauhinia guianensis</i>	Woody Climber	Medicinal used of root for diarrhea; of wood for malaria, to bitter the blood and to stop haemorrhage
Monkey Plum		Tree	-
Kufa	<i>Clusia grandiflora</i>	Epiphyte	Commercial NTFP -

VERNACULAR NAME	SCIENTIFIC NAME	FAMILY	USE
Turtle Ladder		Liana	
Manicole	<i>Euterpe oleracea</i>	Palm(multi-stemmed)	Medicinal and Commercial NTRP
Granny back bone	<i>Curarea candicans</i>	Woody Climber(Flat stemmed liana)	Medicinal aphrodisiac
Acia Palm	<i>Euterpe oleracea</i>	Palm tree	Medicinal
Monkey syrup	<i>Trichilia rubra</i>	Tree	-
Ferns	<i>Pityrogramma spp</i>	Shrub	-
Bitter tally	<i>Mikania micrantha</i>	Vine /sub woody climber	-
Congo Pump (Whilte)	<i>Cecropia spp</i>	Tree	Medicinal

Table 2: FLORISTIC COMPOSITION OF SAMPLED AREAS

FLORISTIC COMPOSITION	AVERAGE DRY SEASON	AVERAGE WET SEASON
Tree layer >20cm DBH		
# of individuals in 0.1 ha	81	81
# of species in 0.1 ha	29.5	29.5
# of families in 0.1 ha	13	13
Mean diameter trees >20cm DBH	37.25	37.25
Tree layer <20cm Diameter (saplings and seedlings)		
# of individuals in 0.1 ha	47	47
# of species on 0.1 ha	29.5	29.5
# of families in 0.1 ha	9.5	9.5
Shrub layer <10cm diameter		
# of individuals in 0.1 ha	20	21
# of species in 0.1 ha	11.5	12.5
# of families in 0.1 ha	6.5	7.5
Palm <20cm diameter		
# of individuals in 0.1 ha		3
1.3 COMMERCIAL VOLUME OF TIMBER SPECIES RECORDED		2
# of families in 0.1ha		1

The total standing volume of trees directly sampled within the concession of 12512 acres is 218.77 m³. The total standing volume of commercial timber (>35 cm DBH) recorded 180.00 m³ of which 178.3 m³ is marketable. The volume recorded for species that are utilized for non-commercial purposes (ecological/cultural, subsistence and medicinal) within the areas sampled is 51.7 m³. These results are detailed in the table below.

Table 3: Total Volume of Species Utilized for Commercial and Medicinal Purposes

COMMERCIAL VOLUME		SAMPLED AREAS (1 Ha)
VERNACULAR NAME	SCIENTIFIC NAME	MARKETABLE VOLUME (M ³)
Aromata	Clathrotropis brachypetala	0.8
Mora	Mora excels	56.0
Morabukea	Mora gonggrijpii	48.8
Shibadan	Aspidosperma album	0.9
Simarupa	Simaruba amara	13.6
Wamara	Swartzia leiocalycina	0.9
Baromalli	Catostemma altsonii	4.8
Wallaba soft	Eperua falcate	4.6
Burada	Parinari campestris	2.7
Coffee mortar	Terminalia dichotoma	0.8
Haiawa	Protium guianensis	0.6
Haiawaballi	Protium beglectum & Tenuifolium	1.8
Kakaralli black	Eschweilera sagotiana	11.7
Kauta	Licania guianensis	3.4
Maho	Sterculia spp.	1.9
Parakusan	Swartzia genmanii & arborescens	21.6

Suradan	Hieronyma laxiflora	1.5
Trysil	Pentaclethra macroloba	0.8
Warakosa	Inga alba	1.2
	TOTAL	178.3
VERNACULAR NAME	SCIENTIFIC NAME	TOTAL VOLUME (M³)
Adebero	<i>Paypayrola guianensis & longifolia</i>	0.1
Arara broad leaf	<i>Unonopsis spp.</i>	0.4
Arara rough skin	<i>Unonopsis glaucopetala</i>	0.2
Awatokule	<i>Tovomita schomburgkii</i>	0.1
Burada	<i>Parinari campestris</i>	2.7

Coffee mortar	<i>Terminalia dichotoma</i>	1.3
Corkwood	<i>Pterocarpus officinalis</i>	0.2
Gamma cherry	<i>Cordia Tetrandra</i>	0.5
Kairiballi	<i>Licania spp.</i>	0.1
Kakaralli black	<i>Eschweilera sagotiana</i>	21.1
Marishiballi	<i>Licania buxifolia & micrantha & mollis</i>	1.3
Okokonshi	<i>Quiina obovata</i>	0.3
Parakusan	<i>Swartzia genmanii & arborescens</i>	21.7
Trysil	<i>Pentaclethra macroloba</i>	0.9
Turu Palm	<i>Jessenis bataua</i>	0.7
Yarri Yarri	<i>Duguetia spp.</i>	0.0
Total	TOTAL	51.7

Species are classified by the GFC as Special Class Category (SC), Class I, Class II and Class III based on their market value and durability. Species ranked highest in economic value and durability is SC timber. Lower ranked species are placed in Class I, Class II and Class III respectively, according to their market value and durability.

A total of 33 species of commercial timber with 35 cm DBH and above were identified by the survey. No special class category were recorded during the survey however, 7 (seven) species of Class 1 and 2 (Two) species of class 2. The majority of species identified are designated as Class III species. Special Class Category Species as well as Class I, II and III Timber species recorded by the survey are presented in the table below.

Table 4: Species Classification for Timber Species

LOCAL NAME	SCIENTIFIC NAME	TOTAL MARKETABLE VOLUME (M ³)/HA	GFC ROYALTY CATEGORY
Aromata	<i>Clathrotropis brachypetala</i>	2.450998	1
Itikiboroballi	<i>Swartzia benthamiana & bannia</i>	0.70686	1
Mora	<i>Mora excelsa</i>	59.24704	1

VERNACULAR NAME	SCIENTIFIC NAME	TOTAL MARKETABLE VOLUME (M ³)/HA	GFC ROYALTY CATEGORY
Simarupa	<i>Simaruba amara</i>	13.57171	1
Baromalli	<i>Catostemma altsonii</i>	5.300665	2
Wallaba soft	<i>Eperua falcata</i>	5.838664	2
Adebero	<i>Paypayrola guianensis & longifolia</i>	0.05702	3
Arara broad leaf	<i>Unonopsis spp.</i>	0.384846	3
Arara rough skin	<i>Unonopsis glaucopetala</i>	0.170118	3
Awasokule	<i>Tovomita schomburgkii</i>	0.134146	3
Burada	<i>Parinari campestris</i>	2.7489	3
Coffee mortar	<i>Terminalia dichotoma</i>	1.264494	3
Corkwood	<i>Pterocarpus officinalis</i>	0.243474	3
Gamma cherry	<i>Cordia Tetrandra</i>	0.536114	3
Haiawa	<i>Protium guianensis</i>	3.022769	3
Haiawaballi	<i>Protium beglectum & Tenuifolium</i>	3.952604	3
Kairiballi	<i>Licania spp.</i>	0.067859	3
Kakaralli black	<i>Eschweilera sagotiana</i>	21.09985	3
Kakaralli fine leaf	<i>Eschweilera wachenheinii</i>	0.093463	3
Kakaralli smooth leaf	<i>Eschweilera decolorans</i>	1.133646	3
Kanakudiballi	<i>Cochlospermum orinocense</i>	0.092363	3

Kauta	<i>Licania guianensis</i>	4.164034	3
Kautaballi	<i>Licania majuscula</i>	1.448906	3
Kwako	<i>Marlierea montana</i>	0.081603	3
Maho	<i>Sterculia spp.</i>	2.79783	3
Maho black	<i>Sterculia guianensis</i>	0.019792	3
Marishiballi	<i>Licania buxifolia & micrantha & mollis</i>	1.323399	3
Okokonshi	<i>Quiina obovata</i>	0.327355	3
Parakusan	<i>Swartzia genmanii & arborescens</i>	21.6761	3
Silverballi kereti	<i>Ocotea puberula</i>	0.023091	3
Suradan	<i>Hieronyma laxiflora</i>	1.486605	3
Sweetheart	<i>Talisia elephantipes</i>	0.242453	3

VERNACULAR NAME	SCIENTIFIC NAME	TOTAL MARKETABLE VOLUME (M ³)/HA	GFC ROYALTY CATEGORY
Trysil	<i>Pentaclethra macroloba</i>	0.931406	3
Turu Palm	<i>Jessenia bataua</i>	0.686597	3
Waiaballi	<i>Tapura guianensis</i>	0.476973	3
Waiaballi	<i>Hebepetalum humiriifolium</i>	0.369452	3
Wallaba ituri	<i>Eperua grandiflora</i>	1.355757	3
Warakosa	<i>Inga alba</i>	1.161135	3
Wild Cherry	<i>Eugenia patrisii</i>	0.066523	3
Yarri Yarri	<i>Duguetia spp.</i>	0.011781	3

Table 5: Plant Species Observed Fruiting During the Wet Season Survey

VERNACULAR NAME	SCIENTIFIC NAME	FAMILY
Ants bush	<i>Cordi nodosa</i>	Boraginaceae
Kakaralli black	<i>Eschweilera sagotiana</i>	Lecythidaceae
Morabukea	<i>Mora gonggrijpii</i>	Caesalpiniaceae
Ruri	<i>Chaetocarpus schomburgkianus</i>	Euphorbiaceae
Haiawaballi	<i>Protium beglectum & Tenuifolium</i>	Burseraceae

Table 6: Transect Specific Record Of Mammals Within The Concession – Dry Season

ORDER	GENERA	SPECIES	TRANSECT(S) AND NO. OF INDIVIDUALS	IDENTIFICATION METHOD(S)	COMMENTS
Carnivora	<i>Puma</i>	<i>concolor</i>	T1: (1 individual) T2: (1 individual)	Interview, Foot tracks	Foot track identified on the road alignment close to both transects. Additionally, reports received indicated the species presence at other locations in the proposed mine site
	<i>Potos</i>	<i>flavus</i>	T1: (6 individuals)	Direct encounter, Vocalization, Interview.	A total of 6 individuals were documented. All were spotted high in the canopy feeding on black kakarali flowers
Artiodactyla	<i>Mazama</i>	<i>americana</i>	T1: (2 individuals) T2 (1 individual)	Foot tracks, interview	At both sites foot tracks were seen on the road alignment. At T1 foot tracks were also seen along the transect.
	<i>Mazama</i>	<i>gouazoupaira</i>	T2 (1 individual)	Food tracks, interview	Tracks seen on the road alignment
	<i>Pecari</i>		T1, T2 (numbers could not have been determined)	Feeding ground, interview	Feeding ground seen in forest. However, area appears to have not been recently inhabited by peccaries.
Cingulata	<i>Dasybus</i>	<i>spp</i>	T1, T2 (Unable to determine number of individuals)	Trails, interview	A few trails some of which appeared to be in active use were observed at both sites. No burrows were encountered making it impossible to determine the species present in the area.
Perissodactyla	<i>Tapirus</i>	<i>terrestris</i>	T1 (1 individual) T2: (2 individuals)	Scat, foot tracks, resting site, interview	Foot tracks indicate a total of two adult individuals at T 2.
Pilosa	<i>Bradypus</i>	<i>tridactylus</i>	T 1 (1 individual)	Direct encounter, interview	A single individual was spotted on a liana close to the road alignment at T 1
	<i>Cyclopes</i>	<i>didactylus</i>	-	Interview	Reports indicate the widespread presence at T1 and areas close to the camp
Rodentia	<i>Cuniculus</i>	<i>paca</i>	T2 (1 individual)	Foot tracks, interview	A single foot tract was seen on the road at T2
	<i>Dasyprocta</i>	<i>leporina</i>	T1, (5 individuals)	Foot tracks, interview	Several foot tracks identified at T2. Additionally, interview revealed the presence of a group of 5

			T2 (3 individuals)		individuals inhabiting an area close to the main camp.
	<i>Sciurus</i>	<i>aestuans</i>	T1	Interview	Reports indicate the recent sighting at T1
	<i>Sciurillus</i>	<i>puscillus</i>	T2 (1 individual)	Direct encounter, interview	An adult was trapped in the morning in the mist net used to capture birds
Primata	<i>Aloutta</i>	<i>seniculus</i>	-	Vocalization	Heard early in the mornings
	<i>Cebus</i>	<i>olivaceous</i>	-	Interview	
	<i>Saimiri</i>	<i>sciureus</i>	-	Interview	

Table 7: Transect Specific Record of Mammals Within the Concession – Wet Season

ORDER	SPECIES	TRANSECT (S)	IDENTIFICATION METHOD(S)	COMMENTS
Carnivora	<i>Eira barbara</i>	T2	Interview	Presence of this species confirmed during interview with 2 miners that occasionally traverse the area.
	<i>Potos flavus</i>	T2	Vocalization	A single individual was heard vocalizing in the canopy of a tree close to the access road.
Artiodactyla	<i>Mazama americana</i>	T, T2	Foot tracks, interview	At both sites foot tracks were seen on the road alignment. Footprints of 2 individuals were identified at each Transect.
	<i>Pecari</i>	T2	Interview	Only confirmed via interviews. No feeding ground or food tracks observed along transect.
Cingulata	<i>Dasyopus sp.</i>	T2	Animal trail, interview	A single foot track and impression of the tail of an armadillo was observed on the road.
Perissodactyla	<i>Tapirus terrestris</i>	T1 ,T2	Foot tracks, camera trap	On adult was photographed at T2 (GPS location 0229706 UTM 0719244). Additionally, foot tracks were observed at T1 and T2.

Rodentia	<i>Cuniculus paca</i>	T2	Camera trap	A pair was photographed at 11:22 pm at GPS location 0230300 UTM 0716798.
	<i>Dasyprocta leporina</i>	T1, T2	Foot tracks, camera trap	One individual was photographed at T1 at GPS location 0232046 UTM 0717163. Additionally, a foot print was observed at T1.
Primata	<i>Aloutta seniculus</i>	-	Vocalization	Heard in the morning, midday and afternoon in the area. None was spotted.
	<i>Pithecia Pithecia</i>	Opportunistic encounter	Spotted	A pair (one male, and female) was spotted in the canopy of a tree close the airstrip. The pair was spotted on a hill.

Table 8: Transect Specific Record of Bats Within the Concession

A1 is a transect location sampled within the main sample plot which exhibited micro-habitat cues/features

DRY SEASON SURVEY

TAXON	COMMON NAME	T1	T2	A1	TOTAL
Family: Phyllostomidae					
Sub-Family: Stenodermatinae					
<i>Artibeus obscurus</i>	Sooty fruit eating bat	1	-	-	1
Sub-Family: Lonchophyllinae					
<i>Lonchophylla thomasi</i>	Thomas's nectar bat	1	-	-	1
Family: Mormoopidae					
<i>Pteronotus parnellii</i>	Greater moustached bat	1	-	-	1
TOTAL	WET SEASON SURVEY	3	0	0	3

TAXON	COMMON NAME	T1	T2	BASE CAMP	TOTAL
Family: Phyllostomidae					
Sub-Family: Stenodermatinae					
<i>Artibeus obscurus</i>	Sooty fruit eating bat	1	0	0	1
<i>Sturnira lilium</i>	Little yellow shouldered bat	0	1	0	1
Sub-Family: Lonchophyllinae					
<i>Lonchophylla thomasi</i>	Thomas's nectar bat	3	0	0	3
Sub-Family: Carollinae					
<i>Carollia brevicauda</i>	Silky short tailed bat	5	2	2	9
<i>Carollia perspicillata</i>	Seba's short tailed bat	3	0	0	3
<i>Rhinophylla pumilio</i>	Dwarf little fruit bat	2	0	0	2
Family: Molossidae					
<i>Molossus molossus</i>	Palla's mastiff bat	0	0	6	6
Family: Mormoopidae					
<i>Pteronotus parnelli</i>	Greater moustached bat	1	0	1	2
TOTAL		15	3	9	27

Table 9: Transect Specific Record of Birds (Via Mist Net) Within the Concession (Dry and Wet Season

SCIENTIFIC NAME	COMMON NAME	FAMILY	DRY SEASON			WET SEASON		
			T1	T2	TOTAL	T1	T2	TOTAL
<i>Thalurania furcata</i>	Fork-tailed Woodnymph	Trochilidae	1		1			
<i>Phaethornis superciliosus</i>	Long-Tailed Hermit	Trochilidae	1		1	1		1
<i>Campylopterus largipennis</i>	Gray Breasted Sabrewing	Trochilidae		1	1	1		1
<i>Myrmeciza athrothorax</i>	Black-throated Antbird	Thamnophilidae	1		1			
<i>Myrmotherula guttaralis</i>	Rufous Bellied Antwren	Thamnophilidae	1	2	3	1		1
<i>Myrmotherula schisticolor</i>	Slaty Antwren	Thamnophilidae	3		3			
<i>Hypocnemoides melanopogon</i>	Black-Chinned Antbird	Thamnophilidae	2	1	3			
<i>Thamnomanes ardesiacus</i>	Dusky Throated Antshrike	Thamnophilidae	1	1	2	1		1
<i>Thamnomanes caesius</i>	Cinereous Antshrike	Thamnophilidae		1	1			
<i>Thamnophilus murinus</i>	Mouse-Coloured Antshrike	Thamnophilidae		3	3	1		1
<i>Hypocnemis cantator</i>	Warbling Antshrike	Thamnophilidae		1	1			
<i>Pithys albifrons</i>	White Plumed Antbird	Thamnophilidae		1	1		2	2
<i>Schiffornis turdina</i>	Thrush-like Schiffornis	Pipridae	1		1	1	1	2
<i>Lepidothrix coronata</i>	Blue-Crowned Manakin	Pipridae	3		3	1		2
<i>Dixiphia pipra</i>	White-Crowned Manakin	Pipridae	2		2	2	2	4
<i>Pipra erythrocephala</i>	Golden-Headed Manakin	Pipridae		1	1			
<i>Corapipo gutturalis</i>	White-Throated Manakin	Pipridae		1	1	1		1
<i>Xenops minutus</i>	Plain Xenops	Furnariidae		1	1			
<i>Hylophilus sp</i>	Greenlet	Vireonidae		5	5			
<i>Mionectes oleagineus</i>	Ochre Bellied Flycatcher	Tyrannidae		1	1			
<i>Myiobius barbatus</i>	Whiskered Flycatcher	Tyrannidae	1		1		2	2
<i>Euscarthmus meloryphus</i>	Tawny Crowned Pygmy Tyrant	Tyrannidae	1	2	3	1		1
<i>Knipolegus poecilurus</i>	Rufous Tailed Tyrant	Tyrannidae					2	2
<i>Euphonia violacea</i>	Violaceous Euphonia	Thraupidae		1	1			
<i>Glyphorhynchus spirurus</i>	Wedge-billed Woodcreeper	Dendrocolapitidae	6	3	9	3	3	6
<i>Xiphorynchus guttatus</i>	Buff Throated Woodcreeper	Dendrocolapitidae		1	1	1		1

SCIENTIFIC NAME	COMMON NAME	FAMILY	DRY SEASON			WET SEASON		
			T1	T2	TOTAL	T1	T2	TOTAL
<i>Cyanocompsa cyanoides</i>	Blue-Black Grosbeak	Cardinalidae				2		2
<i>Galbula albirostris</i>	Yellow-Billed Jacamar	Galbulidae		2	2			
Number of Individuals			24	29	53	17	12	29
Number of Species			12	18	26	13	6	16

Table 10: Birds Recorded Via Point Counts During the Wet and Dry Season Surveys

FAMILY	SCIENTIFIC NAME	COMMON NAME	T1	ACCESS ROAD	T2	TRIP	TOTAL	T1	ACCESS ROAD	T2	TRIP	TOTAL
Accipitridae	<i>Buteo magnirostris</i>	Roadside Hawk		1	1	1	3		1	1		2
Falconidae	<i>Ibycter americanus</i>	Red Throated Caracara		12					9			9
Columbridae	<i>Columba plumbea</i>	Plumbeous Pigeon	1	3		8	12		2			2
	<i>Patagioenas cayennensis</i>	Pale-vented Pigeon				7	7					
Cotingidae	<i>Lipaugus vociferans</i>	Screaming Piha	6	19	13	3	41	1		5	8	14
Cuculidae	<i>Coccyzus americanus</i>	Yellow-Billed Cuckoo			1		1					
Dendrocolapitidae	<i>Xiphorynchus guttatus</i>	Buff Throated Woodcreeper			3		3			1		1
	<i>Glyphorhynchus spirurus</i>	Wedge-billed Woodcreeper	4	8	6		18	2	1	2		5
Apodidae	<i>Chaetura spinicaudus</i>	Band-rumped Swift				9	9		2			2
Picidae	<i>Campephilus rubricollis</i>	Red-necked Woodpecker	1		1		2		1			1
	<i>Celeus elegans</i>	Chestnut Woodpecker			1		1				1	1
Pipridae	<i>Schiffornis turdina</i>	Thrush-like Schiffornis	4	3	3		10	2	1			3
	<i>Dixiphia pipra</i>	White-crowned Manakin	2	6	2		10	1	3	2		6

Psittacidae	<i>Amazona amazonica</i>	Orange-Wing Parrot	18	36			54	5	42			47
	<i>Pionus menstruus</i>	Blue-headed Parrot	6	12			18		17			17
	<i>Ara macao</i>	Scarlet Macaw						3				3
	<i>Brotogeris chrysoptera</i>	Golden-winged Parakeet	6	3			9		2			2
Cracidae	<i>Crax alector</i>	Black Curassow			2		2		2	1		3
Ardeidae	<i>Bubulcus ibis</i>	Cattle Egret							2			2
Psophiidae	<i>Psophia crepitans</i>	Gray Winged Trumpeteer			6		6					
Strigidae	<i>Pulsatrix perspicillata</i>	Spectacled Owl	1				1			1		2
Thamnophilidae	<i>Cercomacra cinerascens</i>	Gray Antbird	1	7	3		11					
	<i>Myrmoborus leucophrys</i>	White Browed Antbird		5	1		6		2			2
	<i>Hypocnemis cantator</i>	Warbling Antbird	2	6	4	2	14	1	5			6
	<i>Hypocnemoides melanopogon</i>	Black Chinned Antbird	1	7	2		10		4			4
	<i>Pithys albifrons</i>	White Plumed	1		3		4			2		2

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		Antbird											
	<i>Myrmeciza longipes</i>	White Bellied Antbird	1	2	4	1	8		1	3	1		5
	<i>Myrmornis torquata</i>	Wing Banded Antbird		1	6	1	8						
	<i>Chamaeza campanisona</i>	Short Tailed Anthrush	3				3	1					1
	<i>Grallaricula nana</i>	Slate Crowned Antpitta		2	2		4	1	1	1			3
	<i>Myrmeciza ferruginea</i>	Ferruginous Back Antbird	2	10	7		19	1	5	2			8
	<i>Thamnomanes caesius</i>	Cinereous Antshrike	3	8	11		22						

	<i>Cercomacra tyrannina</i>	Dusky Antbird	1	4	5		10					
	<i>Hylophylax poecilonota</i>	Rufous-throated Antbird		7			7		2			2
	<i>Dichrozona cinta</i>	Scale-backed Antbird	2	9			11	1	7			8
	<i>Myrmeciza athrothorax</i>	Black Throated Antbird	2	3	1		6	1	1	1		3
	<i>Myrmotherula gutturalis</i>	Brown Bellied Antwren	2		5		7		1	2		3
	<i>Myrmotherula schisticolor</i>				7		7			1		1
	<i>Thamnomanes ardesiacus</i>			4	2		6		2			2
	<i>Thamnophilus murinus</i>			3	6		9			4		4
	<i>Thamnophilus amazonicus</i>	Amazonian Antshrike		4	1		5		1	1		2
Thraupidae	<i>Euphonia violacea</i>	Violeceous Euphonia			2		2					

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	<i>Cyanerpes caeruleus</i>	Purple Honeycreeper	2	4	9		15					
Trochilidae	<i>Phaethornis superciliosus</i>	Long Tailed Woodnymph	2		3		5					
Trogonidae	<i>Trogon rufus</i>	Black-throated Trogon		5	1	2	8		2			2
Tyrannidae	<i>Lophotriccus galeatus</i>	Zimmer's Flycatcher	1	3			4		1			1
	<i>Tolmomyias assimilis</i>	Olivaceous Flatbill		1	1		2					
	<i>Rhynchocyclus olivaceus</i>	Whiskered Flycatcher		4	2		6					
	<i>Myiobius barbatus</i>	McConnell's Flycatcher	2	3	1		6			1		1

	<i>Mionectes macconnelli</i>	White-throated Spadebill	1	2	13		16					
	<i>Mionectes oleagines</i>	Ochre Bellied Flycatcher			4		4					
	<i>Platyrinchus mystaceus</i>	Yellow-throated Flycatcher		4			4					
Vireonidae	<i>Hylophilus sp</i>	Greenlet			12		12					
	<i>Hylophilus muscicapinus</i>	Buff-cheeked Greenlet			11		11					
TOTAL Number of Individuals			7 8	211	16 8	34	479	20	120	31	10	182
TOTAL Number of Species			27	34	3 9	10	51	11	24	17	3	37

**Table 11: Transect Specific Record Of Herptofauna Within The Concession
AMPHIBIANS**

SPECIES	COMMON NAME	DRY SEASON							WET SEASON						
		T1 Forest	T1 Road	Access Road	T2 Forest	T 2	Airst rip	TOT AL	T1 Forest	T1 Road	Access Road	T2 Forest	T 2	Airst rip	TOT AL
AROMOBATID															
AE															
<i>Allobates femoralis</i>	Brilliant-thighed Poison Frog					6		6	4			5			9
BUFONIDAE															
<i>Rhaebo nasicus</i>	Werner's Toad										4			4	
<i>Rhaebo guttatus</i>	Smooth Side Toad		2			1	1	4		3	4	2	2	2	13
<i>Rhinella marina</i>	Giant Marine Toad		5	2		5	4	16		11	21	37	9	82	160
DENDROBATI															
DAE															
<i>Ameerega trivittata</i>	Three-striped Poison Arrow Frog				2			2	3	6		2			11
HYLIDAE															
<i>Hypsiboas boans</i>	Giant Gladiator		13	10		2	4	29		2	7	4			13
<i>Hypsiboas crepitans</i>	Rattle-voiced Treefrog	4	3		1	6		14		17	34	31			82

<i>Osteocephalus buckleyi</i>				1		1		2					1		1
<i>Osteocephalus taurinus</i>	Manaus Slender-legged Treefrog			3	1	4		8		1		1			2
<i>Phyllomedusa trinitatis</i>						1		1				9		2	11
<i>Phyllomedusa bicolor</i>	Waxy Monkey Frog									2		2	1		5
<i>Pseudis paradoxa</i>	Paradox Frog		14	17		6		37		7	23	7	1	1	48
<i>Scinax ruber</i>	Red Snouted Treefrog		16		3	57	47	123		52	23	57	1	63	214
												9			

<i>Scinax nebulosus</i>	Spix's Snouted Treefrog												2			2
<i>Trachycephalus resinifictrix</i>	Cacique-Headed Treefrog		3	2	3	3	2	13		6	5	2				13
<i>Dendrosophus marmoratus</i>	Marbled Treefrog	1	4	9	2	28		44		3		2				5
LEPTODACTYLIDAE																
<i>Leptodactylus petersii</i>	Peter's Thin-Toed Frog					7		7								
<i>Leptodactylus knudseni</i>	Knudsen's Thin-toed Frog		1	2	2	2		7		11	7	2	8	5		33
<i>Leptodactylus mystaceus</i>	Amazon Basin White-lipped Frog	1			2	3		6	1				3			
MICROHYLIDAE																3
<i>Ctenophryne geayi</i>						2		2				3				
TOTAL INDIVIDUALS		6	61	46	16	13	58	32	8	121	124	169	5	154	629	
TOTAL - # of		3	9	8	8	16	5	17	3	12	8	17	8	5	19	

SPECIES															
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REPTILES

SPECIES	COMMON NAME	DRY SEASON							WET SEASON						
		T1 Fores t	T1 Roa d	Access Road	T2 Fores t	T2 Roa d	Airs trip	TOT AL	T1 Fores t	T1 Roa d	Access Road	T2 Fores t	T2 Roa d	Airs trip	TOT AL
POLYCHROTID AE															
<i>Anolis chrysolepis</i>	Goldenscale Anole				1	2		3							
<i>Anolis fuscoauratus</i>	Slender Anole					1		1					1		1
TEIIDAE															
<i>Kentropyx calcarata</i>	Striped Forest Whiptail	1	3	5		2	7	18		3	7	8		5	23

<i>Ameiva ameiva</i>	South American Ground Lizard		7	1	2	6	16	32		4	1	2		8	15
GEKKONIDAE															
<i>Gonotodes humeralis</i>		1						1	1						1
<i>Thecadactylus rapicauda</i>	Turnip-tailed Gecko		1		1	1		3				1			1
GYMNOPHTHALMIDAE															
<i>Lepasoma sp</i>		1						1							
SCINCIDAE															
<i>Copeoglossum nigropunctatum</i>	Black Spotted Skink											3	2		5
COLUBRIDAE															
<i>Siphlophis compressus</i>	Tropical Flat Snake								1	2	1	1			5
<i>Leptophis ahaetulla</i>	Parrot Snake								1						
<i>Liophis miliaris</i>	Common Water Snake					1		1							
<i>Pseudoboa</i>	Crowned False Boa								1						1

<i>coronata</i>															
VIPERIDAE															
<i>Bothrops atrox</i>	Common Lancehead								2	1			1		4
ALLIGATORID															
AE															
<i>Paleosuchus palpebrosus</i>	Cuvier's Dwarf Caiman			1					2					1	3
Number of Individuals		3	11	7	4	13	23	61	3	13	10	12	5	16	59
Number of Species		3	3	2	3	6	2	9	3	5	4	4	3	4	10

Table 12: Transect Specific Record of Terrestrial Macro-Invertebrates Within the Concession

FREQUENCY CODES

U – Small numbers recorded – not more than one or two individuals (uncommon)

F – Less than 5 individuals recorded for the day (fairly common)

C – Observed between five to ten individuals for the day (common)

A – Observed more than ten individuals for the day (abundant)

A1 AND A2 are opportunistic transect locations sampled within the concession that exhibited micro-habitat cues/features

TERRESTRIAL MACRO-INVERTEBRATES – DRY SEASON

VERNACULAR NAME	ORDERS	SITES			
		T1	T2	A1 (OLD CAMP GROUND) BAT HOLE	A2 CURRENT CAMP GROUND
Mites and Ticks	Acari	A	A	A	A
Segmented Worms	Annelida	U	-	U	-
Spiders	Araneae	C	A	F	C
Cockroaches	Blattidea	A	A	A	A
Centipedes	Lithobiomorpha	-	U	-	-
Beetles	Coleoptera	U	U	F	U
Millipedes	Callipodida	C	F	C	A
True Flies	Diptera	A	A	A	A
True Bugs	Hemiptera	U	U	U	U
Bees, Wasp and Ants	Hymenoptera	A	A	A	A
Termites	Isoptera	A	A	A	A
Butterflies, moths and skippers	Lepidoptera	A	A	A	A
Praying Mantis	Mantodea	U	-	-	-
Dragon and Damselflies	Odonata	A	A	A	A
Crashoppers, locusts, crickets and katydids	Orthoptera	F	A	C	A
Stick Insects	Phasmidae	-	U	-	-

TERRESTRIAL MACRO-INVERTEBRATES – WET SEASON

VERNACULAR NAME	ORDERS	SITES				
		T1	T2	(OLD CAMP GROUND) BAT HOLE	(BASE CAMP)	MAIN ACCESS ROAD TO BASE CAMP TRANSECT START: 21 N 0233301/UTM 0717224 TRANSECT END: 21 N 0231612/ UTM 0717170
Mites and Ticks	Acari	F	A	A	A	A
Segmented Worms	Annelida	-	-	-	-	-
Spiders	Araneae	C	A	F	A	A
Cockroaches	Blattidea	A	A	A	A	A
Centipedes	Lithobiomorpha	-	-	-	-	-
Beetles	Coleoptera	C	C	C	F	A
Millipedes	Callipodida	F	A	U	C	A
True Flies	Diptera	A	A	A	A	A
True Bugs	Hemiptera	U	F	F	F	F
Bees, Wasp and Ants	Hymenoptera	A	A	A	A	A
Termites	Isoptera	A	A	A	A	A
Butterflies, moths and skippers	Lepidoptera	F	F	F	F	A
Praying Mantis	Mantodea	-	-	-	-	-
Dragon and Damselflies	Odonata	C	C	F	U	A
Crashoppers, locusts, crickets	Orthoptera	C	A	F	A	A
Stick Insects	Phasmidae	-	U	-	F	-
Scorpiones		U	-	-	-	U

Table 13: Transect Specific Record of Fish Within the Concession

FAMILY	SCIENTIFIC NAME	COMMON NAME	DRY SEASON	WET SEASON			
			# INDIVIDUALS	AQ1	AQ-a	AQ-b	AQ-c
Characidae	<i>Moenkhausia sanctaefilomenae</i>	Serebe	3				
	<i>Roeboides descalvadensis</i>	Scale Eater	2				
	<i>Astyanax bimaculatus</i>	Serebe	11				
	<i>Moenkhausia sp</i>	Serebe	-	13		1	
	<i>Phenacogaster sp</i>	Cacabelly	-	1			
	<i>Charax gibbous</i>	Broke Neck	-	1		1	
	<i>Bryconops colaroja</i>	Cacabelly	-	10			
	<i>Moenkhausia chysargyrea</i>	Serebe	-	1		1	
Curimatidae	<i>Cyphocharax spilurus</i>	Cacabelly	-			3	
Prochilodontidae	<i>Prochilodus nigricans</i>	Silverfish	1				
	<i>Prochilodus sp</i>	Silverfish	-			1	
Iguanodectidae	<i>Bryconops sp.</i>	Red Tail Tetra	2				
Anostomidae	<i>Leporinus sp.</i>	Daray	1	2			
Gasteropelecidae	<i>Gasteropelecus sternicla</i>	Hatchet fish	3				
	<i>Thoracocharax stellatus</i>	Hatchet Fish	-	4		4	
Erythrinidae	<i>Hoplias sp.</i>	Huri	5				
	<i>Hoplerythrinus unitaeniatus</i>	Yarrow	1				
	<i>Hoplias malabaricus</i>	Huri	-	1	1	3	
Poeciliidae	<i>Poecilia reticulata</i>	Goupy	-				1
Sternopygidae	<i>Eigenmannia virescens</i>	Night fish	-	7			
Cichlidae	<i>Cichlasoma amazonarum</i>	Patwa	10				
	<i>Guianacara cuyunii</i>	Patwa	6				
	<i>Crenicichla alta</i>	Sun fish	2				
	<i>Aequidens tetramerus</i>	Patwa	-	2		2	
	<i>Apistogramma sp</i>	Patwa	-	14			
Loricariidae	<i>Rineloricaria sp.</i>	Whip tail Catfish	2	1			
	<i>Hypostomus sp.</i>	Smoke Hassa	7				
	<i>Ancistrus leucostictus</i>	Spottedblack hassa	-	1			1
Pimelodidae	<i>Pimelodella cristata</i>	Kassie	11				
	<i>Pimelodus ornatus</i>	Ornate Pim Catfish	1				
Heptapteridae	<i>Rhamdia quelen</i>	Kassie	2				

	<i>Pimelodilla sp</i>	Ornate Pim Catfish	-	3			
Callichthyidae	<i>Callichthys sp.</i>	Hassa	2				
	<i>Megalechis thoracata</i>	Hassa	-			7	
Trichomycteridae	<i>Henonemus taxistigmus</i>	Soft Body Catfish	-	1			
	<i>Ituglanis cf metae</i>	Vandilia	-	1			
Synbranchidae	<i>Synbranchus marmaratus</i>	Eel	-			1	
		TOTAL	72	62	1	24	2